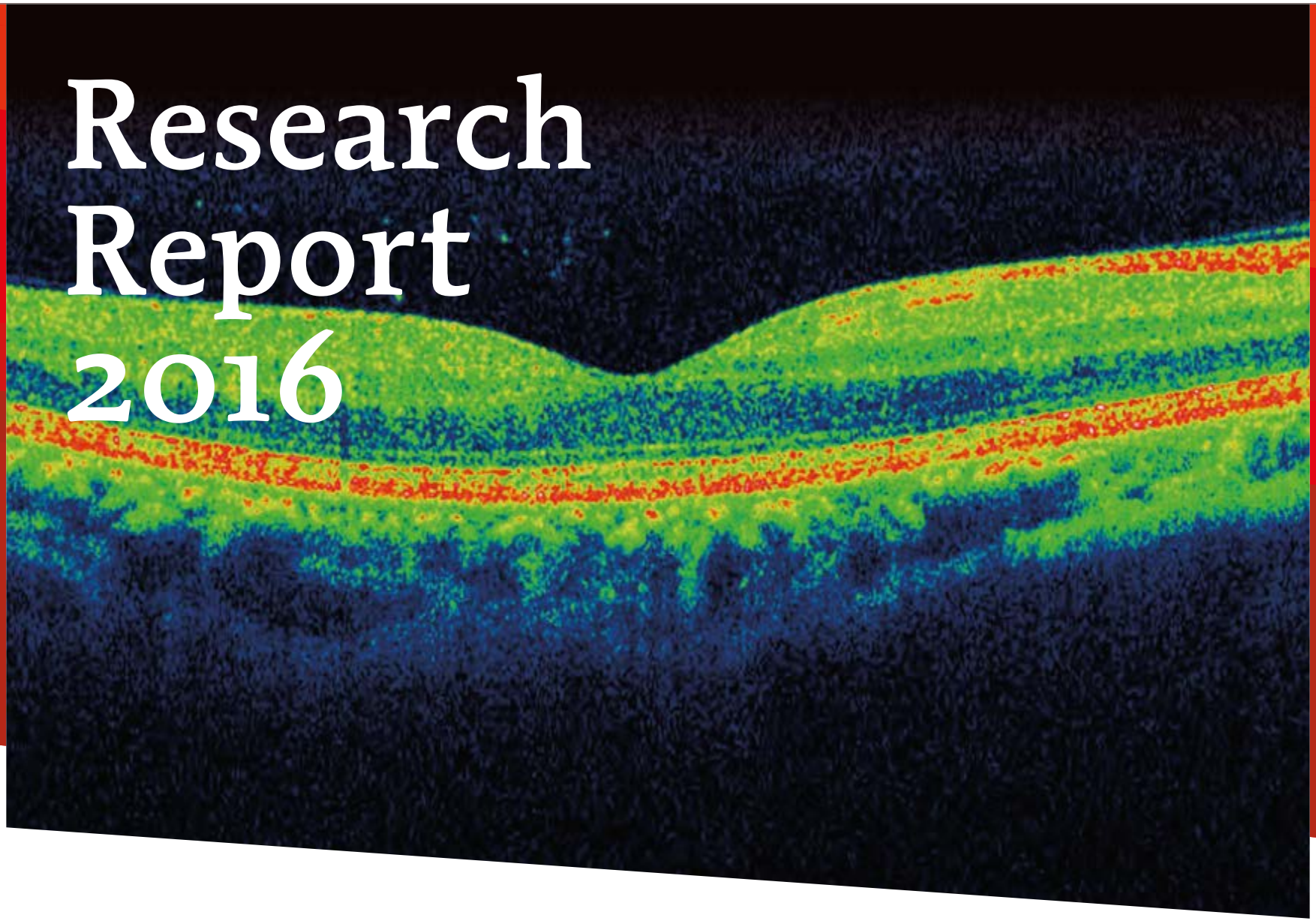
Research Report 2016



Radboud University

Cover photo: Optical Coherence Tomography (OCT) is a non-invasive research method for use with partly reflective materials with which images (cross-sections) can be constructed. The method is comparable with echography, but based on light instead of sound. OCT is often used in ophthalmology to study the retina of an eye. The resolution is as small as 10 µm; hence tiny details can be made visible. The picture shows an OCT scan (cross-section) of a healthy retina showing – in the middle – the macula: the part which enables an eye to see small details. Professor Anneke den Hollander (Molecular Ophthalmology) is an expert in age-related macular degeneration. She has identified most of the genetic causes of congenital blindness. A major achievement in her recent work was identifying defects in the complement system in age-related macular degeneration, the most common cause of vision loss in the elderly.

Research Report 2016

Radboud University

The Harvesters. A painting by Pieter Brueghel the Elder (1525-1569).

Preface

If we were looking for just two words to sum up how far we've come in 2016, they would be HARVEST TIME. After 'sowing' numerous investments designed to enhance the quality of our research and our state-of-the-art facilities, we can now see the fruits of our labour. Perhaps most impressive was the fact that our scientists received two prestigious NWO Spinoza Prizes and two ERC Advanced Grants last year. But there were also research breakthroughs in a wide range of disciplines. Significantly, many of these successes can be attributed to our younger academics, who obtained no less than four NWO Vici Grants and five ERC Consolidator Grants in 2016. We are happy to report that these exciting successes took place right across the campus.

As a broad, internationally oriented, student-centred university, education and research are closely intertwined in everything we do. This not only benefits individual students who are pursuing a scientific career, but also strengthens our research by bringing in diverse perspectives.

In this version of our annual Research Report we present the most significant results and developments at our university in 2016. This year, you can find the full reports on each of our 15 Research Institutes in PDF form on our website www.ru.nl/researchreport, where a digital version of this report is also available.

By publishing this report we account for the resources that society has allocated to us. It also confirms that we have been successful in achieving our ambitions and that we are in good shape to make further advances in the future.

Wilma de Koning-Martens, MSc
Vice-president

Professor Han van Krieken
Rector Magnificus

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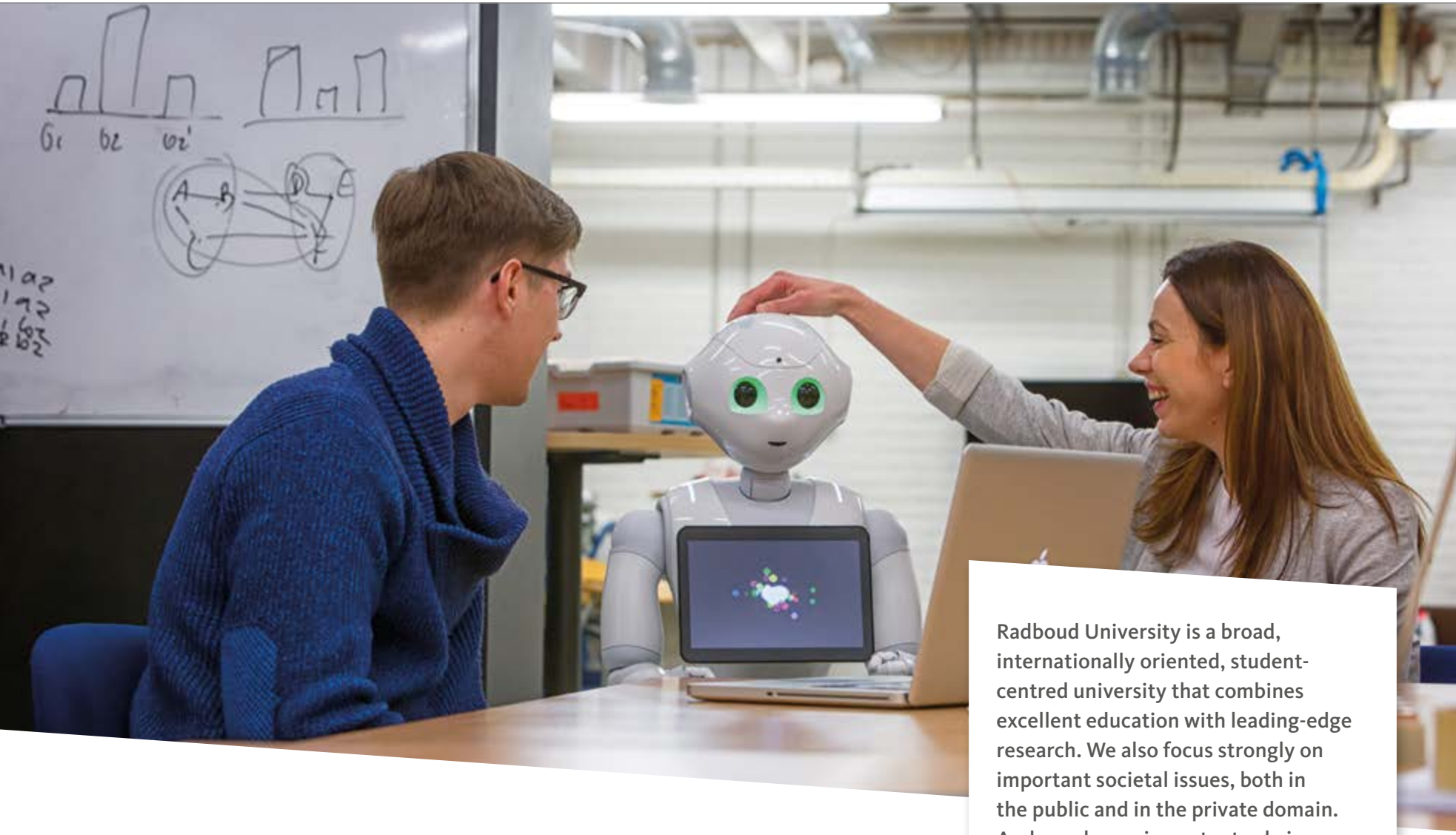


Radboud University is a broad, internationally oriented, student-centred university that combines excellent education with leading-edge research. We also focus strongly on important societal issues, both in the public and in the private domain. And we play an important role in transferring knowledge to society. Regional entrepreneurs also benefit from our activities.

Our ambition

We aim not only to stay in the top echelons of universities in the Netherlands, but also to be among the very best in Europe. And, at the global level, we expect to see increasing recognition of our capabilities. We will therefore further consolidate and improve the quality of our research, based on the significant progress we have achieved in the past. In addition, we will intensify the impact of our research, particularly internationally. We will also strengthen our collaboration with strategic partners, both in the university context and in other parts of society. A key aim is to ensure we continue to employ highly talented staff and that there is an optimal climate for performing high-quality research. In 2016 we again made good progress towards achieving these aims.

Professor Han van Krieken

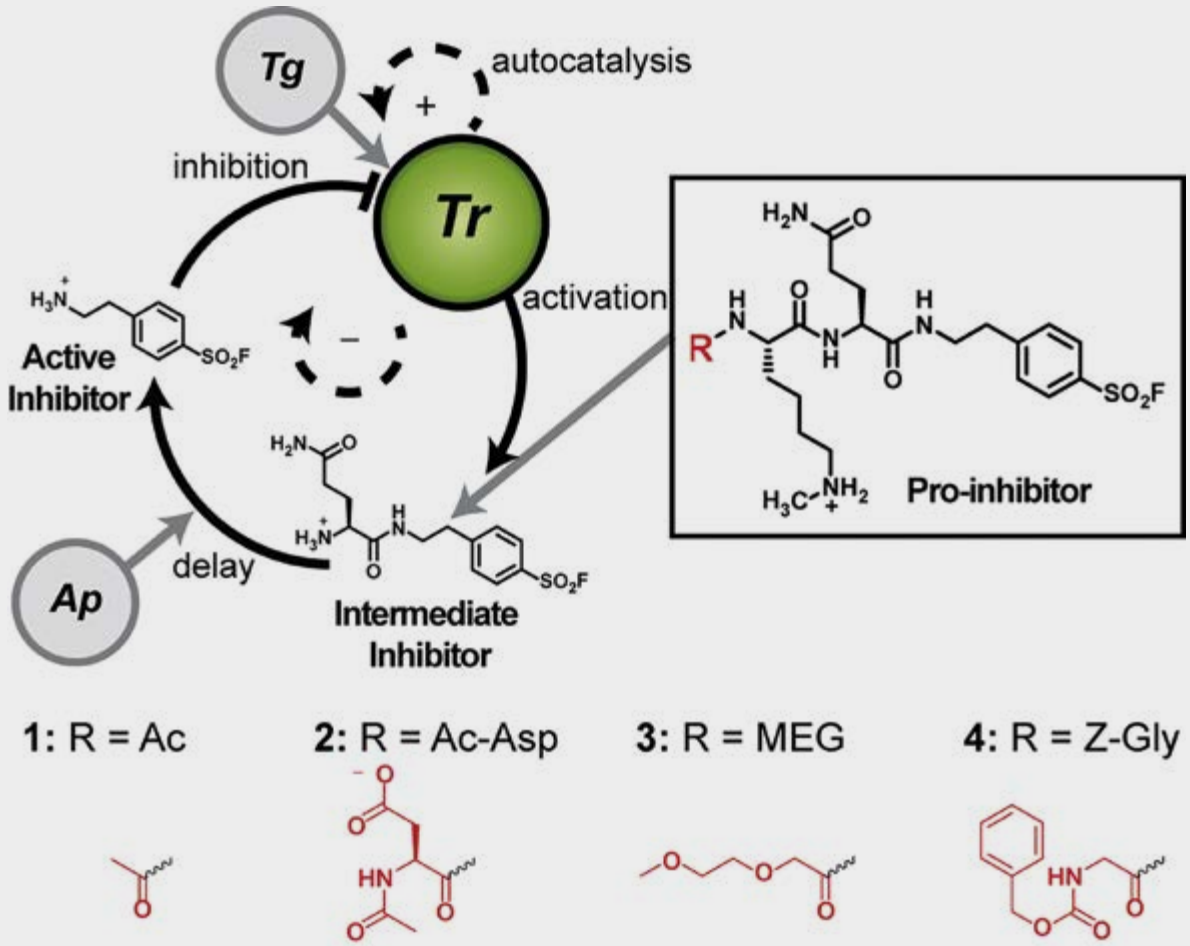
Since May 2016, Prof. Han van Krieken has been *Rector Magnificus* of the University. Professor van Krieken (General Pathology) is a prolific, well regarded researcher in Pathology, particularly in relation to tumours. As former President of the European Society of Pathology, he is a key player in the discipline. He connects Pathology with other disciplines, such as Oncology, Surgery and Gastroenterology and thus contributes to building European networks. Within the Radboudumc he held various managerial positions, including Director of the Oncology Research Institute and chair of the committee that recently re-organised the research institutes. He is a Member of the *Academia Europaea* and the German Academy of *Sciences Leopoldina*.

Professor Gerard Meijer

Professor Gerard Meijer left the University after serving for more than four years as President of the Executive Board. During his presidency he made some important improvements. For instance, he founded the Radboud Excellence Initiative and enabled participation in European networks such as the *European Magnetic Field Laboratory (EMFL)* and *The Guild*. He also encouraged greater awareness of interdisciplinary collaboration, for example through the *Healthy Brain* initiative. Finally, he served the entire Dutch academic community by strongly promoting Open Access publishing, including negotiating with major publishers of academic journals on behalf of the Association of Universities in the Netherlands (VSNU). Since January 2017, Prof. Gerard Meijer has been reappointed as Director of the *Fritz Haber Institute of the Max Planck Society* in Berlin.

Our academic profile

Research at the university is carried out in 15 dedicated institutes. These are responsible for planning the best way to advance research programmes as well as for training and supervising researchers. We do our best to ensure that all programmes within the institutes remain competitive internationally and that they make a strong contribution within the research communities in which we operate. These institutes are peer reviewed according to national research evaluation guidelines every six years. Ten sub-disciplines have been identified where the quality is even higher than the level achieved by researchers in the rest of the university. On the following pages these areas are explained in more detail.



Organic Chemistry

The key focus area within Chemistry is Organic Chemistry and other strong fields are Material Science, Life Science, Biomedical Science and Supra-Molecular Chemistry. In particular we concentrate on Synthesis, Physical Organic Chemistry and the Life Sciences. Most of the latter research takes place at the Institute for Molecules and Materials, but it also includes the Radboud Institute for Molecular Life Sciences. The research infrastructure and facilities in both institutes are excellent. Numerous prestigious grants awarded over the years reflect the high quality of the research in Organic Chemistry. These include ERC Grants, NWO Spinoza Prizes, Vici grants and – together with the Eindhoven University of Technology and the University of Groningen – one of the 12 highly prestigious 'Gravitation' programmes for major projects that will be extended for at least 10 years. In 2016, the international peer review committee that assessed IMM concluded that the quality of research within the theme Molecular Life-like Systems is '*world leading and excellent*'.

Some highlights

- Dr Daniela Wilson and her team (Bio-organic Chemistry) developed nanorockets with a molecularly built temperature-responsive braking system consisting of brushes made of polymers, enabling the rockets to start and stop at desired locations. (Nature Chemistry).

- The group led by Prof. Roeland Nolte (Molecular Nanotechnology), in collaboration with Prof. He Tian and colleagues at the East China University of Science and Technology in Shanghai, China, has developed a new supra-molecular system which displays tunable multicolour photoluminescence, including the emission of pure white light *(J. Am. Chem. Soc.)*.

- Prof. Alessandra Cambi and her colleagues analysed how dendritic cells probe their environment via podosomes. Unravelling the architecture and dynamics of protrusive structures may provide novel leads which can improve the specificity and efficacy of experimental anti-cancer therapies (Meddens *et al. Nature Communications, 2016*).

Prof. Wilhelm Huck (Professor of Physical Organic Chemistry) received an NWO Spinoza Prize in 2016, the highest recognition for scientific achievements in the Netherlands. He has previously received an ERC Advanced Grant.

More information Institute for Molecules and Materials, www.ru.nl/imm, Radboud Institute for Molecular Life Sciences, www.rimls.nl

EXAMPLE OF SOCIETAL IMPACT

Valorisation via the spin-off Protinhi Therapeutics

The virus family *Flaviviridae*, of which the dengue virus is a member, also includes West Nile, Yellow fever, Hepatitis C and Zika. Dengue virus is responsible for the most arboviral infections in tropical and sub-tropical regions, with up to 390 million cases annually worldwide. Its symptoms are a strong fever, headache, and aching muscles and joints, which can progress to serious complications such as internal bleeding and organ failure (affecting 25-60 million people/year) and ultimately death (25,000 victims/year).

The proteases of dengue and other pathogens play a role in infection by insect-borne viruses (arboviruses). Proteases are important targets in many clinical applications, including diseases such as dengue. To date, effective protease inhibitors designed to reduce the virus load have not been available. The research group led by Dr Martin Feiters, however, has made a serendipitous discovery of a set of compounds that may have a medical application as a novel scaffold of protease inhibitors.

In the infection process, the viral RNA is expressed as a membrane-bound polyprotein, from which the virus's structural (capsid) and non-structural ('NS', enzymes, including protease NS3) proteins are liberated by concerted action of viral and host proteases (Figure 1). Indeed some of these compounds were found to be strong inhibitors of the protease of the dengue virus. A patent application has been filed based on these results and the Synthetic Organic Chemistry group at the Institute of Molecules and Materials has joined forces with researchers from Erasmus MC and entrepreneur Dr van Buuren to found *Protinhi Therapeutics* in order to further develop this compound class into drugs to combat the diseases mentioned above. This spin-off company is now established at the Novio Tech Campus in Nijmegen.
In the framework of a Pre-Seed grant, the newly discovered compounds were further developed so that they specifically target the viral protease rather than the host protease. Further research grants and Pre-Seed and Proof-of-Concept grants were acquired and recently, IMM – together with *Protinhi Therapeutics* (among other partners) – have set up a new public-private consortium, which has applied for an EU EFRO grant.

> ***"The ultimate goal is to reduce the enormous societal impact of Dengue and Zika."***

There will be further developments in the years ahead and additional grants and investments are expected which will bring the ultimate goal of reducing the enormous societal impact of Dengue and Zika closer. The aim is to treat the many millions of cases annually which currently represent a huge unmet medical need.

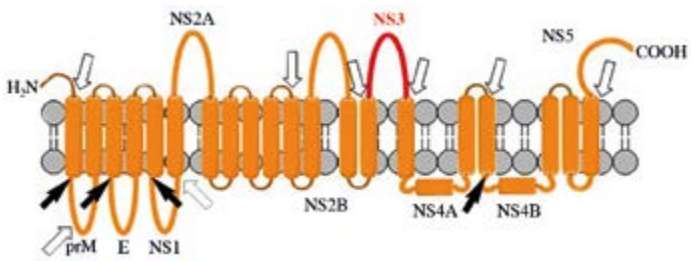
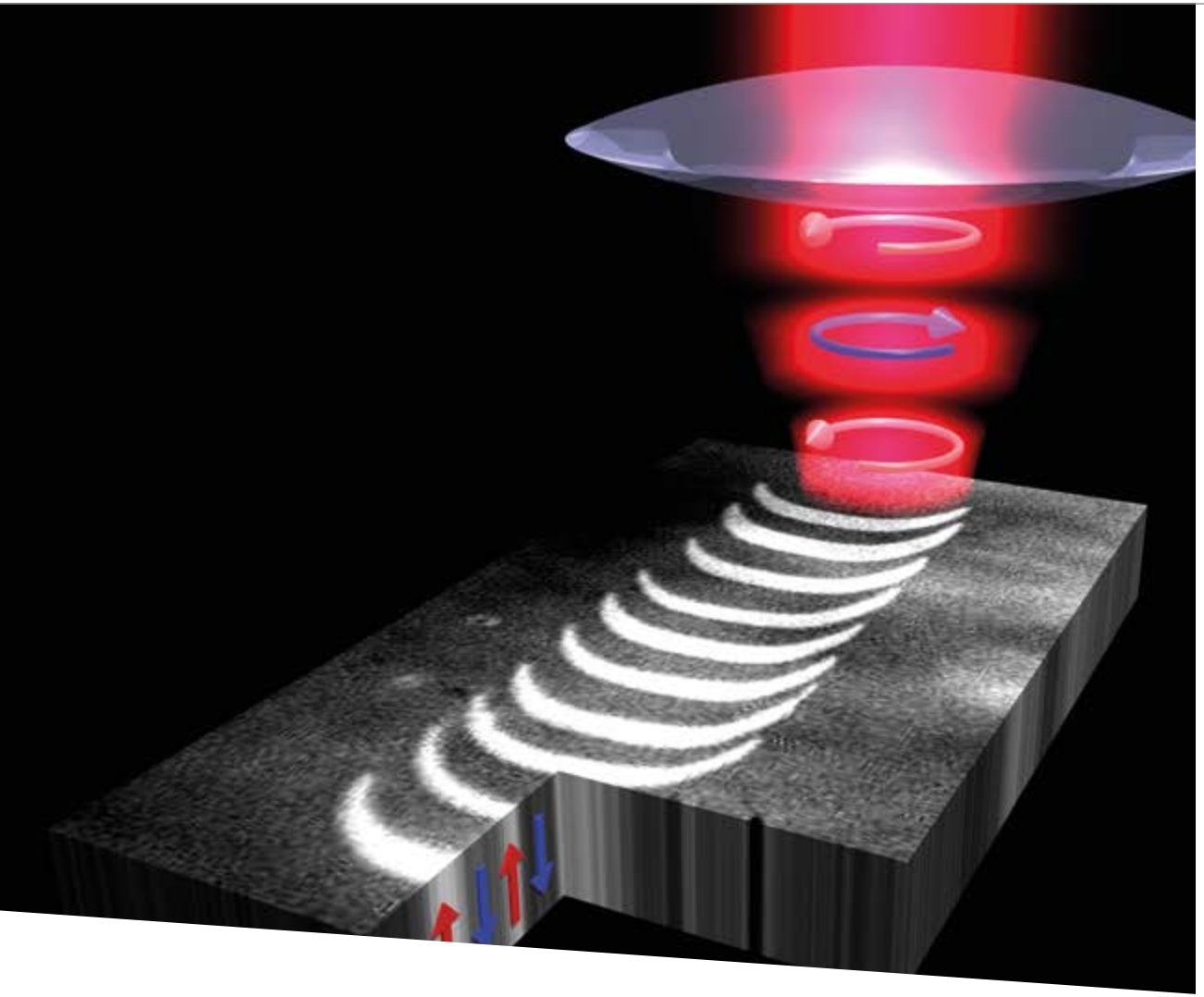


Figure 1. Membrane-bound dengue polypeptide (orange), with viral protease NS3 highlighted in red, and cleavage sites for viral (open arrow) and host (closed arrow) protease (adapted from Leung *et al*., 2001; Bollati *et al*., 2010).



Physics of Condensed Matter

Closely related to research in Chemistry is work on the Physics of Condensed Matter. Our researchers contribute to the Dutch national programmes Nanoned and Nanonext, as well as to various EU programmes. International cooperation is excellent, for example employing our unique infrastructure, including the High Field Magnet Laboratory (HFML) and three advanced Free-electron Laser Units (FELIX/FELICE/FLARE). We lead worldwide in Experimental Physics of Condensed Matter and Theoretical Physics of Condensed Matter. The work on graphene, involving cooperation between experimental and theoretical physicists, formed the basis for the 2010 Nobel Prize in Physics, which was awarded to Extraordinary Professors André Geim (formerly an Associate Professor) and Konstantin Novoselov (a PhD graduate from the University). The award of NWO Spinoza Prizes and ERC Advanced Grants also demonstrates the strong reputation of our research in this field. Since 2013, the Netherlands' Magnetic Resonance Research School – a collaborative venture with colleagues from the Universities of Utrecht, Wageningen, Leiden, and Eindhoven – has provided a perfect platform for training young researchers. In 2016, the international peer review committee that assessed IMM concluded that the quality of research within the theme Quantum Matter is '*world leading and excellent...*' and added: *'they largely surpass international standards'*.

Manipulation of magnetic polarity using laser technology.

Some highlights

- Prof. Bas van de Meerakker and his colleagues (Spectroscopy of Cold Molecules) measured irregular diffraction patterns for inelastic collisions between NO radicals and rare gas atoms. These patterns revealed a new type of quantum stereodynamics that has no classical analogue or interpretation (Nature Chemistry).

- The Molecular Structure and Dynamics (MSD) group led by Prof. Jos Oomens uses the radiation from FELIX to record IR spectra of a wide variety of ultra-low density samples in tandem mass spectrometers. The IR spectra provide detailed information on molecular structures that is not available from the mass spectra alone (*Nature Communications*).

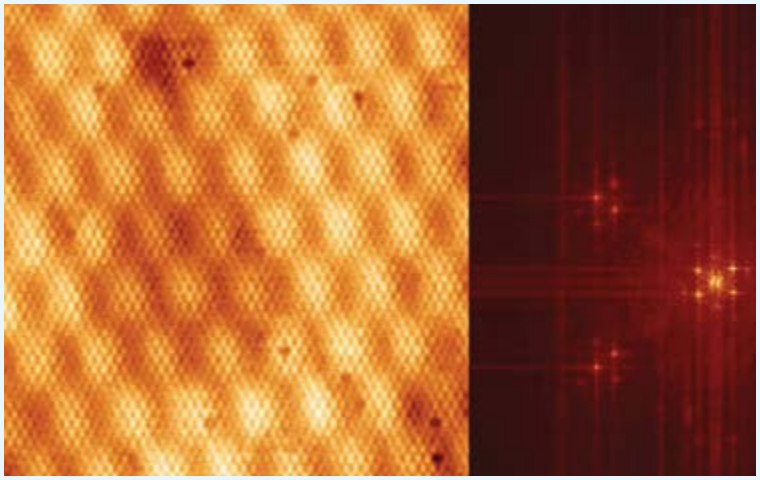
Prof. Mikhail Katsnelson (Professor of Theory of Condensed Matter) is the recipient of an NWO Spinoza Prize and an ERC Advanced Grant. In 2016 he won the Hamburg Prize for Theoretical Physics.

More information Institute for Molecules and Materials, www.ru.nl/imm

EXAMPLE OF SOCIETAL IMPACT

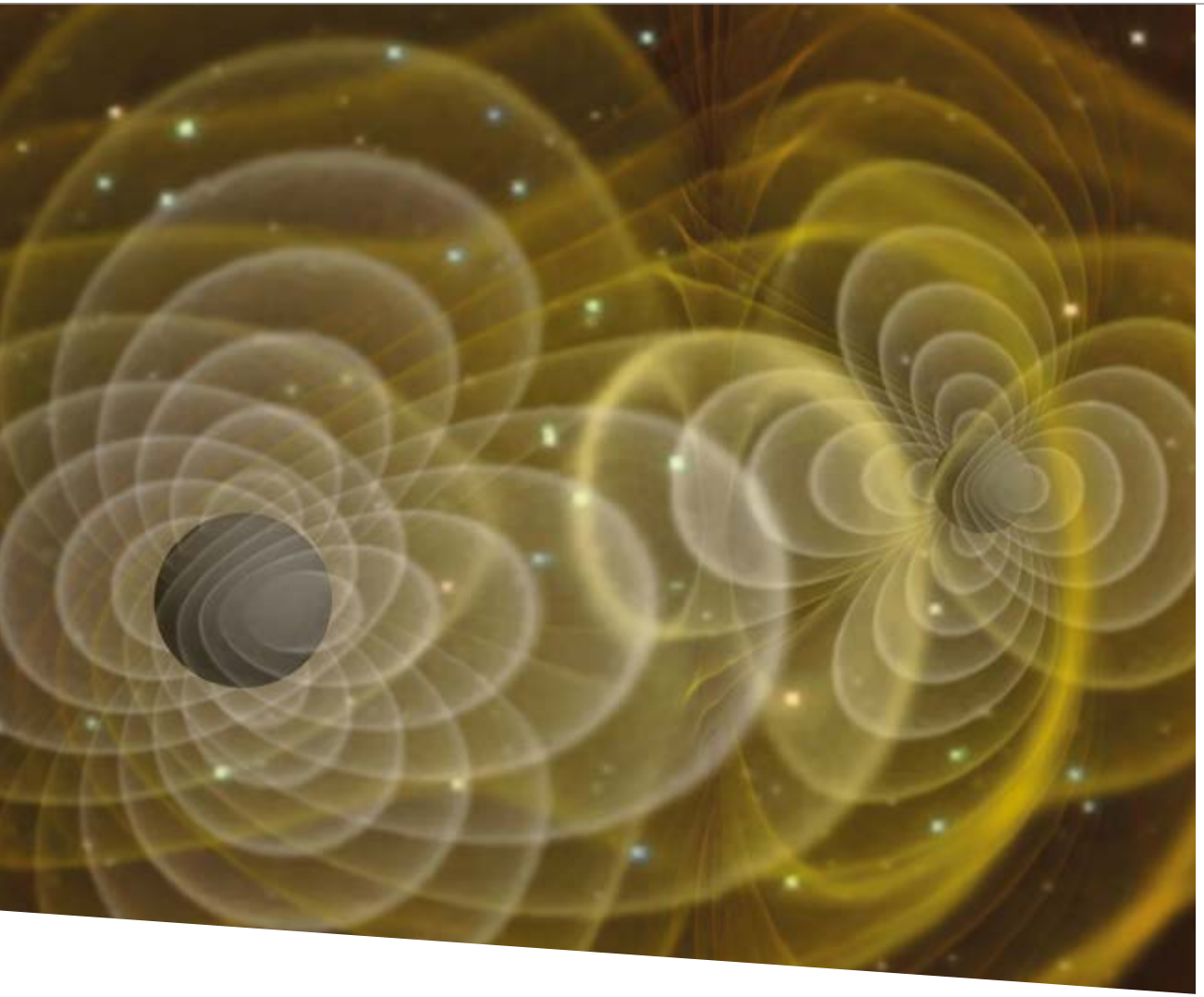
Energy efficient Al-Optical Magnetic Storage

While data has become an indispensable part of modern society, the data generated every second is growing enormously, both in its volume and in its content (texts, pictures, videos, music, etc.). This is not only pushing current data storage technologies to their limits, but also making excessive demands on energy production: data centres already consume around 5% of global electricity. With an annual increase of 7%, this is rapidly becoming unsustainable. The research team led by Prof. Theo Rasing discovered that magnetisation reversal using a single femtosecond laser pulse *in principle* provides an alternative, fast, novel, energy-efficient approach to magnetic recording. By using plasmonic antennas they have recently scaled this all-optical magnetic switching (AOS) to the nanoscale, demonstrating the potential of storing data using less than 20 femto-Joule per bit, which is more than three orders of magnitude less than current technologies. Achieving the current today's laboratory results requires large experimental set-ups and infrastructure. To move towards the practical implementation of AOS, the team is currently working within a European consortium on a novel integration platform that combines photonic, magnetic and electronic components (Spintronic-Photonic Integrated Circuit platform for novel Electronics; SPICE). The aim of SPICE is to create a conceptually new spintronic-photonic memory chip demonstrator, with three orders of magnitude higher write speed and two orders of magnitude lower energy consumption than state-of-the-art spintronic memory technologies. Other materials may even lead to a further reduction. The team's approach may also lead to new ways of energy-efficient spin-based logic, making it possible to address the challenge of reducing the energy consumption of computer processors as well.



An atomically resolved single layer of TaS_2, a new 2-dimensional material on top of an Au(111) surface.

"Magnetisation reversal using a single femtosecond laser pulse in principle provides an alternative, fast, novel, energy-efficient approach to magnetic recording."



Astrophysics

For many decades now, researchers in the Netherlands have played a leading role in astrophysical research. Since 2001, when a group of highly talented researchers came to the University, this research – which focuses on the evolution of double stars, compact objects and astrophysical particles – has become highly competitive internationally. The quality of the research is reflected in the successful acquisition of prestigious grants such as ERC Advanced grants, the NWO Spinoza Prize and an ERC Synergy grant.

3D-visualization of gravitational waves created by two orbiting black holes.

Some highlights

- Prof. Renate Loll has made significant progress in understanding the phase structure of Causal Dynamical Triangulations, in particular, the properties of the newly discovered bifurcation phase. There is good evidence that the associated new phase transition is also of a higher order, thus providing new candidates for continuum theories of non-perturbative quantum gravity. Intriguingly, the new transition can be interpreted in terms of breaking the homogeneity and isotropy of the space-time geometry of the ground state of the universe.
- Dr Frank Saueressig is formulating an exact functional renormalisation group equation for quantum gravity, including a causal structure of space-time, and showed that the dynamic dimensional reduction of space-time leaves a distinct fingerprint in the corresponding thermal radiation spectrum.
- Prof. Gijs Nelemans' team was deeply involved in the discovery of gravitational waves and he was one of the two editors of the astrophysical paper interpreting the collaboration.
- Prof. Sijbrand de Jong, Dr Jörg Hörandel and Dr Charles Timmermans led the radio detection of air showers with the Auger Engineering Radio Array, AERA.

Prof. Heino Falcke (Professor of Astrophysics) is an NWO Spinoza Prize laureate. He also received an ERC Advanced Grant and an ERC Synergy Grant.

More information Institute for Mathematics, Astrophysics and Particle Physics, www.ru.nl/imapp

EXAMPLE OF SOCIETAL IMPACT

Star-gazing for the general public

The Astronomy department – in collaboration with amateur astronomer organisation The Astronomical Circle Nijmegen – organises monthly star-gazing evenings during winter time. Visitors can visit the domes and observe celestial bodies (weather permitting) and there is a lecture and a video. These evenings attract around 1000 visitors per season. Most of those are private individuals (mainly parents with their children aged 4-12). About 25% are from schools or other organisations. The domes also open to the public on special occasions, *e.g.* the transit of Venus across the face of the Sun in June 2012, the newly exploded supernova SN2014J in nearby galaxy M82 in early 2014 and the partial solar eclipse in March 2015.

Collaboration with industry

The requirements for the performance of our astronomical instrumentation are so stringent that innovative, state-of-the-art techniques are needed. For that reason cooperation with high-tech industries is essential. At the same time industry is beginning to recognise that it can learn and profit from the standards set by astronomers. For a number of space-based astronomical instrumentation projects there has been close collaboration with industry partners who have a strong heritage in the space and/or optical domain.

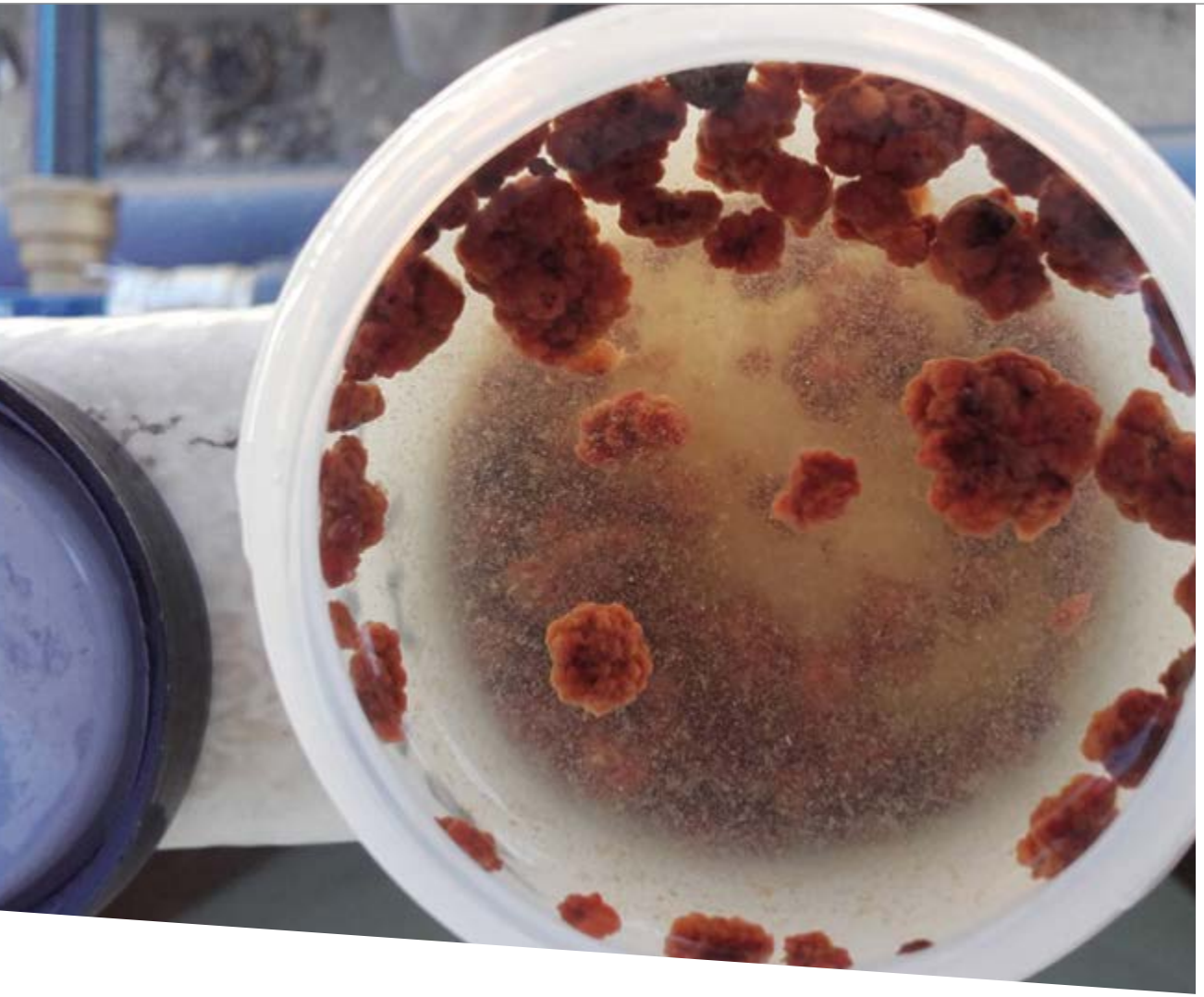
In our department, industry partners join the process very early to make sure that a clear role is identified for them in projects and to ensure that technology development is carried from the design and prototype phase in the academic environment to manufacturing and spin-off for market applications in the industrial environment. Astronomical projects can provide unique showcases for spin-offs, while future astronomical projects can benefit from spin-in opportunities. As of 2015 we are bundling this coordination through the Radboud Radio Lab.

> ***"Industry is beginning to recognise that it can learn and profit from the standards set by astronomers."***

The BlackGEM project is probably one of the best examples of successful collaboration with industry. Within this project we started a number of subprojects in which components are co-designed by the BlackGEM team and industry (at Radboud University and at the NOVA Optical-Infrared Group), and are then produced by the industry partner. The most important are the design and production of composite (carbon-fibre) parts for the telescope, the custom-designed mount for the telescope and the design and realisation of the remote-control and operations software for the BlackGEM facility (three telescopes).

Hipersense is an innovative off-grid energy system (employing solar and wind energy) that is used to supply power to equipment in remote places and to process Big Data.

In another project called HIPERSENSE a total of five industrial partners collaborated with Radboud University and the University for Applied Sciences in Arnhem/Nijmegen (HAN) to design and produce a stand-alone power production, storage and data processing unit. This unit will serve the BlackGEM facility on the observatory site at La Silla in Chile.

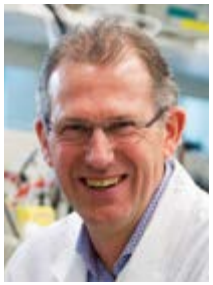


Microbiology

Our research on gene-environment interactions centres on the composition, functioning and evolution of ecosystems. This research covers all major biotic organisms, including micro-organisms, plants and animals, as well as their interactions. Adaptations – alongside stress responses – by these organisms are investigated in terms of how their molecular and physiological mechanisms are regulated. Our microbiologists specialise in the reactions of ecosystems to the quantity and quality of water. In particular, their research on anammox bacteria, which efficiently degrade ammonium without oxygen, has led to revolutionary insights and a series of world-class publications. The team has received three ERC Advanced Grants and Prof. Mike Jetten received the NWO Spinoza Prize for discovering many new bacteria and elucidating their unique properties. Together with NIOZ, Wageningen UR and TU Delft, this team received an NWO 'Gravitation' Programme and it participates in a project led by the University of Utrecht in which VU Amsterdam and Wageningen UR are also involved.

Some highlights

Our microbiologists made several discoveries, most notably the use of iron as an electron acceptor by methanotrophic archaea (Ettwig *et al. PNAS*). These archaea appear to be very abundant in rice paddy fields (Vaksmaa *et al.* FEMS Ecology) and can also be used in more sustainable wastewater treatment. The life cycle analysis of such a new type of wastewater treatment plant was investigated together with our environmental scientists (Hauck *et al.*). Further the complete metagenome of a full-scale anammox waste water treatment plant was elucidated and published in *Nature communications* (Speth *et al.*).



Prof. Mike Jetten (Professor of Ecological Microbiology) twice received an ERC Advanced Grant and is also an NWO Spinoza Prize laureate.

More information Institute for Water and Wetland Research, www.ru.nl/iwwr

EXAMPLE OF SOCIETAL IMPACT

Anaerobic ammonium-oxidising (anammox) bacteria are able to convert ammonium into nitrogen gas without using oxygen. When these so-called 'impossible' bacteria were discovered in the late 1990s, the reactions were quite sceptical. This was the reason why Prof. Mike Jetten started to study these special micro-organisms in more detail. In Mike Jetten's laboratory his team investigated their peculiar metabolism and cell biology and they found some exciting results: anammox bacteria are able to synthesise the rocket fuel hydrazine in a special organelle surrounded by unique ladderane lipids (*Nature* 1999, *Nature* 2002, *Nature* 2003, *Nature* 2006, *Nature* 2011, *Nature* 2015). This research not only resulted in fundamental new knowledge on the metabolism and cell structures, but was also very important for innovation in wastewater treatment. Mike Jetten holds three patents on the application of anaerobic bacteria and in 2001 he succeeded in obtaining a large European grant to improve the application of anammox bacteria for full-scale nitrogen removal from wastewater. This grant allowed full-scale trials at the Rotterdam wastewater treatment plant Dokhaven-Sluisjesdijk. The research showed that implementation of anammox could save 80% on energy and aeration costs and in addition that CO^2 emissions could be reduced by more than 90% (Science 2010). These trials, which were carried out in collaboration with a biotechnology group at TU Delft, were so promising, that in 2002 the first full-scale anammox reactor (75 m^3) was commissioned. In 2004 this reactor reached its design capacity of 500 kg nitrogen removed per day, and currently many more full-scale anammox plants are operational around the world. Based on this success, more than 100 research groups worldwide are studying the properties and application of anammox bacteria, and it is expected than many more anammox reactors will be built in the years ahead (especially in China). Both ERC (Proof of Concept) and Dutch research funding agencies have awarded Prof. Jetten further grants to study the adaptation of the anammox bacteria to cold temperatures and thus make nitrogen removal from wastewater even more sustainable, potentially saving billions of euros in operational costs.

"Implementation of anammox could save 80% on energy and aeration costs and CO^2 emissions could be reduced by more than 90%."

Cognitive Neuroscience

As a result of cutting-edge insights into the brain and cognition in recent years, several leading institutes on the campus joined forces to form the Donders Institute for Brain, Cognition and Behaviour. Affiliated institutes (also located on the campus) are: the Max Planck Institute for Psycholinguistics, the Centre for Language Studies and the Behavioural Science Institute. The University's cognitive neuroscience research covers all aspects of cognition: from molecules and genes, neurons and networks of brain areas, to behavioural and clinical implications. Excellent advanced infrastructure and facilities, together with the multidisciplinary approach taken in Nijmegen, ensure high-quality research. This is apparent from the many grants that have been received – against strong competition – by researchers working at this institute. These include leadership of large European and global research programmes, ERC Advanced Grants, a Spinoza Prize, several NWO Vici grants and an NWO 'Gravitation' Programme.

Some highlights

A study on neuroimaging genetics used a biology-driven strategy to relate variations in genomic loci – which were previously identified as being active in early embryonic development – to the structure of subcortical brain regions. In a study on >13,000 healthy adults, significant associations were found between targeted single nucleotide polymorphisms and hippocampal volume.

In terms of higher order processes, in a large longitudinal study it was found that puberty shifted emotional control from subcortical brain structures to the prefrontal cortex, with testosterone playing a key role. The *in vivo* potential for splice modulation therapy to treat a retinal disorder was demonstrated for the first time.

In another investigation morphological studies in mice were used to describe mutations in alpha-catenin as a novel cause of macular dystrophy. In a large genome-wide association study, meta-analysis researchers showed that early-onset bipolar disorder (≤21 years old) has a significant genetic covariation with attention-deficit/hyperactivity disorder.

Prof. Guillén Fernández (Professor of Cognitive Neuroscience) studies the brain basis of memory, emotion, and their interaction. He is the recipient of an ERC Advanced Grant.

More information Donders Institute for Brain, Cognition and Behaviour, www.ru.nl/donders

EXAMPLE OF SOCIETAL IMPACT

Need to remember something? Exercise, but not straightaway

A new study suggests an intriguing strategy that can be used to boost remembering what you've just learned: hit the gym four hours later. The findings reported in the Cell Press journal *Current Biology* on June 2016 show that physical exercise after learning improves memory and memory traces, but only if the exercise is done within a specific timeframe and not immediately after learning. "It shows that we can improve memory consolidation by doing sports after learning," says Prof. Guillén Fernández of the Donders Institute at the Radboud University Medical Center.

Guillén Fernández, along with Eelco van Dongen and their colleagues, tested the effects of a single session of physical exercise after learning for memory consolidation and long-term memory. Seventy-two participants learned 90 picture-location associations over a period of approximately 40 minutes before being randomly assigned to one of three groups: one group performed exercise immediately, the second performed exercise four hours later, and the third did not perform any exercise. The exercise consisted of 35 minutes of interval training on an exercise bike at an intensity of up to 80 percent of the participants' maximum heart rates. Forty-eight hours later, participants returned for a test to show how much they remembered, while their brains were scanned using magnetic resonance imaging (MRI).

> ***"It shows that we can improve memory consolidation by doing sports after learning."***

The researchers found that those who exercised four hours after their learning session retained information better two days later than those who exercised either immediately or not at all. The brain images also showed that exercise after a time delay was associated with more precise representations in the hippocampus, an area important for learning and memory, when an individual answered a question correctly.

Physical exercise can improve long-term memory

"Our results suggest that appropriately timed physical exercise can improve long-term memory and highlight the potential of exercise as an intervention in educational and clinical settings," the researchers conclude. It's not yet clear exactly how or why delayed exercise has this effect on memory. However, earlier studies of laboratory animals suggest that naturally occurring chemical compounds in the body known as catecholamines, including dopamine and norepinephrine, can improve memory consolidation. One way to boost catecholamines is through physical exercise.

Infection & Immunology

Fundamental as well as clinical translational research in infection and immunology at the University take place at the interface between micro-organisms and man. This research includes the study of defence mechanisms and inflammation after infection, inflammatory diseases (such as auto-immune diseases), as well as cancer and transplantation. There is close cooperation with researchers at clinical centres for infectious, inflammatory and immune diseases *e.g.* within the NWO 'Gravitation' programme, which is led by the Netherlands Cancer Institute (NKI) in Amsterdam. A number of prestigious grants were acquired, including ERC Advanced Grants and Spinoza Prizes, acknowledging the excellent performance of the teams working on infection and immunology. In 2016, Prof. Mihai Netea (Professor of Experimental Medicine) received an NWO Spinoza Prize.

Some highlights

- Dr Teun Bousema and colleagues published the first conclusive efficacy study on the use of low-dose primaquine to prevent malaria transmission (*Lancet Infectious Diseases*, 2016).
- The group led by Prof. Henk Stunnenberg and collaborators showed that B-glucan exposure can re-instate a pro-inflammatory phenotype *ex vivo* – the first time that the tolerant state has been reversed. This discovery paves the way for future clinical trials in sepsis patients (*Cell, 2016*).
- Dr Taco Kooij provided growing support for a potential link between heavy metal homeostasis and host switching, revealing potential targets for the rational design of new intervention strategies to combat malaria, including a new lead for a genetically attenuated whole-parasite vaccine (*Nature Communications*, 2016).
- Prof. Mihai Netea, Prof. Leo Joosten and their colleagues published a number of studies combining 'omics' technologies with in-depth functional phenotyping of the immune responses in healthy and diseased individuals (*Nature Medicine, 2016; Cell, 2016Cell, 2016; Cell, 2016*).

Prof. Carl Figdor (Professor of Immunology) – the recipient of an NWO Spinoza Prize and ERC Advanced Grant – and **Prof. Jolanda de Vries** (Professor of Translational Tumour Immunology) – the recipient of an NWO Vici grant – are successfully developing immunological treatments against cancer.

More information Radboud Institute for Health Sciences, www.rihs.nl, Radboud Institute for Molecular Life Sciences, www.rimls.nl

EXAMPLE OF SOCIETAL IMPACT

With an annual increase of 3% in the incidence of cancer, it is of the utmost importance that knowledge obtained from fundamental and translational research is used to benefit cancer patients as quickly as possible. Thanks to a huge effort, both financially and in terms of the labour involved, Prof. Jolanda de Vries is able to translate laboratory findings directly into clinical applications. Her findings from preclinical work are translated within a limited timeframe into clinical trials, leading to the ultimate in knowledge utilisation when they are included in funding by health insurance programmes. Jolanda was among the first in the world to introduce tumour antigen-loaded dendritic cell (DC)-based vaccines in the clinic. Dendritic cells are considered to be professional antigen-presenting cells of the immune system highly effective in initiating primary immune responses. Their decisive role in inducing immunity formed the rationale for DC immunotherapy: DCs loaded with tumour antigens are injected into cancer patients to stimulate T-cells to eradicate tumours.

After many years of small pilot studies – testing innovative strategies developed in her lab and working together with cancer patients – Jolanda recently achieved a major

breakthrough with her latest discovery that naturally circulating dendritic cells isolated from the blood can be activated to control tumour growth in melanoma patients. The robustness of this result is reflected in the implementation of this novel therapy in the Netherlands and its inclusion in treatments funded by basic health insurance.

> ***"Imaging of immune cell behaviour in patients is the key to success."***

Imaging of immune cell behaviour in patients is the key to success. Jolanda was the first to track the migratory behaviour of dendritic cells in patients, demonstrating how important the route of administration can be to maximising the capacity of cellular vaccines to boost anti-cancer immunity. Furthermore, she is driving force behind the development of novel nanoparticles that can be used to track cell behaviour *in vivo* in patients. This technique can be used with a range of imaging techniques which will open up unprecedented avenues for novel types of imaging.

The next step to be taken by Jolanda is preventive cancer vaccination in high-risk patients. Recently she conducted the first clinical trial worldwide in which Lynch syndrome patients who are prone to develop colon cancer at a young age received dendritic cell vaccines (this susceptibility is due to mutations in their DNA repair mechanisms). Jolanda de Vries is the scientific leader in the implementation, development and elucidation of the mode of action of dendritic cell-based cancer vaccines. She strongly believes that basic research integrated with clinical application opens up great opportunities for both. Her research thus encompasses both bench-to-bedside and bedside-to-bench translational studies.

Cyber Security

Cyber Security researchers at the University work on regulating access to digital assets, which can be information or services. Good digital security begins with security requirement engineering, *i.e.* identifying actors, their assets and interests, and their authorisation levels (who is allowed to do what). One research topic at the Institute for Computing and Information Sciences (iCIS) is identity-centric security, which focuses on identity management. This includes investigating the policies and protocols used for identity management, mechanisms such as smart cards, RFID tags, and biometrics, as well as their impact on privacy and anonymity. Another research topic is software security, which includes the role that software plays on the one hand in providing security and on the other as a source of security vulnerabilities. The focus is on ways to ensure the correct implementation of security functionality and the lack of security vulnerabilities, by formal specification of the security properties of code, and checking these by means of verification, typing, (penetration) testing or code inspection. A broader research topic is formulating and formalising security policies and security rules, as well as methods for risk management and risk assessment. iCIS is a leading institute internationally. Its reputation is reflected in excellent assessments as well as the award of an ERC Advanced Grant, NWO Vici grants, etc. In 2016, an international independent peer review committee concluded: '*The research quality of iCIS is excellent*'.

Some highlights

- Prof. Joan Daemen's discovered an efficient solution for achieving uniformity in threshold schemes against side-channel attacks.
- Dr Peter Schwabe presented the *Newhope* post-quantum key exchange protocol at *USENIX Security 2016*. The software was used in a post-quantum TLS experiment by Google.
- Dr Lejla Batina and her group focused on efficient and side-channel secure implementations of curve-based cryptography with a publication at *Eurocrypt*.

Prof. Bart Jacobs (Professor of Digital Security) is the recipient of an ERC Advanced Grant. He is member of the National Cyber Security Council which advises the Dutch Minister of Security and Justice.

More information Institute for Computing Science and Information Science, www.ru.nl/icis

EXAMPLE OF SOCIETAL IMPACT

Privacy safely protected thanks to the Digital Security group

Digital systems are often designed in a way that does not respect our basic rights in relation to privacy. Prof. Bart Jacobs and his Digital Security group have been successfully drawing attention to this point for many years. He not only criticises the current situation; his group also works for instance together with manufacturers to ensure that digital systems are secure.

Safe identification of privacy issues is a fundamental right, which is too often violated in the digital era. The computer scientists at the University are committed to checking and developing software in which protection of that fundamental right is guaranteed. Two examples illustrate the relevance of what they have achieved: *IRMA* and *PEP*.

IRMA

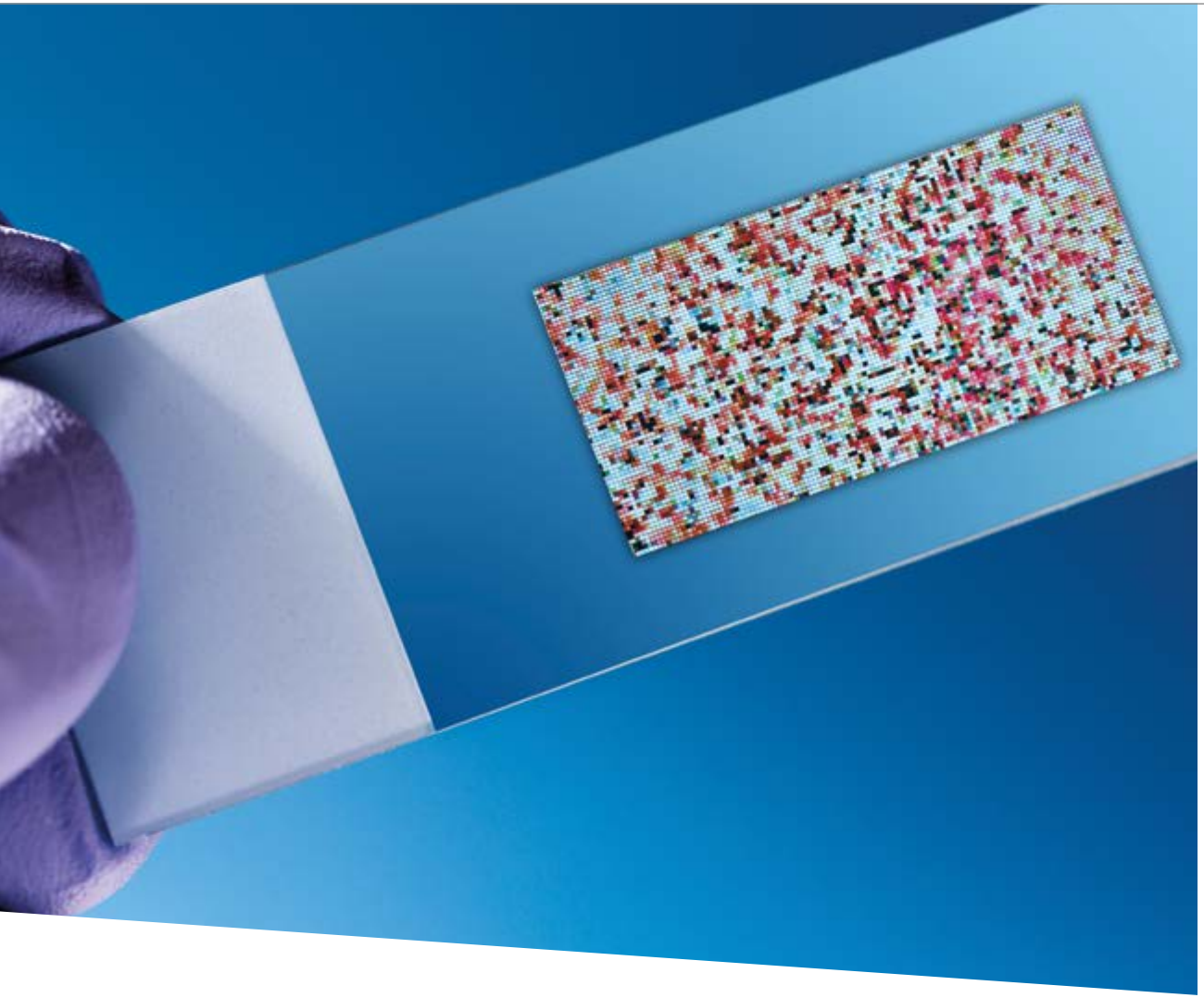
They are working on a system that can be used in digital identity cards which does not reveal more information than is needed for authorising a single task. This project is called IRMA: I Reveal My Attributes. By using IRMA, the person involved decides which personal information will be disclosed, while no central party has access to all information. That makes IRMA privacy-friendly, safe and easy to use.

PEP

Collecting and analysing medical data on a Big-Data scale is becoming an essential approach when attempting to understand complicated diseases. In order to gain new insights it is important that international researchers can cooperate: they need access to each other's data and an ability to contribute to data sets. In many cases, such medical research involves privacy-sensitive data about patients. Patients should be able to count on preservation of their privacy and on secure storage of their data. All this should comply with European privacy regulations, which are among the most stringent in the world.
The PEP project builds on the *Polymorphic Encryption and Pseudonymisation* technique developed by Profs Bart Jacobs and Eric Verheul. This technique stores anonymised data in encrypted form. Researchers working on the data can only decrypt the parts for which they have access rights.
The first study applying the PEP technique is a large-scale Parkison's research project being carried out by the Radboud University Medical Centre. This involves monitoring 650 patients over a period of two years, using *e.g.* wearable devices. The data collected this way will be shared, in pseudonymised form, with top research institutes around the world.

> ***"Safe identification of privacy issues is a fundamental right which is too often violated in the digital era."***

Meanwhile, the University's computer scientists are preparing for the introduction of quantum computers. Their goal is to understand theoretical quantum phenomena on a mathematical level. This should result in algorithms and models that are clear and suitable for colleagues in the field, in particular those working on Computer Security.



Human Genetics

Human Genetics researchers at the University specialise in identifying the genes involved in congenital abnormalities, intellectual disability, psychiatric diseases, heritable development of tumours, deafness, and blindness – as well as the mode of action of these genes. With access to advanced bio-informatics equipment, they use the very latest techniques. Translational research at the University is also very successful. Some of the latest genetic techniques for diagnosis, such as DNA chips and Exome sequencing, were used in Nijmegen for the first time worldwide. The excellent Human Genetics team has acquired multi-million-euro grants from highly competitive funding bodies in the Netherlands and in the EU. Significant achievements such as an ERC Advanced Grant and many NWO Vici grants reflect the academic quality of the work. In 2016, Prof. Han Brunner was awarded the Carter Medal of the Clinical Genetics Society Great Britain. Together with Professor Joris Veltman he was also awarded the King's Faisal International Prize in Medicine.

Some highlights

- The results of a study by Dr Richarda de Voer and Dr Marjolijn Ligtenberg suggest a polygenic model of colorectal cancer (CRC) susceptibility in which patients with early-onset CRC carry a set of rare, pathogenic variants in their germline that put them at risk of developing CRC (*PLOS Genet, 2016*).

- Dr Toine van de Heijden and Prof. Fred Witjes found that progressive and non-progressive bladder tumours have different gene expression patterns and they identified a five-gene signature that can be used to predict progression in high-risk non-muscle invasive bladder cancer (*Eur J Cancer, 2016*).

- The group led by Prof. Jack Schalken proposed a two-gene risk score to detect high-grade, clinically significant prostate cancer accurately. This risk score could therefore be used in decision making, reducing the number of unnecessary prostate biopsies and avoiding potential overtreatment (*European Urology, 2016*).

Prof. Han Brunner (Professor of Human Genetics) and **Prof. Nicoline Hoogerbrugge** (Professor of Hereditary Cancers) are both research leaders at the Radboud University Medical Centre and the driving forces in the University's research on the genetics of tumour development.

More information Donders Institute for Brain, Cognition and Behaviour, www.ru.nl/donders, Radboud Institute for Molecular Life Sciences, www.rimls.nl

EXAMPLE OF SOCIETAL IMPACT

Lynch syndrome from basic research to implementation in daily clinical practice and beyond

The continuing work on the genetic basis of colorectal cancer and the search for preventive options is a good example of the strong research within the theme Tumours of the Digestive Tract. This is a multi-disciplinary subject with strong collaboration between medical doctors and lab scientists working on Human Genetics, Pathology, and Gastroenterology. The translational impact of this work is exemplified by the research performed on Lynch syndrome in the groups led by Prof. Nicoline Hoogerbrugge and Dr Marjolijn Ligtenberg.

Lynch syndrome is the most frequent genetic cause of colorectal cancer. Patients with Lynch syndrome are characterised by germline mutations in known DNA mismatch repair genes. Carriers of such a mutation have a lifetime risk of up to 70% of developing colorectal cancer. Tumours that develop in the context of inactivation of these DNA mismatch repair genes can be recognised by the tumour-specific instability of microsatellite sequences. Routine testing for microsatellite instability of colorectal tumours that develop before the age of 50 was implemented in the Netherlands

in 2008 and this enhanced the recognition of families with Lynch syndrome. Recognition of this predisposition to cancer can lead to cancer prevention (as a result of specific surveillance) in up to 80% of genetically related healthy relatives. Recently, knowledge of this predisposition led, in collaboration with Professor Jolanda de Vries – *the* expert in *ex vivo* generated and tumour-antigen-loaded dendritic cells – to a unique study on the prevention of cancer development in patients with Lynch syndrome.
In 2009 Dr Ligtenberg *et al.* described

> ***"Lynch syndrome is the most frequent genetic cause of colorectal cancer."***

a novel genetic mechanism that leads to inactivation of the *MSH2* gene in some patients. Evaluation of the cancer history of a large number of patients with an *EPCAM 3'*end deletion revealed that their risk of developing colorectal cancer is similar to that of patients with an inactivating mutation within the *MSH2* gene.
In contrast, the risk for women with such a deletion is lower than that of women with an *MSH2* mutation.

Another important finding is that bi-allelic tumour-specific mutations in DNA-MMR genes appeared to be a contributory factor in some young patients with tumours characteristics of Lynch syndrome. This phenomenon reduces the ethical constraints felt by some clinicians when actively tracing tumours with Lynch-like characteristics. This finding and a novel cost-effectiveness study on the tumour test used to predict Lynch syndrome were important building blocks for proposing increasing the age at diagnosis from 50 to 70 years old. This is one of the essential changes in the multi-disciplinary evidence-based guideline on hereditary colorectal cancer that was written under chairmanship of Prof. Nicoline Hoogerbrugge and became effective in 2015.

Linguistics

Linguists at the university carry out ground-breaking research in language, language behaviour, language and speech technology, and communication. This research focuses on two main themes: *Language in the mind* (including learning a mother tongue and the production and processing of language) and *Language in society* (covering the use of language in a variety of cultures and subcultures). These researchers are among the best of the world and cooperate closely with multidisciplinary institutes on the campus such as the Max Planck Institute for Linguistics and the Donders Institute for Brain, Cognition and Behaviour. They have received impressive grants including ERC Advanced Grants and the NWO Spinoza Prize, and they participate in the prestigious NWO 'Gravitation' programme *'Language in Interaction'*.

Some highlights

- Dr Kobie van Krieken studied the coverage of criminal events in newspapers. These articles often consist of narratives that combine characteristics of journalistic discourse with elements of literary fiction. The function of these stories is not so much to inform readers about what happened, but to create an immersive reading experience. Journalists see this form of journalism as a way of competing with online news media.
- Dr Linda van Meel finished her PhD thesis on the Dutch spoken by Turkish-Dutch and Moroccan-Dutch young people, who use sounds, words and constructions that rarely occur in the speech of 'native' Dutch speakers, such as the 'sharp' pronunciation of the /z/, which originates from Moroccan languages. However, 'native' Dutch speakers are usually unaware that their compatriots also have typical regional Dutch accents and exhibit the same deviations from the standard language as 'native' Dutch speakers.
- Raechel Maskikit-Essed MA and Prof. Carlos Gussenhoven discovered that in Ambonese Malay neither stress nor pitch is being used to give meaning to words. That there is a language without word prosody had never previously been established.

Prof. Mirjam Ernestus (Professor of Psycholinguistics) is the recipient of several highly prestigious personal grants such as the NWO Vici and Vidi grant, the ERC Starting Grant and an ESF European Young Investigator (EURYI) Grant.

More information Centre for Language Studies, www.ru.nl/cls, Donders Institute for Brain, Cognition and Behaviour, www.ru.nl/donders

EXAMPLE OF SOCIETAL IMPACT

'Deaf normal': a website for parents of deaf children

The website www.doofgewoon.nl was published at the end of 2016. The title Doofgewoon ('Deaf normal') is a pun based on the Dutch expression 'doodgewoon', meaning 'quite normal'. Most deaf children are born to hearing parents, who have little or no experience with the deaf community, sign language or bilingualism. This site addresses their needs, based on research over the past fifteen years at the University showing that Sign Language of the Netherlands is a full-fledged natural human language. International research also shows that growing up bilingually is an asset rather than a threat to the development of children.

So far six families with either deaf or hearing parents have been interviewed. Both groups report on their experiences with their deaf (and hearing) children: the emotions involved, whether special or mainstream education was chosen, contacts with the deaf community, etc. Deaf adults report on their own lives: what was it like to grow up being deaf in a hearing or a deaf family, how did they experience deaf education, and how do they interact with other deaf and hearing people? Eight deaf and hearing experts specialising in subjects ranging from bilingual education to deaf culture answer questions on the basis of research findings and their own experiences. And, last but not least, the site offers some suggestions on how to communicate better with deaf children, encouraging parents to be more sensitive to the visual world of deaf people. All sections of the website will be expanded in the course of 2017 and 2018, while a Facebook group facilitates the exchange of the latest information, and allows parents to discuss issues with each other.

A trailer highlighting some of the content of the website can be found at vimeo.com/signrr/doofgewoon.

"Growing up bilingually is an asset rather than a threat to the development of children."

Business & Law

The University's Business and Law Research Centre cooperates closely with fourteen highly renowned law firms, financial institutions and companies, most of which operate internationally. Their lawyers work together with our researchers on academic research in 1) company law, 2) financing, security rights and insolvency, 3) business and patrimonial law, and 4) financial law. The Centre has produced numerous authoritative text books, monographs and serial volumes. The research groups are also very successful in raising funds. Over the last decade the Centre has been assessed twice by international peer review committees as 'excellent' and 'world leading'. In 2016, Prof. Claartje Bulten (Professor of Company Law) was appointed to the Dutch government's advisory body the Social-Economic Council (SER).

Some highlights

- A strong area of research that the Centre is traditionally engaged in is international and comparative insolvency law. A permanent network of insolvency experts from 20 countries across the globe contribute to the Oxford International and Comparative Insolvency Law Series.
- In 2016 the manuscript of a comprehensive volume on 'Ranking and Priority of Creditors' was published. This volume deals with what many would regard as the *raison d'être* of insolvency law: the creditors' claims. It presents the analyses of treatments of various categories of claims and the allocation of control rights among creditors and various other actors in insolvency proceedings.
- European Law is also increasingly important for private law. In his book *European Law and National Private Law* (published in 2016), Prof. Arthur Hartkamp addressed the various sources of European law, as well as the influence of fundamental rights on Private Law. In it particular attention is devoted to a review of national private law regulation in the light of European legislation.

Prof. Michael Veder (Professor of Insolvency Law) is an expert in Comparative Law, International Insolvency Law and Bankruptcy. He chairs the Academic Forum of INSOL Europe.

More information The Business & Law Research Centre, www.ru.nl/law/research

EXAMPLE OF SOCIETAL IMPACT

One of the ways in which the Business & Law Research Centre (OO&R) has societal impact is through its involvement in law-making. The field of Insolvency Law is an example where researchers are involved in law-making, both at a national and at an international level, regarding the restructuring of viable businesses in financial distress. Prof. Michael Veder is a member of the Expert Group on Restructuring and Insolvency that assists the European Commission in preparing EU legislation. With regard to this future legislation the international conference Eyes on Insolvency 2017: Preparing the pre-insolvency proceedings of the future was organised. This conference was co-organised by public and private stakeholders, such as the European Commission and INSOL Europe. The research centre also contributes to law-making through the editing by Prof. Dennis Faber and Niels Vermunt LLM of the Oxford International Comparative Insolvency Law book series, which provides comparative insights that serve as a basis for future legislation. Involvement at the national level is demonstrated by the different ways the OO&R provides advice for the Ministry of Justice in relation to the preparation of new legislation. The Centre is often consulted in relation to an extensive legislative programme designed to recalibrate Dutch insolvency law. Under the direction of Prof. Michael Veder and Prof. Leonard Verburg, it carried out an empirical study into the relationship between the legal position of employees and the restructuring possibilities of employers in financial difficulties. The Centre also produced reports that are used by those who draft laws, including a comparative investigation into bar dates in the law of thirteen European countries and a review of a draft bill designed to modernise Dutch bankruptcy proceedings, both undertaken by Prof. Michael Veder and Ben Schuijling LLM, PhD.

> *"The Centre is often consulted in relation to an extensive legislative programme designed to recalibrate Dutch insolvency law."*

Our academic reputation

As in previous years, in 2016 many of our researchers received acknowledgement for their work and they continued to contribute to high-impact international academic publications. The quality of research is also reflected in citations (see Figure 1) and many of our leading academics were invited to give keynote lectures around the globe.

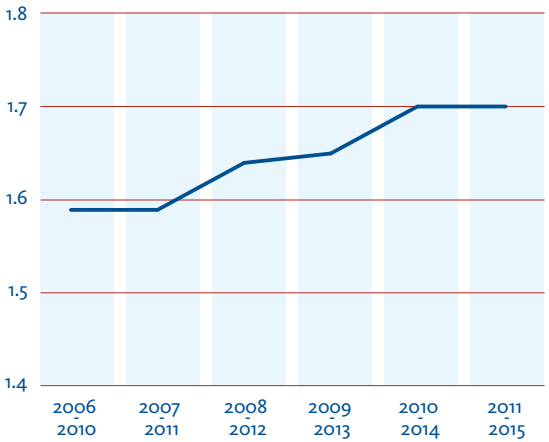
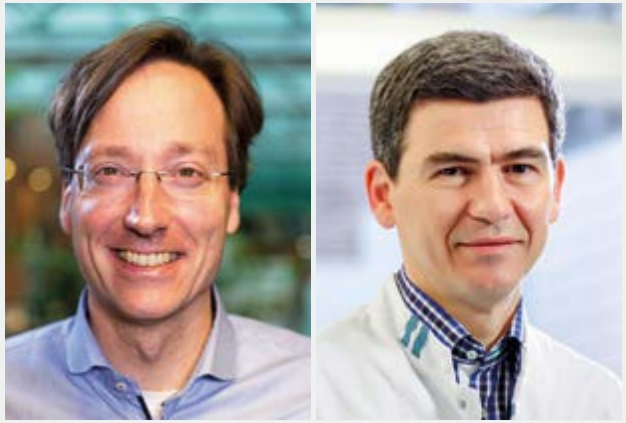


Figure 1: Normalized citation impact scores – *i.e.* citations in relation to the world average per subject area – of scientific publications (according to Web of Science) at Radboud University per period of time. (world average = 1.0)

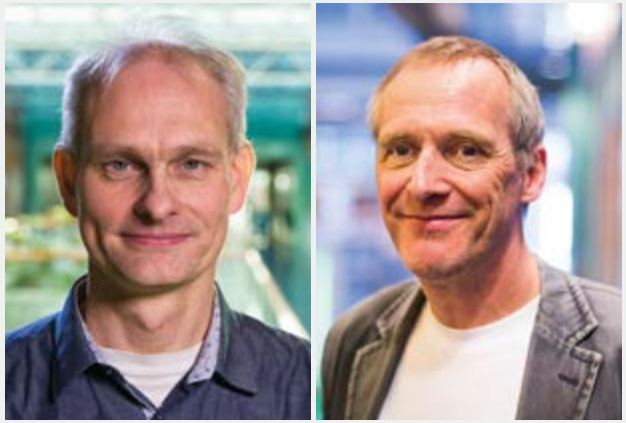
Newly elected members at national and international academic societies

- Profs Mihai Netea and Harold Bekkering were elected as members of the Royal Netherlands Academy of Arts and Sciences (KNAW).
- Profs Lutgarde Buydens, Roshan Cools, Bart Kiemeney, Sijbrand de Jong and Hans Schulte Nölke were elected to the Academia Europaea.

NWO SPINOZA PRIZE LAUREATES AND ERC ADVANCED GRANT LAUREATES IN 2016



Left: Prof. Wilhelm Huck (Professor of Physical Organic Chemistry) and Right: Prof. Mihai Netea (Professor of Experimental Medicine) are two of the four NWO Spinoza Prize laureates in 2016.



Left: Prof. Jan van Hest (Professor of Bio-organic Chemistry) and Right: Prof. John van Opstal (Professor of Biophysics) each received the highly prestigious ERC Advanced Investigator Grant.

- Profs Nico Verdonschot and Peter Desain were elected as members of the Netherlands Academy of Technology and Innovation.
- James McQueen was elected as a Fellow of the Association for Psychological Science.
- Prof. Christian Doeller was elected as a member of the Memory Disorders Research Society (MDRS).
- Prof. Mike Jetten was elected to the European Academy of Microbiology.
- Prof. Floris Rutjes (Synthetic Organic Chemistry) was elected as chairman of the KNCV, the Dutch Chemistry Association.
- Prof. Dave Parker (Molecular Laser Physics) was elected as a member of the American Physics Association.

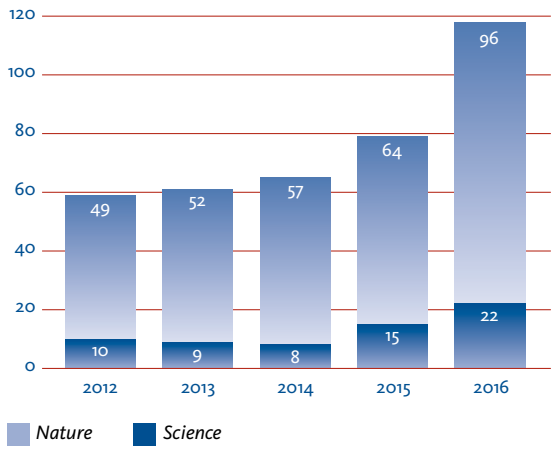


Figure 2: Number of publications in *Nature** and *Science*** per year.

* Journals in the Nature Publishing Group.

** Journals published by the American Association for the Advancement of Science.

Examples of recognition

- Dr Jo Frencken was awarded China's prestigious International Scientific and Technological Cooperation Award for his decade-long efforts promoting more accessible cavity treatment.
- Profs Gijs Nelemans and Paul Groot, together with Dr Samaya Nissanke, received the Special Breakthrough Prize and the Gruber Cosmology Prize.
- Prof. Misha Katsnelson received the Hamburg Prize for Theoretical Physics.
- Prof. Michiel de Vries received an honorary degree of Doctor Honoris Causa from the Masaryk University in Brno (Czech Republic) for development of Public Administration internationally and his contribution to the development of the Masaryk University in particular.
- Han Brunner was awarded the Carter Medal of the Clinical Genetics Society of Great Britain.
- Han Brunner and Joris Veltman were awarded this year's King Faisal International Prize in medicine.
- Prof. Claartje Bulten has been appointed to the Dutch government's advisory body Sociaal-Economische Raad (SER; Social-Economic Council).
- Prof. Joan Daemen was among the finalists for the European Inventor of the Year awards, which are organised by the European Patent Office.
- Herman Westerink was appointed as an Extraordinary Professor at the University of Leuven.
- Prof. Harry Knoors *et al.* received the Premio Tarra Motivazioni Award from the University of Genua for the book *Educating Deaf Learners*.
- Peter Desain and his team have been awarded First Prize in the Assistive Technology Challenge.
- Facebook awarded the 2016 Internet Defence Prize to Dr Peter Schwabe.

Key figures

Research staff

Tenured

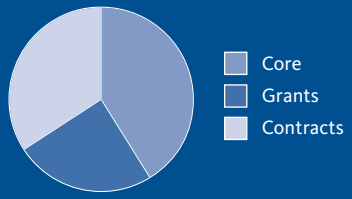
Full Professors	180.7 FTE
Associate Professors	78.4 FTE
Assistant Professors	231.8
FTE Researchers	158.2 FTE
Lecturers	2 FTE

Non-tenured

Researchers	660.2 FTE
Lecturers	10.3 FTE
Doctoral candidates	1064 FTE

Research staff funding

(percentage of FTE per type of funding)



Research output

Dissertations	412
Scientific publications	7165
Professional publications	1133
Annotations	284
Patent applications	11

Internationalisation

Researchers from abroad contribute to increasing the diversity on our campus. Our goal is to have 25% international staff by 2020. We provide good support for new international colleagues. Special attention to intercultural communication and a bilingual campus help to make international researchers feel at home in Nijmegen. We created a central meeting place on the campus for researchers from abroad: the *Global Lounge*, where the International Staff Information Desk is also housed. At this desk international staff members can get answers to questions related to their stay in the Netherlands. Moreover they are supported with, for example, residence, insurance, setting up bank accounts, formal registration and childcare, etc.

Our researchers also regularly join forces with colleagues at other institutes around the world. For instance, this happens when equipment is too large – and expensive – for one university to purchase alone (good examples include research in Astronomy, Astrophysics, Particle Physics, High Magnetic Fields and Cognitive Neuroimaging).

Research is by its nature international and many research topics are global through the impact they have on human health, education, literature, international law, cyber security and nature management. This is why we value international cooperation so highly: to complement and create synergy (of expertise and/or facilities), to increase critical mass, to contribute to international research consortia, to recruit talented students and to provide our PhD students with the best career opportunities. Many of our doctoral candidates, post-doctoral researchers and other staff were born outside the Netherlands: this percentage was 23.5% of all researchers (in FTE; 2016).

Radboud Excellence Initiative

In order to strengthen international connections at our research institutes, the Radboud Excellence Initiative was launched in 2013. As international partnerships between researchers and leading academics around the world are so important to the University, the Radboud Excellence Initiative promotes contacts and cooperation between outstanding academics. Within the scope of this initiative, very talented scientists based outside the Netherlands can work at the University for shorter or longer periods.

Radboud Excellence Professorships

These are intended for leading academics whose research has had a significant impact in their discipline – and beyond – and who can be expected to remain active as researchers for at least a number of years. Each professorship enables an eminent researcher to conduct research in Nijmegen for about six months.

In 2016, such professorships were awarded to the following professors:

Prof. Jude Cassidy (University of Maryland, USA) who worked at the Behavioural Science Institute, Prof. Derek Gregory (University of British Columbia, Canada) who joined the Institute for Management Research, Prof. Stephen Faraone (SUNY Upstate Medical University, Syracuse, USA) who participates in the research at the Donders Institute for Brain, Cognition and Behaviour, Prof. Roy Chantrell (University of York, United Kingdom) who soon will join the Institute for Molecules and Materials and Prof. Laurie Beth Feldman (Haskins Laboratories, Yale University, USA) who is currently doing research at the Centre for Language Studies.

Prof. Stephen Faraone, Prof. Derek Gregory, Prof. Jude Cassidy, Prof. Laurie Beth Feldman and Prof. Roy Chantrell

Radboud Excellence Fellowships

These fellowships are intended for exceptionally talented young researchers. They are selected on the basis of their academic record, but also have to submit a promising original research plan. The target group are researchers based outside the Netherlands who have obtained their doctorates between two and eight years ago. Each Fellowship funds a research project that lasts one to two years in one of our research groups.

In 2016 Radboud Excellence fellowships were awarded to the following researchers:

Dr Carsten Sauer (Bielefeld University, Germany), Dr Christian Jogler (Leibniz-Institut DSMZ, Germany), Dr Hui Zhao (Weizmann Institute of Science, Israel), Dr Leila Samson (Nanyang Technological University, Singapore), Dr Malgorzata Mikucka (CEPS/Instead,

Luxembourg), Dr Tyrone Crisp (Max Planck Institute for Mathematics, Germany), Dr Lisa Genzel (University of Edinburgh, United Kingdom), Dr Delia Popa (Catholic University of Louvain, Belgium), Dr Karen Strung (Institute of Mathematics, Polish Academy of Sciences, Poland), Dr Andrey Chetverikov (University of Iceland, Iceland), Dr Marta Alves (Institut d'Astrophysique Spatiale, France) and Dr Nicola Tamanini (Institute de Physique Theorique, Universite Paris-Saclay, France).

The Guild

In November 2016, 18 universities in 12 European countries that were already engaged in longstanding collaboration, joined forces in a new network: *The Guild*. *The Guild*, which is composed of some of Europe's most distinguished research-intensive universities, is dedicated to enhancing the impact of universities in Europe in terms of research and teaching. It will engage with politicians and officials as well as public and private companies through debate based on cutting-edge scholarship. *The Guild's* members are committed to sharing their knowledge, experience and good practice for the benefit of all members.

The Guild
of European Research-Intensive Universities

Radboud University is a member of *The Guild*. The other participating universities are: Aarhus University, Ghent University, Jagiellonian University in Krakow, King's College London, University of Bologna, University of Glasgow, University of Göttingen, University of Groningen, University of Ljubljana, University of Louvain, University of Oslo, University of Paris Diderot, University of Tartu, University of Tübingen, University of Vienna, University of Warwick and Uppsala University.

CROSS-CAMPUS INTERDISCIPLINARY RESEARCH INITIATIVES

Healthy Brain

The Anatomy Lesson of Dr Jan Deyman.
A painting by Rembrandt van Rijn (1606-1669).

Our brain enables us to be conscious, social and creative in an increasingly complex environment. It is an enormous task to unravel the workings of this central organ. This challenge can only be met successfully if excellent researchers from a wide range of disciplines join forces. The Radboud campus is an ideal location in this respect. Our researchers have taken the initiative to cooperate to meet this major scientific challenge. This is why, in 2015, a campus-wide research programme focusing on *Healthy Brain* was initiated to accelerate our understanding of how the human brain works in health and disease. *Healthy Brain* will make science better, improve education and foster further interactions with society. In 2016, researchers from Radboud University, Radboudumc and the Max Planck Institute for Psycholinguistics worked together on this discipline-transcending theme. They prepared a large cohort investigation on the intersection of health and brains: the *Healthy Brain Community* study.

Data Science

A tape robot used to store data from experiments at CERN, Geneva

The Radboud Data Science Centre is another novel initiative that was established to bring together data science researchers across the campus in a truly interdisciplinary approach to contemporary data-driven research challenges. The Centre will act as a catalyst in the field of data science and provide an end-to-end interdisciplinary research capability – from infrastructure and data-science algorithms to globally relevant concerns and the social, legal and ethical issues raised by the use of Big Data.

Grants and awards for excellent young scientists

The university accommodates a large number of highly talented young researchers. They work at research institutes across the campus and have received many prestigious grants and awards, often acquired in strong national and international competitions.

Grants from the European Research Council (ERC)

Three prestigious Starting Grants from the European Research Council (ERC) were awarded to Drs Janneke Jehee (Neuroscience), Jasmin Mecinovic (Organic Chemistry) and Miriam Schmidts (Human Genetics). These grants allow budding top researchers to initiate their own line of investigation.

Three highly prestigious ERC Consolidator Grants were awarded to Profs Christian Doeller (Cognitive Neuroscience), Betty de Hart (Sociology of Law and Migration Law) and Dr Annemiek van Spriel (Tumour Immunology). These substantial grants will enable them to further develop their line of research.

An ERC Proof of Concept Grant was awarded to Dr Mangala Srinivas (Nanomedicine) and Dr Tom Scheenen (Radiology). This grant is meant for researchers who previously received an ERC Grant and who intend to further explore the potential of their results to stimulate innovation.

Grants from the Netherlands Organisation for Scientific Research (NWO)

Seventeen Radboud researchers received an NWO Veni grant in 2016. This will enable them to do research for three years after completing their PhD. The winners this year were Drs Anneleen Arnout, Marije Doppenberg-Oosting, Koen Haak, Harmen Ghijsen, Rick Helmich, Sandra Heskamp, Jakko van Ingen, Peter Korevaar, Jasper Krommendijk, Bart Mennink, Roza Meuleman, Inge Molenaar, Joost Rommers, Giesje Nefs, Natalia Revelo Nuncira, Nelleke Spruijt and Paul Verbruggen.

Eight post-doctoral researchers received an NWO Vidi grant in 2016. This major achievement will enable them to develop their line of research for five years. These grants were awarded to Drs Wilco Verbeek, Ross Kang, Daniela Wilson, Samaya Nissanke, Roos Pijpers, Sharon Unsworth, André Marquand and Michiel Schreuder.

Four – more senior – researchers received NWO Vici grants in 2016. These substantial grants, which will enable them to further develop their line of research for five years, were awarded to Profs Agnes Akkerman (Labour Market Institutions and Labour Relations), Olivier Hekster (Ancient and Medieval History), Olga Igonka (Experimental High-Energy Physics) and Gijs Nelemans (Gravitational wave astrophysics).

Various grants and acknowledgements

- Dr Lize Glas (International and European Law) was awarded the *2016 Max van der Stoel Human Rights Award* for her PhD dissertation.
- Dr Floris Heukelom (Economic Theory and Economic Policy) was awarded the *Young Researcher Award* of the European Society for the History of Economic Thought.
- Dr Willem Frankenhuis (Developmental Psychology) received the *Boyd McCandless Award* from the American Psychological Association.
- Dr Corina Greven (Behaviour Genetics) received the *Kramer-Pollnow Young Investigator's Award*.
- Dr Sina Radke (Neuroscience) received the *Heinz-Heckhausen Jungwissenschaftler-Preis* from the Deutsche Gesellschaft für Psychologie.
- Mariya Manahova MSc (Neuroimaging) received a *Research Talent grant* from NWO.
- Drs Sandra Heskamp (Rare cancers) and Willemijn Hobo (Cancer development and Immune defence) were awarded the Dutch Cancer Foundation (KWF) *Young Investigators grant* (€600,000).
- Dr Sebastian Luecker (Ecological Microbiology) received the *Antonie van Leeuwenhoek Prize* as Best Microbiology Postdoc.
- Dr Muriel van Teeseling (Ecological Microbiology) received the *Westerdijk Award* for Best Microbiology PhD Thesis and an EMBO Fellowship.

Veni, Vidi, Vici	2012	2013	2014	2015	2016
Veni					
This university	20	19	18	20	17
% of all grants acquired	14.0%	12.8%	13.5%	13.7%*	11.8%
Vidi					
This university	7	10	6	11	8
% of all grants acquired	8.1%	12.5%	7.5%	12.9%	10.5%
Vici					
This university	4	5	2	3	3
% of all grants acquired	14.3%	17.9%	7.1%	9.1%	9.7%

Table 1. Success rate in acquiring personal grants for research (NWO)

*In most cases the percentage exceeds 8.2%, which would be expected if the percentage of total grants was equivalent to the University's share of core funding (core funding is based on student numbers and the number of graduations per year).

- Prof. Bas van de Meerakker (Spectroscopy of Cold Molecules) received the *Zdenek Herman MOLEC Young Scientist Prize*.
- Dr Jeroen Jansen (Analytical Chemistry) received *The Chemometric and Intelligent Laboratory Systems Award*.
- Dr Daniela Wilson received the *NML Researcher Award* for research excellence in nano-science and micro-science.
- Dr Alix McCollam (HFML) was the recipient of the 2016 *EMFL Prize*.

Societal impact

As a result of the research and education at our University, academic knowledge delivers practical results with societal value in a number of ways. By transferring knowledge and technology to society, we stimulate innovation and create the conditions for entrepreneurship. And societal problems are also an important inspiration for the academic research carried out at our institutes.

We encourage the use of academic knowledge in society by focusing on the following activities: publishing articles and books for professional target audiences, post-academic education, joint research involving private and public partners, public events, the formulation of guidelines, helping establish new companies, supporting start-up companies and educating students in entrepreneurship. The University is also closely involved in regional development programmes.

Examples of transfer of knowledge and technology
Below we highlight some projects that illustrate the societal relevance of research on a range of topics.

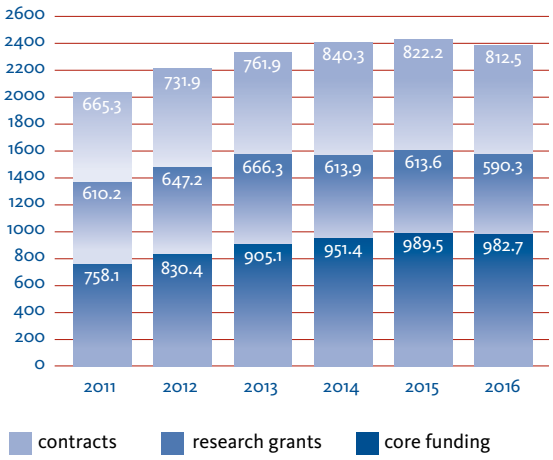
In 2016, the Bosch Research and Conservation Project, which was set up in 2010 by art historian Prof. Jos Koldeweij, came to fruition. The main outcome of the project was the exhibition *Jheronimus Bosch – Visions of genius*, of which Jos Koldeweij was curator, together with Dr Matthijs Ilsink. Koldeweij and Ilsink are also the authors of the catalogue that accompanied the exhibition. Held from 13 February to 8 May in the Noordbrabants Museum in 's Hertogenbosch, the exhibition attracted more than 400,000 visitors and was chosen as 'Exhibition of the Year' by the prestigious British art magazine *Apollo*. Source material on the painter has been made available for anyone who wants to know more about the life and work of the artist in Boschdoc, an online database containing nearly 1000 documents. Boschdoc was awarded the 2016 Nederlandse Dataprijs (Dutch Data Award, in the category humanities and social sciences).

Profs Ellen van Wolde (Theology) and Klaas Landsman (Mathematics) co-initiated the 'Week of Chance', which attracted a great deal of attention from newspapers, websites and radio stations, and led to a theatre performance, a KNAW symposium, and the 2016 Lecture at the University's *Dies natalis* by Ellen van Wolde.

Radboud Reflects was established to make the world of science and scholarship that is philosophically enhanced accessible to a wide audience through lectures, debates, workshops and festivals. Each year, *Radboud Reflects* organises more than a hundred events, which are attended by over 10,000 people and reach over 100,000 people through its website and social media.

The publication *Kabinetsformaties 1977-2012* offers an in-depth description and analysis of the formation of the fourteen Dutch coalition governments from 1977 until 2012; it discusses political, procedural and strategic aspects as well as personal relations among the political leaders involved. With this new book, which was edited by Prof. Carla van Baalen and Dr Alexander van Kessel, the Centre for Parliamentary History (CPG) completes

Figure 3: Researchers (in FTEs) per year



its research on the history of post-war government formations. *Kabinetsformaties 1977-2012* was presented in the Upper House of the Dutch Parliament.

Prof. Jan Terpstra completed three projects on the national police (WODC), police officers and the role of mayors in police work (Politie & Wetenschap).

Researchers at the Institute for Management Research are regularly consulted by public authorities. For instance, on 20 July 2016 the Health Council of the Netherlands published the report 'Considering health in environmental policy'. The Council has advised State Secretary Sharon Dijksma to raise the standards in the Environment and Planning Act as a way of reducing the disease burden caused by environmental factors.

A symposium on *The Young Consumer* was organised in September 2016, targeting professionals who have young people (children, adolescents and young adults) as a target group. BSI scholars joined practitioners in the

field to present an academic yet applied approach to 'hot topics' in youth-directed communication such as positive and responsible persuasion, age segmentation, character marketing, storytelling, co-creation and tailored communication. The symposium, which was attended by over a hundred people, was much appreciated.

Research on sleep and performance among elite athletes was carried out in close cooperation with NOC*NSF and several commercial partners. It resulted in invited workshops and master classes for staff members of several sports associations (*e.g.* those for swimming, sailing and hockey) as well as expert groups (*e.g.*, coaches, sports physicians, physiotherapists and sport psychologists). Research results were integrated in official recovery protocols (fact sheets), and media interviews were given, for example on Dutch radio (NPO 1). In December 2016 collaboration between NOC*NSF, Mline and Radboud University was established to initiate a new externally funded PhD project on power napping.

In the blog 'Donders Wonders', researchers at the Donders Institute write articles on neuroscientific topics designed for the general public. With two blogs per week in Dutch and English, and over 150,000 views in 2016, this initiative clearly has considerable impact.

Scientists at the Donders Institute disseminate new findings and knowledge to industry, mostly through numerous mutually beneficial collaborations with commercial partners varying from smaller companies that manufacture technical devices (such as Noldus and Otticon) to large multinationals (*e.g.* Philips, Siemens, Heinz and Danone). The institute is a member of 'ICT for Brain, Body & Behaviour' (i3B), a European network of ICT companies and knowledge institutes working on brain, cognition, physiology and behaviour that aims to connect business and encourage innovation through joint R&D projects.

A team led by Dr Wieb Bosma organised the 25th edition of the Mathematics tournament for secondary schools. This is the largest activity of its kind in the Netherlands, which attracts around 500 participants each year. The tournament also includes a special programme for high school teachers. Prof. Eric Cator and Dr Ross Kang organised the Study Group Mathematics with Industry, which took place at the University in January 2016.

Radboud microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, using both ammonium and methane as an electron donor, thus considerably extending the application of these processes in municipal wastewater treatment systems.

SCREENIVF, an instrument designed to screen psychosocial risks in IVF couples, which was developed by Dr Chris Verhaak and his Radboudumc colleagues, was implemented in the European Guidelines for clinical practice of the European Society of Human Reproduction and Embryology and adopted by more than 1000 European fertility clinics.

In collaboration with the Oxford University Clinical Research Unit in Vietnam, Prof. Heiman Wertheim showed that use of a rapid (five-minute) test can reduce antibiotic misuse when treating respiratory infections. Cutting the number of unnecessary antibiotic prescriptions is a key way to prevent the spread of antibiotic-resistance.

The 'Radboud Innovation' unit

Radboud Innovation is a network organisation in which all of our faculties are directly involved. It provides support and advice to our researchers by enhancing the visibility of their research in terms of societal, cultural and economic values. Within *Radboud Innovation* expertise has been built up on the external funding (regional, national and European) of research and on start-up companies, legal rules, opportunities for public-private collaboration and the availability of research facilities. In addition, the staff of *Radboud Innovation* are informed on important regional, national and European themes and focal areas.

Radboud Innovation supports researchers and faculties by providing grant support and protection of intellectual property. Advice and guidance is given on writing proposals for research funding. Science-to-business support, *i.e.* promoting and supporting new entrepreneurship for instance by offering research facilities, is another activity. Finally, the *Radboud Innovation* unit is involved in project development (public-private collaboration and collaboration with governments and branch organisations).

Radboud Innovation is a member of the steering committee of *Healthy Brain* (see page 33). As such it was co-creator of the collaborative venture between our University and Wageningen University & Research called *Food & Cognition.* This new research programme is designed to encourage innovations in health, life-style and the social environment.

A few results from Radboud Innovation activities:
In May and October meetings have been organised together with VNO-NCW and the Nijmegen ICT network which includes entrepreneurial researchers, students and start-ups.

Some examples of new spin-off initiatives are Aerochem, Agreen, BioMed Elements, BisQQ, Gight, MindAffect, MindTrace, MarbelousMinds and TicaPro.

In December the event *Design for Recycling and Resource Efficiency* took place at our campus, which attracted fifty representatives of science institutions and companies.

In 2016, seven projects funded by the European regional development programme EFRO started. Two of these projects are COILED (early development of candidate medicines with the contribution of the University's spin-off MedChem and the Pivot Park Screening Centre) and BES (joint development of energy-neutral region by balancing the generation, use and storage of energy).

Three proposals for a Top consortium on Knowledge and Innovation (TKI) were awarded including a large research project for *ParkinsonNet* in collaboration with Verily (the Life Science subsidiary of Alphabet in the USA).

Radboud Innovation supported the establishment of the *Foundation for Reinforcing Memories of Second World War Gelderland*, an initiative by Radboud University, Heritage Province of Gelderland, and RBT KAN.

For more information, see www.ru.nl/radboudinnovation.

Radboud Research Facilities

The Dutch province of Gelderland, together with the University, financed *Radboud Research Facilities* – a project designed to provide advanced research equipment for medical and scientific studies. This state-of-the-art equipment can also be used by companies in the region, providing an important stimulus for some of the leading research areas at the University. Think of research on new diagnostics, developing new drugs, new surgery techniques, brain research, research on behaviour, mobility research, genetics, digital security in health care and climate research. The facilities are of particular interest to young start-up companies, for example those working in health care, chemistry and life sciences, where access to high-tech equipment is key to product development. These young companies often lack the resources to make such investments in equipment.

UNIVERSITY-WIDE DATA ON SOCIETAL VALUE PRESENTED IN EIGHT CATEGORIES (2016 DATA)

1 Courses and training for public professionals: around 1200 courses with a turnover of €32.8 million (and participation from all over the Netherlands). Life Long Learning (post-academic education for *e.g.* physicians, lawyers, morticians, priests and vicars) and higher education for elderly people (HOVO).

2 Consortia: Collaborations with partners at the European, national and regional level as well as with non-European partners such as NGOs and companies.

3 Memberships of advisory councils: National Health Council, Cyber Security Council, Parliament and Senate, ministries, provinces, cities, residential areas, Water Management Boards, companies, national police, schools, institutions for mental health and other types of healthcare, etc. There are also numerous memberships of editorial boards of scientific journals and professional journals, of organising committees for conferences, of governing boards of *e.g.* museums and institutions for healthcare.

4 Research in collaboration with public partners: preparing exhibitions such as those on Jheronymus Bosch and Constantin the Great, and debates, plays and meetings with special interest groups and/or the wider public.

5 Projects for societal actors: 813 FTE (34%) of our researchers are involved in contract projects for public, private and/or public-private organisations. The turnover of contract research in 2016 was €91.7 million, 15% of which came from companies, 36% from non-profit organisations, 31 % from international organisations and 11% from charities. A total of 1133 articles were published in professional journals, as well as 284 annotations to laws (for legal practice) and several hundred guidelines and protocols for improving medical treatments.

6 Requests from the public sector: Researchers were involved in thousands of articles and interviews in print, online media and radio or TV appearances. In addition, they contributed to many popular books or other publications, open days and demonstrations for the general public. Around 18% of the Radboud Research Facilities (21 facilities) were used by other organisations outside the University, resulting in a turnover of €700,000. Of the 482 Full Professors, 66 have an appointment as Extraordinary Professor, implying that they are also engaged academically elsewhere.

7 Patent applications: 11 new patents were applied for in 2016. The patent policy of the University results in applications for patents, which are then sold to companies. Patent management and collecting royalties is not regarded to be core business.

8 Spin-offs: Based on the results of research, six new spin-off companies have been established. Courses on entrepreneurship have been offered to doctoral candidates. In June 2016, the Entrepreneurial Month concluded with a meeting on *Social Entrepreneurship* in which more than 120 start-ups, students and teachers participated.

In 2016, *Radboud Research Facilities* started or expanded collaboration with the following companies: HCM Medical, BC Semi, PinkRF, ModiQuest, Mead Johnson, Mercachem, Aspen and Hycult. As a result, the use of our research facilities by external parties increased. In 2016, more than forty companies have done so, which resulted in a turnover of €400,000. The website of *Radboud Research Facilities* (www.ru.nl/radboudresearchfacilities) has also been further professionalised and provided with a number of showcases. Much interest was shown for the nano-valorisation lab of the Faculty of Science. Two external parties currently use this advanced laboratory.

External evaluations

Our research institutes are evaluated periodically by an international committee of peers. Plans for further improvements are based on their assessments and recommendations.

These international committees assess the institutes according to the Standard Evaluation Protocol (SEP) for Academic Research in the Netherlands, which includes evaluating the training and education programme for PhD students. As of 2015 a revised version of this protocol was introduced (SEP 2015-2021) which has three criteria: research quality, relevance to society and viability.

The assessments, which range from excellent to unsatisfactory, are defined as follows:
1 World leading/excellent
2 Very good
3 Good
4 Unsatisfactory

In 2016 there were Assessment Reports on three institutes.

Institute for Molecules and Materials (IMM)

Overall the Peer Review Committee rated the Institute as very good to excellent:

- Research Quality 1
- Societal Relevance 1-2
- Viability 2

The Committee was also very positive about the quality of the four research themes:
The Committee presented some recommendations

Evaluation IMM

	Res. Qual	Soc. Rel	Viability
Theme 1 (Structure & Dynamics of Materials)	1	2	2
Theme 2 (Molecular Life-Like Systems)	1	1	2
Theme 3 (Quantum Matter)	1	1	1
Theme 4 (Materials Design)	2	2	3

for the next six years, which have since for a large part been implemented.

Institute for Mathematics, Astrophysics and Particle Physics (IMAPP)

This institute also received a very positive assessment. Some quotes from the report (no scores were given at the institute level):

- Research Quality: The overall quality of research activities and outputs of IMAPP are impressive and the excellent spirit of collegiality was evident throughout the site visit.
- Societal Relevance: The Committee is of the opinion that IMAPP's relevance to society is exemplary.
- Viability: The Institute seems to be well equipped for the future, with strong groups and strong leadership. ... Overall, the Committee finds the outlook for IMAPP's future very exciting.

The Committee was also very enthusiastic about the three departments of IMAPP:

Evaluation IMAPP

	Res. Qual	Soc.Rel	Viability
Mathematics	1	1	1.5
Astrophysics	1	1	1.5
High-Energy Physics	1	1	1.5

Some recommendations for the next six years were presented and these have for a large part been implemented.

The Research Centre for State and Law (SteR)

This Research Centre also received an overall positive assessment (no scores were provided at Centre level). Some quotes from the report:

- Research quality: The Committee is very enthusiastic about the specific focus SteR has chosen. Legal dogmatic research is the key to conceptual and principal consistency and integrity and SteR has positioned itself favourably in this respect, assuming a unique position in the Netherlands. ...The Committee found SteR's key publications to be of high quality.
- Societal Relevance: The Committee commends SteR's clear ambition to have a strong link with legal practice. Its relevance to society is evidenced through the numerous invitations to SteR researchers for advisory roles, their temporary judge positions, their media performances, the numerous publications aimed at legal practice (e.g. annotations) and the important fraction of SteR's income that is generated by contract research.
- Viability: The Committee is of the opinion that the chosen strategy ...merits continuation in future years. The Committee applauds (the fact) that in times of decreasing structural funding, the faculty has decided that it will continue to invest structurally in its research.

The generation change that has taken place, during which very good staff were attracted, has started to bear fruit during the reporting period and puts SteR in a good position for the years ahead.

The two programmes of SteR were assessed as follows:

Evaluation SteR

	Res. Qual	Soc.Rel	Viability
Principles of Public Law	2	2	2
Migration Law (CMR)	2	2	3

The Board of the Centre is currently formulating their response to the recommendations for the next six years as presented by the Committee.

The Assessment Reports are published in their entirety on our website: www.ru.nl/english/research/radboud/research-assessments/

Diversity

In order to design education and research from different perspectives, we aim to ensure we have diverse personnel, as more diversity will lead to more creativity and innovation. The University has a pro-active attitude regarding attracting and keeping talent, including males and females of diverse nationalities in all research positions. One of our targets for 2020 is to have at least 25% females and at least 25% males at all levels within the organisation. To achieve this, we launched the Christine Mohrmann Programme, named after the first female professor at Radboud University in 1952. Within this programme improving gender diversity contains three elements:

1 *Recruiting, selecting and developing personnel*
The programme enables young female talent to make a career in science through fellowships. Another possibility is to promote a female researcher to professor in an overlapping 'roofing tile structure', *i.e.* before her predecessor retires. For gifted female researchers there is a mentoring programme available and the recruiting and selecting process has been further professionalised.

2 *Enhancing awareness through training*
Since gender inequality is mainly due to unconscious prejudice, training of managers and selection committees is part of the programme.

3 *Offering facilities designed to create a better balance between work and private life*
The programme offers support to personnel in fine-tuning the balance between work and private life, in particular at peak periods such as participating in conferences, periods requiring extra care and pregnancy.

Recipients of a Christine Mohrmann stipend allowing them to work abroad for some time.

New options are being developed *e.g.* extension of possibilities for childcare and colleagues taking over research duties during maternal leave.

In addition to this programme, there is a Christine Mohrmann stipend, which allows ten female PhD students to continue their scientific career abroad after finishing their PhD each year. For top female scientists who finished their PhD no longer than five years previously, there is a *Network Female Professors Prize*.

In addition to this University-wide programme, faculties also take measures to improve gender and diversity. Some have a Gender Fund to cover the costs incurred by their policies. In cases when a female researcher acquires an NWO Vidi or Vici grant, she is offered an NWO Aspasia Grant, which enables promotion from Assistant Professor to Associate Professor and from Associate Professor to Full Professor, respectively. This grant also funds general costs involved in policies used to improve gender diversity at the faculty. In 2016, NWO gave the University the option to apply for six Aspasia Grants, four of which were applied for and awarded.

The proportion of female Full Professors at our University (24.2% in 2016) is among the highest in Dutch universities.

Academic integrity

The University Board actively promotes academic integrity and accountability by increasing awareness among researchers. In 2016 the research institutes reported on current practice, improvements and the implementation of rules for sound scientific conduct. These practices include dedicated seminars for staff, doctoral candidates and Research Master's students.

In addition to the confidential advisers on academic integrity at the University level, several research institutes also appointed their own confidential advisers. University guidelines have been developed which cover the duties and roles of de-centralised confidential advisers on academic integrity, in relation to the University's overarching confidential advisers on this issue. They meet twice a year for reflection among peers.

In line with *The Netherlands Code of Conduct for Scientific Practice* it is recognised that one of the most important ways to ensure reliable, verifiable and responsible research is good data management and safe storage in approved repositories. In the guidelines on the University policy, the primary responsibility for storage and management of research data lies with the researchers or project leaders, while the director of the research institute has final responsibility. The University facilitates this process. In this context, in 2016 three ICT pilots on storage and management of data were facilitated. The user interface for central storage of data and meta-data was also put into operation.

Radboud University has the following faculties:

- Faculty of Philosophy, Theology and Religious Studies
- Faculty of Arts
- Faculty of Law
- Faculty of Social Sciences
- Nijmegen School of Management
- Faculty of Science
- Faculty of Medical Sciences

Fundamental and applied research is carried out within 15 specialized institutes:

- Research Institute for Philosophy, Theology and Religious Studies
- Institute for Historical, Literary and Cultural Studies

- The Business & Law Research Centre
- Research Centre for State and Law

- Institute for Management Research

- Nijmegen Institute for Social & Cultural Research

- Behavioural Science Institute
- Centre for Language Studies
- Donders Institute for Brain, Cognition and Behaviour

- Radboud Institute for Health Sciences
- Radboud Institute for Molecular Life Sciences

- Institute for Water and Wetland Research
- Institute for Molecules and Materials
- Institute for Mathematics, Astrophysics and Particle Physics
- Institute for Computing and Information Sciences

On the Following pages: summaries on each of the 15 research institutes. The entire 2016 reports are available on www.ru.nl/researchreport

A picture of the University campus where all 15 research institutes are located.

Research Institute for Philosophy, Theology and Religious Studies

Director: Prof. Karin van Nieuwkerk

Researchers at the Research Institute for Philosophy, Theology and Religious Studies address fundamental questions concerning the nature, place and meaning of humans in the world. Research covers philosophical, theological and socio-cultural issues, and notably philosophical and religious concepts and world views held in the past and present. The Institute's research is subdivided into five themes, three of which coincide with those covered by existing research centres.

- Centre for the History of Philosophy and Science
- Centre for Catholic Studies
- Cognition, Culture and Language
- Centre for Contemporary European Philosophy
- Religion and the Crisis of Meaning

Research facilities

- Central humanities library
- Catholic Documentation Centre
- World's largest microfilm collection of medieval and Renaissance manuscripts

Societal impact

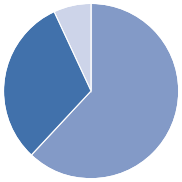
The societal relevance of research in the humanities manifests itself primarily in active contributions to the public domain, which take the form of publications, lectures, media appearances and exhibitions, and engagement in public debates as well as advising and training professionals. The Institute's main instrument here is *Radboud Reflects*, which – through lectures, debates, workshops and festivals – seeks to make the world of scholarship and science that is philosophically enhanced accessible to a wide audience. Each year, *Radboud Reflects* organises more than a hundred events, which are attended by over 10,000 people and reach over 100,000 people through its website and social media.

KEY FIGURES

Tenured	
Full Professors	8.5 FTE
Associate Professors	2.5 FTE
Assistant Professors	5.6 FTE
Researchers	1.6 FTE

Non-tenured	
Researchers	4.2 FTE
Doctoral candidates	14.0 FTE

Research staff funding



KEY PUBLICATIONS

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- Furnal, J.R. (2016). Catholic Theology after Kierkegaard. Oxford: Oxford University Press.
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- Nieuwkerk, K. van, Levine, M. & Stokes, M. (Ed.). (2016). Islam and Popular Culture. Austin: University of Texas Press.
- Palmerino, C.R. (2016). "Geschichte des Kontinuumproblems or Notes on Fromondus's Labyrinthus? On the True Nature of LH XXXVII, IV, 57 r°-58v°" (winner of the Leibniz Essay Award 2016). The Leibniz Review, 26, 63-97.

Dissertations	**16**
Scientific publications	**185**
Professional publications	**69**

Research Institute for Philosophy, Theology and Religious Studies

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Institute for Historical, Literary and Cultural Studies

Director: Prof. Olivier Hekster

The Institute for Historical, Literary and Cultural Studies (HLCS) is part of the Faculty of Arts. Its main objective is to create a stimulating environment for research in literature and literary theory, cultural studies, history, art history and archaeology. HLCS research is based on a common focus: 'Europe in a Changing World'.

The HLCS assembles, promotes and integrates humanities research from a wide range of disciplines in order to gain a deep understanding of the complexities of the past as well as those of the current state of Europe in a changing world. It focuses its research agenda on two major questions that address a range of key issues in contemporary humanities research and major current societal challenges in a mutually reinforcing way:

1. How and under which conditions do different kinds of loyalties, communities and categories of people emerge and disappear?
2. What do art and creativity mean for people and society

Research facilities

- Humaniora Library
- Centre for Art Historical Documentation (collections)
- Databases *e.g.* medieval pilgrim badges and ampullae, documents on life and work of Hieronymus Bosch, archives and publications of Catholic institutions and individuals

Societal impact

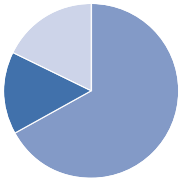
In 2016 the Bosch Research and Conservation Project (BRCP), which was set up in 2010 by art historian Prof. Jos Koldeweij, came to fruition. The main outcome of the project was the exhibition *Jheronimus Bosch – Visions of genius*, of which Jos Koldeweij was curator, together with Dr Matthijs Ilsink. Koldeweij and Ilsink are also the authors of the catalogue that accompanied the exhibition. Held from 13 February to 8 May in the Noordbrabants Museum in 's Hertogenbosch, the exhibition attracted more than 400,000 visitors and was awarded 'Exhibition of the Year' by the prestigious British art magazine *Apollo*. Source material on the painter has been made available for anyone who wants to know more about the life and work of the artist in Boschdoc, an online database with nearly 1000 documents. Boschdoc was awarded the Nederlandse Dataprijs 2016 (Dutch Data Award, category humanities and social sciences) for the accessibility and heritage value of the data and Prof. Jos Koldeweij received the 2016 Radboud Science Award for his research on Jheronimus Bosch.

KEY FIGURES

Tenured	
Full Professors	11.7 FTE
Associate Professors	2.4 FTE
Assistant Professors	16.3 FTE
Researchers	8.5 FTE

Non-tenured	
Researchers	7.8 FTE
Doctoral candidates	33.5 FTE

Research staff funding



KEY PUBLICATIONS

- Bierl, A. & Lardinois, A.P.M.H. (Eds.). (2016). *The Newest Sappho: P. Sapph. Obbink and P. GC inv. 105, frs. 1-4* (Studies in Archaic and Classical Greek Song, 2). Leiden: Brill. (xvi, 544 p.)
- Jensen, L.E. (2016). 'See our succumbing Fatherland, overwhelmed by disaster, woe and strife'. Coping with crisis during the reign of Louis Bonaparte. *Dutch Crossing. a Journal of Low Countries Studies, 40* (2), 151-164. doi: 10.1179/0309656412Z.00000000018
- Verhoeven, M.C.J., Bosman, L. & Asperen, H. van (Eds.). (2016). *Monuments & Memory. Christian Cult Buildings and Constructions of the Past. Essays in Honour of Sible de Blaauw* (ACSHA, 3). Turnhout: Brepols. (405 p.)

Dissertations	**17**
Scientific publications	**238**
Professional publications	**189**

Institute for Historical, Literary and Cultural Studies

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The Business & Law Research Centre

Director: Prof. Ben Schuijling

The Business & Law Research Centre – *Onderzoek-centrum Onderneming & Recht (OO&R)* – is a collaboration between the Faculty of Law and fifteen prominent, mostly international, law firms and Dutch multinationals.

The mission of the Centre is:

- to conduct high-quality (national and international) academic research.
- to enhance understanding of the theories which apply to Business and Law in the context of social, economic, political and financial developments.
- to encourage a practical approach to academic research, particularly by analysing the fundamental principles and foundations of (business-oriented) private law.
- to explore and initiate applications of academic research (*e.g.* in the area of national and international rules, regulations, principles and best practices).
- to educate and supervise Masters students and young researchers.

Research programmes

- Business and Patrimonial Law
- Finance, Security Rights and Insolvency Law
- Company Law
- Financial Law

An overarching theme of research in all programmes involves European Private law, comparative law and private international law.

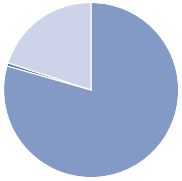
Research facilities

The Centre houses a collection of books, journals and electronic publications on international and domestic Business and Law that is unique in the Netherlands.

KEY FIGURES

Tenured	
Full Professors	7.44 FTE
Associate Professors	2.06 FTE
Assistent Professors	2.04 FTE
Researchers	0.97 FTE
Lecturers	0.2 FTE
Non-tenured	
Researchers	0.3 FTE
Lecturers	3.47 FTE
Doctoral candidates	15.87 FTE

Research staff funding



Societal impact

The Centre plays an active role in consultations launched by Dutch and European legislators. It has been commissioned to carry out two research projects by the Dutch Cyber Security Council and the Dutch Ministry of Security and Justice:

- 'Cyber Security and harmonised duties of care'
- 'Foreign investments and national security'

KEY PUBLICATIONS

- Faber, N.E.D., Vermunt, N.S.G.J., Kilborn, J.J., Richter, T. & Tirado, I. (2016). *Ranking and Priority of Creditors* (Oxford International and Comparative Insolvency Law Series, 3). Oxford: Oxford University Press.
- Hartkamp, A.S. (2016). *European Law and National Private Law. Effect of EU Law and European Human Rights Law on Legal Relationships between Individuals.* Cambridge: Intersentia.
- Jansen, C.J.H. (2016). *De wetenschappelijke beoefening van het burgerlijke recht tussen 1940 en 1992* (Serie Onderneming en recht, 93). Deventer: Wolter Kluwer.
- Jong, B.J. de (2016). The Distinction between Public and Private Companies and its Relevance for Company Law. Observations from the United Kingdom and the Netherlands. *European Business Law Review, 27* (1), 1-23.

Dissertations	**8**
Scientific publications	**126**
Professional publications	**84**
Annotations	**108**

Business & Law Research Centre

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Research Centre for State and Law

Director: Prof. Roel Schutgens

Researchers at the Centre for State and Law – *Onderzoekcentrum voor Staat en Recht (SteR)* – study the basic principles of public law. They critically analyse national, European and international developments in constitutional, administrative and criminal law. All of the Law Faculty's seven public law and meta-juridical departments participate in SteR.

SteR researchers focus on:

- The significance of the foundations underlying the national legal order.
- The national legal order's interaction with other legal systems, particularly the influence of European and international law in an emerging multi-layered legal order.
- The role of public law in the context of shifting roles of public authorities in a changing public domain.

Research programmes

- Principles of Public Law
- Migration Law

Societal impact

One example of great societal relevance is research on the regulation of cannabis (Prof. Van Kempen and Dr Fedorova), which was the subject of much discussion in the Dutch parliament and in the press. Another good example is the Handbook on Dutch migration law (Nederlands Migratierecht), which was presented by the CMR. As a Council of Europe rapporteur on migration issues, Dr Strik conducted research on the responsibilities towards migrants en route to the EU.

KEY FIGURES

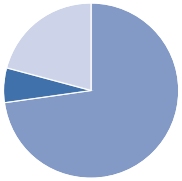
Tenured

Full Professors	5.1 FTE
Associate Professors	3.44 FTE
Assistent Professors	3.09 FTE
Researchers	0.78 FTE
Lecturers	0.78 FTE

Non-tenured

Researchers	6.03 FTE
Lecturers	4.26 FTE
Doctoral candidates	11.76 FTE

Research staff funding



KEY PUBLICATIONS

- Bovend'Eert, P.P.T., 'Judicial independence and separation of powers, A case study in modern court management', *European Public Law 2016*, vol. 22, p. 333-352.
- Fedorova, M.I. & Kempen, P.H.P.H.M.C. van (2016). Internationaal recht en cannabis II. Regulering van cannabisteelt en -handel voor recreatief gebruik. Positieve mensen-rechtenverplichtingen versus VN-drugsverdragen (Serie staat en recht). Deventer: Wolters Kluwer.
- Krommendijk, J. (2016). Is there light on the horizon? The distinction between 'Rewe-effectiveness' and the principle of effective judicial protection in Article 47 of the Charter after Orizzonte. *Common Market Law Review, 53* (5), 1395-1418.
- Mantu, S.A. & Minderhoud, P.E. (2016). Exploring the limits of social solidarity. Welfare tourism and EU citizenship. Unio. *Eu Law Journal, 2* (2), 4-19.

Dissertations	**8**
Scientific publications	**126**
Professional publications	**88**
Annotations	**153**

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Institute for Management Research

Director: Prof. Sandra van Thiel

The Institute for Management Research (IMR) is the research institute of the Nijmegen School of Management (NSM). Its mission is to carry out state-of-the-art research into complex problems of governance and management. The complexity of the problems studied calls for a combination of knowledge and expertise from multiple disciplines, and for collaboration with societally relevant actors. The IMR hosts researchers from business administration, economics and business economics, geography, planning and environmental sciences, as well as political science and public administration. IMR researchers combine scientific excellence with societal relevance. This is reflected in the institute's motto: creating knowledge for society.

The core of the IMR is formed by a number of 'Hot Spots' – collaborative networks of researchers from different disciplines with a joint interest in a specific research topic. Two overarching structures – the IMR Academy and the Doctoral School – ensure the cohesion of work at the institute.

Hot Spots

- Europeanisation of Policy and Law (EUROPAL)
- Governance and Innovation in Social Services (GAINS)
- Gender and Power in Politics and Management (GENDER)
- Global-Local Divides and Connections (GLOCAL)
- Innovation and Entrepreneurship in Business Ecosystems
- Integrated Decision-Making (ID)

Research facilities

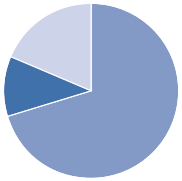
- The Visa Skills Lab for group-based decision-making
- The Decision Lab for research on individual and group decision-making
- Several large databases (examples):
  - Global Data Lab (GDL)
  - A dataset on Europeanisation of the Dutch civil service
  - A dataset on state aid notification procedures
  - Datasets from European projects MAGEEQ, QUING, STAGES, EGERA and GARCIA

KEY FIGURES

Tenured	
Full Professors	12.6 FTE
Associate Professors	9.2 FTE
Assistant Professors	24.9 FTE
Researchers	0.7 FTE
Lecturers	0.7 FTE

Non-tenured	
Researchers	10.0 FTE
Lecturers	1.6 FTE
Doctoral candidates	45.5 FTE

Research staff funding



Core
Grants
Contracts

Societal impact

IMR researchers cooperate with societal partners in a number of projects and events. A striking example is 'NatuurCollege on Tour', which was organised by the Department of Geography, Planning and Environment in cooperation with NatuurCollege. IMR researchers contribute to training courses for the public sector.

KEY PUBLICATIONS

- Aalbers, H.L., *et al.* (2016). Vertical and Horizontal Cross-Ties: Benefits of Cross-Hierarchy and Cross-Unit Ties for Innovative Projects. *Journal of Product Innovation Management*, 33(2), 141-153.
- Brandsen, T. & Honingh, M.E. (2016). Distinguishing Different Types of Coproduction: A Conceptual Analysis Based on the Classical Definitions. *Public Administration Review*, 76(3), 427-435.
- Buren, N. van, *et al.* (2016). Towards a Circular Economy: The Role of Dutch Logistics Industries and Governments. *Sustainability*, 8(7), 647-647.
- Keessen, A, Vink, *et al.* (2016). Solidarity in water management. *Ecology and Society*, 21(4), 1-10.
- Simons, T., *et al.* (2016). There's No Beer without a Smoke: Community Cohesion and Neighboring Communities' Effects on Organizational Resistance to Antismoking Regulations in the Dutch Hospitality Industry. *Academy of Management Journal*, 59(2), 545-578.

Dissertations:	**17**
Scientific publications:	**229**
Professional publications:	**132**

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Radboud Social Cultural Research

Director: Prof. Gerbert Kraaykamp

Within Radboud Social Cultural Research (RSCR) academic work focuses on developments in society with a multidisciplinary perspective. Descriptive and explanatory research is carried out on the central themes of inequality, cohesion and modernisation in both Western and non-Western societies. RSCR research has a comparative focus and employs innovative theoretical approaches, up-to-date analytical methodologies and original strategies for acquiring information.

RSCR consists of two research groups: Cultural Anthropology and Development Studies (CAOS) and Sociology. In 2016, the group working on Gender and Diversity joined the institute.

Research themes

- Inequality
- Cohesion
- Modernisation

Research facilities

Data facilities include both longitudinal collections – on Dutch individuals and their life courses (Family Survey Dutch Population (FSDP), Netherlands Longitudinal Life-course Survey (NELLS), Social and Cultural Developments in the Netherlands (SOCON)) – as well as cross-national surveys (*e.g.* the European Social Survey (ESS) and the New Immigrant Survey Netherlands (NIS2NL)). Within the Anthropology Department small-scale data are collected in Western and non-Western societies using ethnographic field research.

KEY FIGURES

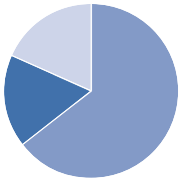
Tenured

Full Professors	3.1 FTE
Associate Professors	1.1 FTE
Assistant Professors	7.3 FTE

Non-tenured

Researchers	4.0 FTE
Doctoral candidates	12.9 FTE

Research staff funding



Societal impact

Researchers at RCSR advise public and private institutions and act as consultants. For instance, advice was given on behalf of the European Parliament, European Institute for Gender Equality, the Dutch Ministries of Social Affairs and Education. RSCR scholars also gave advice on international surveys (such as the European Social Survey/CUPESSE) and national data collection (NDSW and Statistics Netherlands).

KEY PUBLICATIONS

- Jacobs, K.T.E. & Spierings, N. (2016). Social media, parties, and political inequalities. New York: Palgrave Macmillan.
- Jaffe, R.K. & Koning, A. de (2016). *Introducing urban anthropology*. London: Routledge.
- Jansen, L., Weber, T., Kraaykamp, G.L.M. & Verbakel, C.M.C. (2016). Perceived fairness of the division of household labor: A comparative study in 29 countries. *International Journal of Comparative Sociology*, 57(1-2), 53-68.
- Lubbers, M. & Meuleman, R. (2016). Participation in national celebrations and commemorations: The role of socialization and nationalism in the Dutch context. *Social Science Research*, 55, 111-121.
- Vries, J.A. de & Brink, M.C.L. van den (2016). Transformative gender interventions: Linking theory and practice using the "bifocal approach". *Equality, Diversity and Inclusion*, 35(7/8), 429-448.

Dissertations	**5**
Scientific publications	**124**
Professional publications	**98**

Radboud Social Cultural Research

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Behavioural Science Institute

Director: Prof. Toon Cillessen

The Behavioural Science Institute (BSI) conducts research on human behaviour. The work of the Institute is both fundamental (to understand behaviour) and applied to societal challenges (to influence behaviour). A distinctive feature of the BSI is an integrative approach to human behaviour that transcends the traditional disciplinary boundaries of psychology, education and communication science. The BSI is accredited as a research school by the Royal Netherlands Academy of Arts and Sciences (KNAW).

The three main research themes of BSI are:
- Development and Learning
- Psychopathology, Health and Well-Being
- Social Processes and Communication

Research facilities

- A Virtual Reality Lab for immersive, three-dimensional computer-generated environments
- A Sport Lab for behavioural and psychophysiological measures during exercise
- Stabilometric platforms for research on freeze-approach-avoidance behaviour
- A Bar Lab for observational studies of social behaviour in a natural setting

Societal impact

A symposium on *The Young Consumer* was organised in September 2016, for professionals who have young people (children, adolescents, and young adults) as a target group. BSI scholars hooked up with practitioners in the field to present an academic yet applied approach to 'hot topics' in youth-directed communication such as positive and responsible persuasion, age segmentation, character marketing, storytelling, co-creation and tailored communication. It is expected that there will be a follow-up in the spring of 2018.

KEY FIGURES

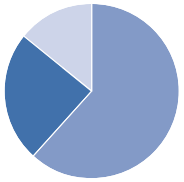
Tenured

Full Professors	9.4 FTE
Associate Professors	6.3 FTE
Assistant Professors	19.4 FTE
Researchers	0.7 FTE

Non-tenured

Researchers	18.6 FTE
Doctoral candidates	62.9 FTE

Research staff funding



KEY PUBLICATIONS

- Chen, Z., Veling, H., Dijksterhuis, A., & Holland, R.W. (2016). How does not responding to appetitive stimuli cause devaluation: Evaluative conditioning or response inhibition? *Journal of Experimental Psychology: General*, 145 (12), 1687-1701.
- Poppelaars, M., Tak, Y.R., Lichtwarck-Aschoff, A., Engels, R.C.M.E., Lobel, A.M., Merry, S.N., Lucassen, M.F.G. & Granic, I. (2016). A randomized controlled trial comparing two cognitive-behavioral programs for adolescent girls with subclinical depression: A school-based program (Op Volle Kracht) and a computerized program (SPARX). *Behaviour Research and Therapy*, 80, 33-42.
- Vries, J.D. de, Hooff, M.L.M. van, Geurts, S.A.E. & Kompier, M.A.J. (2016). Exercise as an intervention to reduce study-related fatigue among university students: A two-arm parallel randomized controlled trial. *PLoS One*, 11(3), art. nr.-e0152137.

Dissertations	**27**
Scientific publications	**531**
Professional publications	**138**

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Centre for Language Studies

Director: Prof. Antal van den Bosch

The Centre for Language Studies (CLS) carries out top-level research in linguistics, psycholinguistics, language and speech technology, as well as communication in a stimulating academic environment. There is a strong focus on innovation and an interdisciplinary approach.

Research at CLS takes place in two programmes:
- Language in Mind
- Language in Society

Research facilities
- State-of-the-art language laboratory
- Large databases (written, spoken and multimodel (sign) language
- Baby lab
- Access to the Donders Institute facilities (Encephalography, MRI, etc.)

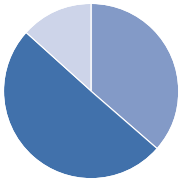
Societal impact
The website DoofGewoon.nl (lit. 'Deaf normal') was created to inform parents of deaf children about what else there is in the lives of deaf children and deaf adults apart from their hearing loss. The site, which presents information about deaf culture, multilingualism and sign language, contains contributions by parents and deaf people. Being deaf turns out to be rather normal. Onno Crasborn was one of the initiators of this site, which was created by sign language researchers from CLS, the University of Amsterdam, as well as FODOK, Dovenschap and NDJ, which are Dutch organisations for the deaf.

KEY FIGURES

Tenured	
Full Professors	8.1 FTE
Associate Professors	5.4 FTE
Assistant Professors	9.5 FTE
Researchers	3.3 FTE

Non-tenured	
Researchers	22.3 FTE
Doctoral candidates	38.7 FTE

Research staff funding



KEY PUBLICATIONS

- Hilberink-Schulpen, B.J.H., Nederstigt, U., Meurs, W.F.J. van & Alem, E. van (2016). Does the use of a foreign language influence attention and genre-specific viewing patterns for job advertisements? An eye-tracking study. *Information Processing & Management, 52* (6), 1018-1030. doi: 10.1016/j.ipm.2016.04.007
- Hubers, F.C.W., Snijders, T.M. & Hoop, H. de (2016). How the brain processes violations of the grammatical norm: An fMRI study. *Brain and Language, 163*, 22-31. doi: 10.1016/j.bandl.2016.08.006
- Schepens, J.J., Slik, F.W.P. van der & Hout, R.W.N.M. van (2016). L1 and L2 distance effects in learning L3 Dutch. *Language Learning: a Journal of Applied Linguistics, 66* (1), 224-256. doi: 10.1111/lang.12150

Dissertations	**14**
Scientific publications	**286**
Professional publications	**72**

Centre for Language Studies

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Donders Institute for Brain, Cognition and Behaviour

Director: Prof. David Norris

The Donders Institute is dedicated to increasing understanding of the basis of human cognition and behaviour – in health and disease – in the brain.

The Donders Institute is home to more than 700 researchers from more than 35 countries who share the common goal of contributing to advancing brain-, cognitive- and behavioural sciences through investigator and curiosity-driven research, and improving health, education, nutrition, and technology by applying advances in this field.

The DI's mission is to be a leading international research centre in the field of systems level cognitive neuroscience. This includes conducting excellent interdisciplinary research at the unique interface between genetic, molecular and cellular processes at one end of the spectrum and computational, system-level neuroscience with cognitive and behavioural analyses at the other end. Within this wide interdisciplinary range the Institute focuses on four research themes:

1 Language and Communication
2 Perception, Action and Control
3 Plasticity and Memory
4 Brain Networks and Neuronal Communication

Research facilities

- fMRI-scanners (including neuroimaging equipment)
- MEG, EEG and Neuro-modulation facilities
- Neural recording and advanced microscopy equipment
- Genetics, Molecular Biology, Biobank and Translational Genomics facilities
- Clinical trial, Babylab and animal model facilities
- Artificial Intelligence laboratory
- Diverse sensorimotor facilities *e.g.* vestibular chair and fall simulator
- Virtual reality equipment

Societal impact

The research carried out at the Institute has considerable potential for benefiting society in five areas: Health & Healthcare, Food & Cognition, Learning & Education, Neurotechnology & Big Data and Public & Policy. A key aim is to disseminate expertise and knowledge to a wide range of stakeholders.

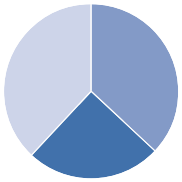
To inform the *general public*, Donders researchers appear regularly on national television, in numerous national and international newspapers, on radio at large festivals and on many websites. In the blog 'DondersWonders', researchers at the Institute write non-specialist articles on neuroscientific topics for the general public. With two blogs per week in Dutch and English, and over 150,000 views in 2016, this clearly has considerable impact.

KEY FIGURES

Tenured	
Full Professors	29.6
Associated Professors	13.4
Assistant Professors	29.6
Researchers	24.6

Non-tenured	
Researchers	139.0
Doctoral candidates	226.6

Research staff funding



KEY PUBLICATIONS

- Saksens, N. T. M., *et al.* (2016). Mutations in CTNNA1 cause butterfly-shaped pigment dystrophy and perturbed retinal pigment epithelium integrity. *Nature Genetics, 48*(2), 144-151.
- Scheeringa, R., *et al.* (2016). The relationship between oscillatory EEG activity and the laminar-specific BOLD signal. *Proceedings of the National Academy of Sciences, 113*(24), 6761-6766.
- Takeuchi, T., *et al.* (2016). Locus coeruleus and dopaminergic consolidation of everyday memory. *Nature, 537*(7620), 357-362.
- Willems, R.M., *et al.* (2016). Prediction during natural language comprehension. *Cerebral Cortex*, 26(6), 2506-2516.

Dissertations	**78**
Academic publications	**1279**
Professional publications	**63**
Patents	**1**

Donders Institute for Brain, Cognition and Behaviour

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Radboud Institute for Health Sciences

Director: Prof. Bart Kiemeney

The mission of the Radboud Institute for Health Sciences (RIHS) is to improve clinical practice and public health. It does so by providing evidence of the efficacy and efficiency of existing and new tests, treatments and policies as well as innovative modes of health care delivery, by training young researchers in methodologies for obtaining such evidence, and by developing new methodologies for improving research programmes in this field.

The Institute's focus is on developing methodologies that optimise personalised healthcare and on the application of these tools in disease-oriented research themes. Societal impact is at the core of the Institute's ambitions. The Institute's education of young researchers is accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW).

Research Themes

- Healthcare improvement science
- Cancer development and immune defence
- Rare cancers
- Tumours of the digestive tract
- Urological cancers
- Women's cancers
- Infectious diseases and global health
- Inflammatory diseases
- Mitochondrial diseases
- Reconstructive and regenerative medicine
- Renal disorders
- Vascular damage

Research facilities

RIHS hosts some of the 19 formal Radboudumc Technology Centres (some examples):

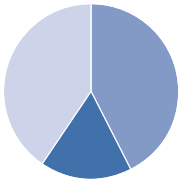
- The Radboud Biobank
- The Clinical Trials Centre
- Consultation facilities for statistics, health economics and transmural research.
- The Minimal Invasive Technology Expert Center (MITeC)
- Human Performance Lab (*in vivo* measurement techniques).
- A 3D lab, which offers 3D imaging and 3D printing

KEY FIGURES

Tenured	
Full Professors	24.2 FTE
Associate Professors	9.7 FTE
Assistant Professors	54.1 FTE
Researchers	80.3 FTE

Non-tenured	
Researchers	151.0 FTE
Doctoral candidates	148.8 FTE

Research staff funding



Societal impact

SCREENIVF, an instrument designed to screen psychosocial risks in IVF couples, developed by Dr Chris Verhaak *et al.* was implemented in the European Guidelines for clinical practice of the European Society of Human Reproduction and Embryology and adopted by more than 1000 European fertility clinics (*Human Reproduction*, 2016). In collaboration with the Oxford University Clinical Research Unit in Vietnam, Prof. Heiman Wertheim showed that use of a five-minute test can reduce antibiotic misuse when treating respiratory infections (*Lancet Global Health*, 2016).

KEY PUBLICATIONS

- Baan, H.F., *et al.* (2016). A New 3D Tool for Assessing the Accuracy of Bimaxillary Surgery: The OrthoGnathicAnalyser. PLoS One, 11(2), e0149625.
- Dicko, A., *et al.* (2016). Primaquine to reduce transmission of Plasmodium falciparum malaria in Mali: a single-blind, dose-ranging, adaptive randomised phase 2 trial. Lancet Infect Dis. 16 (6), 674-84.
- Eilander, H.J., *et al.* (2016). Ten-to-twelve years after specialized neurorehabilitation of young patients with severe disorders of consciousness: A follow-up study. Brain Inj. 30 (11), 1302-1310.
- Rooij, M. de, *et al.* (2016). Accuracy of Magnetic Resonance Imaging for Local Staging of Prostate Cancer: A Diagnostic Meta-analysis. European Urology, 70(2), 233-45.

Dissertations	**85**
Scientific publications	**2094**
Patents	**1**

Radboud Institute for Health Sciences

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Radboud Institute for Molecular Life Sciences

Scientific director: Prof. René J.M. Bindels

Researchers at the Radboud Institute for Molecular Life Sciences (RIMLS) aim to increase insight into the molecular basis of disease as expressed in the slogan "Today's molecules for tomorrow's medicine." This is achieved by integrating molecular and medical research to obtain multifaceted knowledge of normal and pathological processes. Findings are translated into clinical applications, into the development of diagnostics, and into the treatment of patients as part of personalised healthcare.

RIMLS – a leading research institute that focuses on the molecular mechanisms of disease – brings together research groups from the Radboud university medical center (Radboudumc) and the Faculty of Science. Clinical and fundamental scientists who specialise in diverse areas of the life sciences work closely together in programmes designed to understand the underlying causes of disease.

Research themes

- Cancer development and immune defence
- Rare cancers
- Tumours of the digestive tract
- Urological cancers
- Women's cancers
- Infectious diseases and global health
- Inflammatory diseases
- Mitochondrial diseases
- Reconstructive and regenerative medicine
- Renal disorders
- Vascular damage
- Nanomedicine

Research facilities

The 19 Radboudumc Technology Centres are linked to the Radboud University Research Facilities.

RIMLS hosts the following centres:

- The Centre for Molecular and Biomolecular Informatics
- The Genomics Technology Centre
- The Mass Spectrometry Technology Centre
- The Microscopy Facility
- The Central Animal Facility
- The Imaging Technology Centre

KEY FIGURES

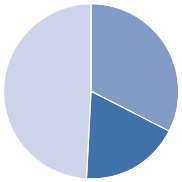
Tenured

Full Professors	31.1 FTE
Associate Professors	15.2 FTE
Assistant Professors	28.7 FTE
Researchers	31.8 FTE

Non-tenured

Researchers	162.6 FTE
Doctoral candidates	207.1 FTE

Research staff funding



- The Investigational Medicinal Products (IMP) technology platform

Societal impact

Prof. Jolanda de Vries (Cancer development and immune defence) appeared in the Dutch media to inform the public of a new experimental vaccine treatment that reduces the risk of the recurrence of skin cancer. This treatment will be covered by national basic health insurance.

KEY PUBLICATIONS

- Bekkering, S., *et al.* (2016). Innate immune cell activation and epigenetic remodeling in symptomatic and asymptomatic atherosclerosis in humans in vivo. *Atherosclerosis*, 254, 228-236.
- Iannetti, E.F., *et al.* (2016). Multiplexed high-content analysis of mitochondrial morphofunction using live-cell microscopy. *Nature Protocols*, 11(9), 1693-710.
- Neste, L. Van, *et al.* (2016). Detection of High-grade Prostate Cancer Using a Urinary Molecular Biomarker-Based Risk Score. *European Urology*, 70(5), 740-8.
- Novakovic, B., *et al.*(2016). beta-Glucan Reverses the Epigenetic State of LPS-Induced Immunological Tolerance. *Cell*, 167(5), 1354-1368.
- Winde, C.M. de,*et al.* (2016). Tetraspanin CD37 protects against the development of B cell lymphoma. *Journal of Clinical Investigation*, 126(2), 653-66.

Dissertations	**78**
Scientific publications	**1331**
Patents	**6**

Radboud Institute for Molecular Life Sciences

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Institute for Water and Wetland Research

Director: Prof. Hans de Kroon

The IWWR encourages interdisciplinary cooperation among scientists engaged in microbial, animal, plant and environmental science. The Institute integrates these disciplines in several themes and encourages joint research that enhances understanding of interactions between different life forms as well as the way they interact with their habitats. Based on novel fundamental insights into these processes, the Institute makes a significant contribution to innovative solutions to urgent global water problems.

Research Clusters

- Microbiology
- Aquatic Ecology
- Environmental Science
- Plant Ecology and Plant Science
- Animal Ecology and Physiology

Research facilities

- Radboud Experimental Garden, including a greenhouse and the Phytotron
- State-of-the-art light microscopy and electron microscopy
- Extensive bioreactor and culture facilities for micro-organisms
- Aquarium facilities for freshwater and seawater fish; permits for transgenes.
- Extensive molecular biological facilities
- Analytical equipment

Societal impact

The IWWR contributes to solutions for some of the most pressing water problems in the world. It does so by establishing close relationships based on novel insights between researchers at the Institute and external stakeholders. Such intensive interactions lead to solutions for urgent societal problems as well as new fundamental research. Novel insights into nature and water management are applied in collaborative studies with governmental and non-governmental organisations, water boards, as well as national, regional and local authorities.

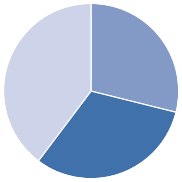
The IWWR collaborates with a large number of companies and partners engaged in nature and water management. Collaboration within the Institute opens up avenues for novel interdisciplinary research as well as more opportunities for knowledge transfer and application.

KEY FIGURES

Tenured	
Full Professors	4.3 FTE
Associate Professors	0.8 FTE
Assistant Professors	6.6 FTE
Researchers	1.6 FTE

Non-tenured	
Researchers	23.4 FTE
Doctoral candidates	39.8 FTE

Research staff funding



KEY PUBLICATIONS

- Angelini, C., *et al.* (2016). A keystone mutualism underpins resilience of a coastal ecosystem to drought. *Nature Communications*, 7, 12473
- Nguyen, D., *et al.* (2016). Drought and flooding have distinct effects on herbivore-induced responses and resistance in Solanum dulcamara. *Plant, Cell and Environment*, 39(7), 1485-1499.
- Salguero-Gomez, R., *et al.* (2016). Fast-slow continuum and reproductive strategies structure plant life-history variation worldwide. *Proceedings of the National Academy of Science USA*, 113(1), 230-235.
- Schipper, A.M., *et al.* (2016). Contrasting changes in the abundance and diversity of North American bird assemblages from 1971 to 2010. *Global Change Biology,* 22(12), 3948-3959.
- Speth, D.R., *et al.* (2016). Genome-based microbial ecology of anammox granules in a full-scale wastewater treatment system. *Nature Communications*, 7, 11172-11181.

Dissertations	**14**
Scientific publications	**240**
Professional publications	**2**

Institute for Water and Wetland Research

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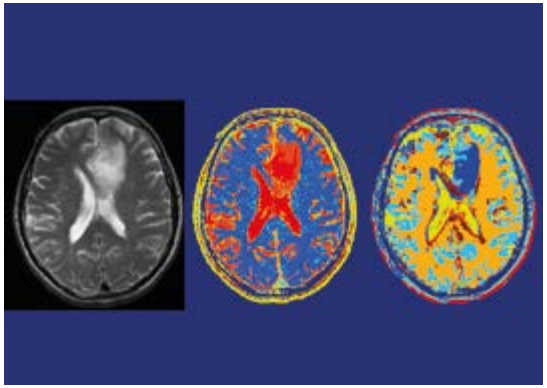
Institute for Molecules and Materials

Director: Prof. Theo Rasing



The Institute for Molecules and Materials is an interdisciplinary institute that is engaged in research in chemistry and physics. Its mission is to perform fundamental research in order to better understand, design and control the functioning of molecules and materials. The institute is a centre of excellence that trains the next generation of leaders in science and entrepreneurship. Its staff actively explores and promotes interaction with industry and the application of its research results.

Themes

- Structure and Dynamics of Molecules
- Chemistry and Spectroscopy of Complex Molecular Systems
- Quantum Matter

Research facilities

- High Field Magnet Laboratory (HFML) for continuous fields up to 37.5 Tesla. A hybrid magnet for achieving 45 Tesla is being constructed.
- FELIX (Free Electron Lasers for Infrared eXperiments) Laboratory. Infrared lasers (FEL-1/FEL-2/FELICE) and Terahertz laser (FLARE)
- Unique combination of FELIX and HFML
- Solid-State NMR Facility
- Scanning Probe Microscopy laboratory
- Trace Gas Facility

Societal impact

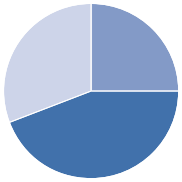
Research at the IMM focuses on societally relevant problems, such as faster and more energy-efficient ways of computing, transferring and storing data, more efficient chemical reactors and molecular quantum devices, as well as new methods for drug delivery. At the IMM innovative products have been co-discovered and developed, including graphene, ultrafast switchable magnetic materials, solar cells and hydrogels for biomedical applications.

KEY FIGURES

Tenured	
Full Professors	10.0 FTE
Associate Professors	2.0 FTE
Assistant Professors	9.8 FTE
Researchers	3.2 FTE

Non-tenured	
Researchers	57.8 FTE
Doctoral candidates	109.6 FTE

Research staff funding



KEY PUBLICATIONS

- Grzybowski, B.A. & Huck, W.T.S. (2016). The nanotechnology of life-inspired systems. *Nature Nanotechnology,* 11(7), 584-591.
- Huisman, T.J., Mikhaylovskiy, R., Costa, J.D., Freimuth, F., Paz, E., Ventura, J., Freitas, P.P., Blugel, S., Mokrousov, Y., Rasing, T. & Kimel, A.V. (2016). Femtosecond control of electric currents in metallic ferromagnetic heterostructures. *Nature Nanotechnology*, 11(5), 455-472.
- Onvlee, J., Gordon, S.D.S., Vogels, S.N., Auth, T., Karman, T., Nichols, B., Avoird, A. van der, Groenenboom, G.C., Brouard, M. & Meerakker, S.Y.T. van de (2016). Imaging Quantum Stereodynamics through Fraunhofer scattering of NO radicals with rare-gas atoms. *Nature Chemistry*, (), 1-8.
- Tu, Y., Peng, F., Sui, X., Men, Y., White, P.B., van Hest, J.C.M. & Wilson, D. (2016). Self-propelled supramolecular nanomotors with temperature-responsive speed regulation. *Nature Chemistry*, 1-7.
- Wallbank, J.R., Ghazaryan, D., Misra, A., Cao, Y., Tu, J.S., Piot, B.A., Potemski, M., Pezzini, S., Wiedmann, S.R., Zeitler, U., Lane, T.L.M., Morozov, S.V., Greenaway, M.T., Eaves, L., Geim, A.K., Fal'ko, V.I., Novoselov, K.S. & Mishchenko, A. (2016). Tuning the valley and chiral quantum state of Dirac electrons in van der Waals heterostructures. *Science*, 353(6299), 575-579.

Dissertations	**29**
Scientific publications	**402**
Professional publications	**1**
Patents	**4**

Institute for Molecules and Materials
Managing director:
Dr Freya Senf-Huijgen

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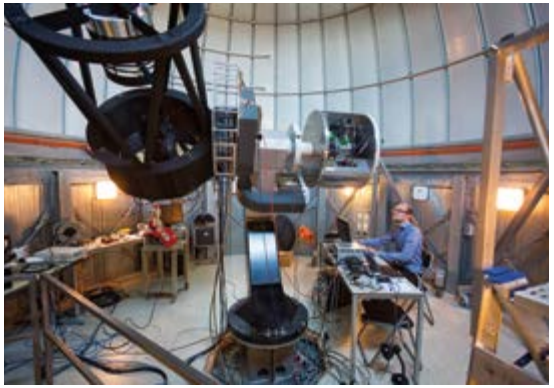
Institute for Mathematics, Astrophysics and Particle Physics

Director: Prof. Frank Verbunt



The Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) carries out fundamental research in mathematics, high-energy physics and astrophysics, with a special focus on interdisciplinary topics. The overarching research theme is the origin and evolution of the universe and its underlying mathematical structures. The Institute is also actively engaged in outreach.

Themes of programmes

- Mathematics
- Astrophysics
- High-energy physics

Research facilities

- Large Hadron Collider (LHC; Geneva), the world's largest and most powerful particle accelerator
- Astronomical and astroparticle observatories: ESO, La Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger
- Under development are the IMAPP-led BlackHoleCam, BlackGEM and MeerLICHT facilities
- Radboud Radio Lab
- Two optical telescopes
- Facilities at the National Institute for Nuclear and High-Energy Physics (Nikhef)

Societal impact

The BlackGEM project collaborates with Airborne Composites in the Netherlands and the Fornax, Sybilla, Cilium and STA companies globally. MeerLICHT and DOME collaborate with IBM on green and exascale computing. Within the NOVA context IMAPP collaborates with a dozen additional Dutch companies.

KEY FIGURES

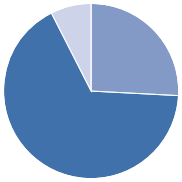
Tenured

Full Professors	6.2 FTE
Associate Professors	3.4 FTE
Assistant Professors	7.9 FTE

Non-tenured

Researchers	27.7 FTE
Doctoral candidates	45.3 FTE

Research staff funding



KEY PUBLICATIONS

- Aaboud, M., Caron, S., Colasurdo, L., Croft, V., Groot, N. de, Filthaut, F., Galea, C., Konig, A., Nektarijevic, S., Strubig, A. & *et al.* (2016). Search for squarks and gluinos in final states with jets and missing transverse momentum at vs = 13 TeV with the ATLAS detector. *The European Physical Journal C: Particles and Fields*, 76(7), 1-29.
- Abbott, B.P., Bloemen, S., Ghosh, S., Groot, P., Nelemans, G., Nissanke, S., Setyawati, Y., Shah, S. & *et al.* (2016). Observation of Gravitational Waves from a Binary Black Hole Merger. *Physical Review Letters,* 116(6), 061102-.
- Buitink, S., Corstanje, A., Falcke, H., Hörandel, J.R., Nelles, A., Rachen, J.P., Rossetto, L., Schellart, P. & Thoudam, S. (2016). A large light-mass component of cosmic rays at 1017-1017.5 electronvolts from radio observations. *Nature*, 531(7592), 70-73.
- Gies, H., Knorr, B., Lippoldt, S. & Saueressig, F. (2016). Gravitational Two-Loop Counterterm Is Asymptotically Safe. *Physical Review Letters*, 116(21), 1-7.
- Suijlekom, W.D. van (2016). Localizing gauge theories from noncommutative geometry. Advances in Mathematics (new York. 1965), 290, 682-708.

Dissertations	**11**
Scientific publications	**505**
Professional publications	**1**

Institute for Mathematics, Astrophysics and Particle Physics

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Institute for Computing and Information Sciences

Director: Prof. Herman Geuvers

The aim of the Institute for Computing and Information Sciences (iCIS) is to contribute both to science and to society. The Institute works from the perspective that computer scientists are not just the architects of the digital world, but have become the architects of the social world as well. The societal focus is on diligence. Now that computing technology is shaping all aspects of modern societies, we need to be careful about how we employ these technologies. iCIS has again been evaluated as the top Computing Science institute in the Netherlands.

Themes

- Digital security
- Software science
- Data science

Societal impact

Research continued on the privacy and security of medical data, in collaboration with Radboudumc (the PEP project). The Cyber Security Council granted an assignment on the role of the 'duty of care' to the Law Faculty of the university, with Prof. Mireille Hildebrandt involved in supervision. Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on Cyber Security issues and Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting that was set up by the Dutch Ministry of the Interior. Further evidence of societal impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) funds a part-time chair in Information Security (Prof. Eric Verheul).

KEY FIGURES

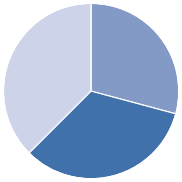
Tenured

Full Professors	5.1 FTE
Associate Professors	1.2 FTE
Assistant Professors	3.6 FTE

Non-tenured

Researchers	13.5 FTE
Doctoral candidates	40.1 FTE

Research staff funding



KEY PUBLICATIONS

- Basold, H. & Geuvers, H. (2016). Type Theory based on Dependent Inductive and Coinductive Types. In S. Koskinen (Eds.), LICS '16: Proceedings of the 31st Annual ACM/IEEE Symposium on Logic in Computer Science, New York, NY, USA – July 05 – 08, 2016, (pp. 327-336). New York: IEEE.
- Erdem, A., Ducas, L., Pöppelman, T. & Schwabe, P. (2016). Post-quantum key exchange – a new hope. In (Eds.), 25th USENIX Security Symposium, August 10-12, 2016, Austin, TX, USA. Proceedings (pp. 327-343). Austin: USENIX.
- Fiterau-Brostean, P., Janssen, R. & Vaandrager, F.W. (2016). Combining Model Learning and Model Checking to Analyze TCP Implementations. In S. Chaudhuri (Eds.), Computer Aided Verification: 28th International Conference, CAV 2016, Toronto, ON, Canada, July 17-23, 2016, Proceedings, Part II (Lecture Notes in Computer Science,9780). (pp. 454-471). Berlin: Springer.
- Traub, M.C., Samar, T., Ossenbruggen, J. van, He, J., Vries, A.P. de & Hardman, L. (2016). Querylog-based Assessment of Retrievability Bias in a Large Newspaper Corpus. In N.R. Adam (Eds.), JCDL '16 : Proceedings of the 16th ACM/IEEE-CS on Joint Conference on Digital Libraries: Big Libraries, Big Data, Big Innovation, Rutgers University, Newark, NJ, USA, June 19-23, 2016, (pp. 7-16). New York: ACM.

Dissertations	**10**
Scientific publications:	**237**
Professional publications:	**6**

Institute for Computing and Information Sciences

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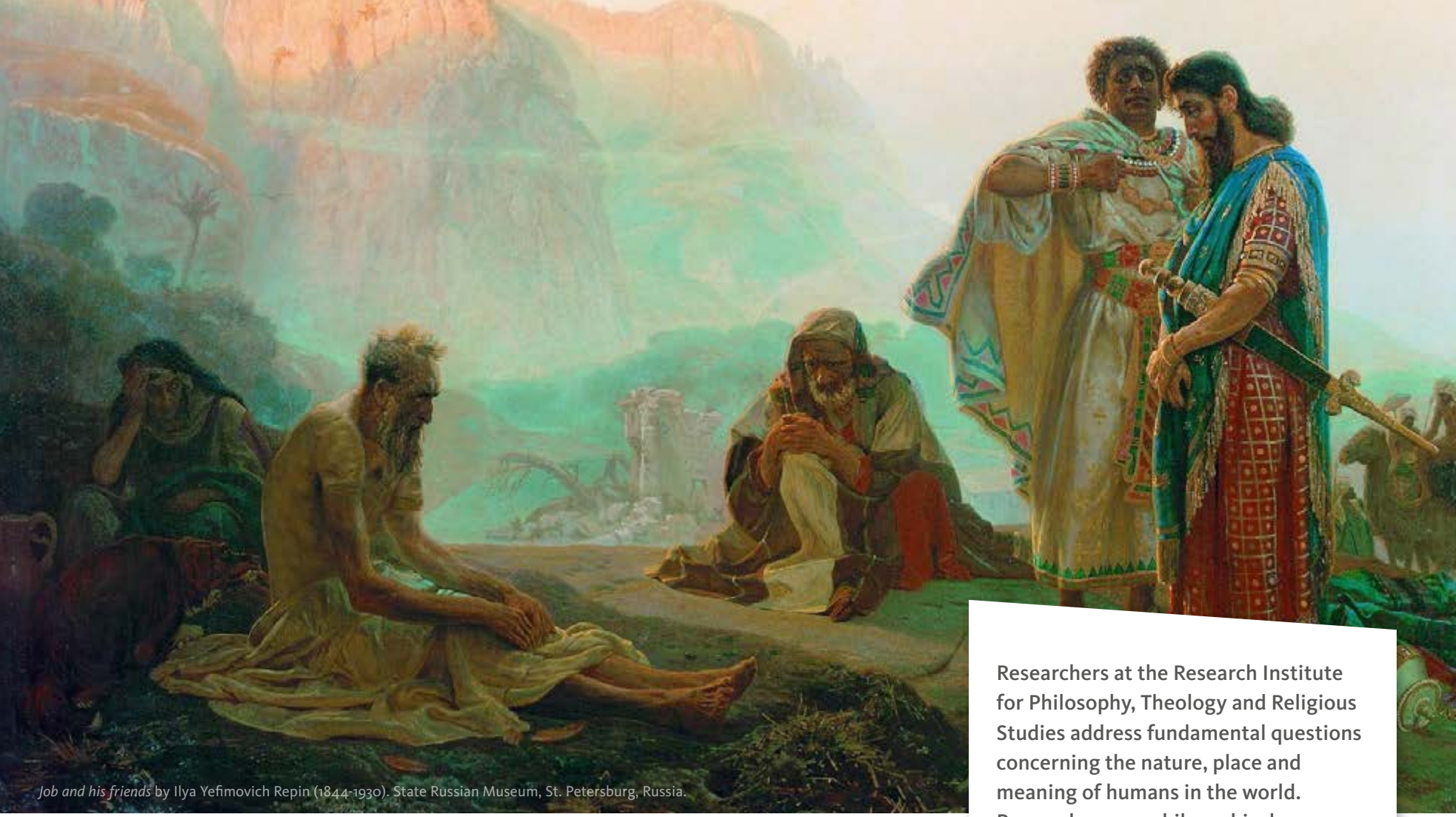
Radboud Research Institutes

Radboud University

A picture of the University campus where all 15 research institutes are located.



Job and his friends by Ilya Yefimovich Repin (1844-1930). State Russian Museum, St. Petersburg, Russia.

Research Institute for Philosophy, Theology and Religious Studies

Researchers at the Research Institute for Philosophy, Theology and Religious Studies address fundamental questions concerning the nature, place and meaning of humans in the world. Research covers philosophical, theological and socio-cultural issues, and notably philosophical and religious concepts and world views held in the past and present. The Institute's research is subdivided into five themes, three of which coincide with those covered by existing research centres.

1 Centre for the History of Philosophy and Science (CHPS)
The CHPS is the only research centre in the world where the history of philosophy and science are investigated as intertwined phenomena. Researchers investigate the emergence and development of the rich discipline of natural philosophy from antiquity right through to its eventual fragmentation into the modern scientific disciplines of the modern age. They also enquire into the relationship between philosophy and science today.

2 Centre for Catholic Studies (CCS)
Researchers at this centre investigate the historical and contemporary interconnections of religion, theology and spirituality with cultural developments and intellectual debates. They contribute to a better understanding of the complexities of today's globalised society and the implications for religion. The main focus is on public theology, a field in which the public relevance of the Christian tradition is addressed, and on the historical roots of current issues within the religious domain.

3 Cognition, Culture and Language (CCL)
Researchers at CCL focus on interdisciplinary issues at the intersection between cognition, culture and language. The overlapping areas of their research are 'situated knowledge' (how are cognitive capacities shaped by cultural norms and linguistic concepts?), 'ordinary discourse' (what is the role of pragmatics, convention and context in the interpretation of everyday language?), and 'ancient texts' (what do they tell us about the concept of mind in Hebrew and Greek culture?).

4 Centre for Contemporary European Philosophy (CCEP)
CCEP is the Netherlands' only research centre with a focus on continental philosophy. Researchers contribute to a variety of contemporary currents, including phenomenology, metaphysics, hermeneutics, psychoanalysis, critical theory, political philosophy and virtue ethics. Subjects of particular interest are the impact and critique of modernity and its various symptoms, including the secularisation and rationalisation of society.

5 Religion and the Crisis of Meaning (RCM)
Researchers at RCM investigate religiosity and spirituality in relation to death, conflict and contingency, and they do so from Christian, Islamic and Asian religious perspectives. Probing the limits of secularisation and modernisation, they analyse ongoing transformations of religious meaning. They investigate the 'crisis of meaning', which manifests itself at the macro level of religion in the public domain, the meso level of institutions, and the micro level of the individual's difficulties in dealing with the vicissitudes of life.

Research facilities

The Faculty library, which is integrated in the central humanities library, has excellent collections of books and journals in philosophy, theology and religious studies. Its special collections include the Catholic Documentation Centre, a unique source for anthropological and missiological research. The Institute also houses one of the world's largest microfilm collections of medieval and Renaissance manuscripts on logic, semantics, natural philosophy, metaphysics and theology.

Collaboration

Researchers at the Institute collaborate with colleagues locally, nationally and internationally. Locally, collaborations involve colleagues at other faculties in the university. Nationally, they involve involvement in various research schools. There are also formal ties with the University of Groningen. Internationally, researchers collaborate with individuals and groups at many universities.
In 2016, researchers at the *CHPS* were engaged in joint PhD projects with the Technische Universität, Berlin, the Université Libre de Bruxelles, the University of Oxford,

Staff

Prof. P.J.J.M. Bakker (p)
Prof. S.C. van Bijsterveld (p)
Prof. J.A.M. Bransen (o)
Prof. B. Geurts (o)
Prof. M.A.C. de Haardt (p)
Prof. P.I.M.M. van Haute (o)
Prof. G.J. van der Heiden (o)
Prof. C.A.M. Hermans (o)
Prof. C.H. Hübenthal (o)
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Prof. D.A.T. Müller (o)
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Prof. J.B.A.M. Schilderman (p)
Prof. M.V.P. Slors (o)
Prof. J.M.M.H. Thijssen (o)
Prof. P.J.C.L. van der Velde (p)
Prof. H.J.M. Venbrux (o)
Prof. J.G. van der Watt (o)
Prof. F.J.S. Wijsen (o)
Prof. J.P. Wils (o)
Prof. E.J. van Wolde (o)
Prof. E. van der Zweerde (p)

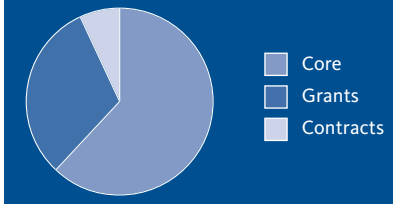
Tenured

Full Professors	8.5 FTE
Associate Professors	2.5 FTE
Assistant Professors	5.6 FTE
Researchers	1.6 FTE

Non-tenured

Researchers	4.2 FTE
Doctoral candidates	14.0 FTE

Research staff funding



and the University of Pisa. They collaborated with British universities in trying to recover the material legacy of Charles Lyell. Researchers at the *CCS* collaborated with institutes in Belgium, France, Slovenia and Germany, and enrolled in the Global Network for Public Theology, together with other 30 institutions. Researchers working on *CCL* obtained funds to work at the University of British Columbia, Vancouver, and the Dimence Institute of Mental Health, Zwolle. Researchers at the *CCEP* set up a collaborative venture with the Université Cheikh Anta Diop in Dakar (Senegal), with a number of visits back and forth. They also contributed to the International Society for Psychoanalysis and Philosophy and the Collegium Phaenomenologicum. Researchers at *RCM* were engaged in the European Research Network on Death Rituals, in the Precious Relics Project of the Moesgaard Museum/ Aarhus University (Denmark), and in the international research group on Religion and Human Rights.

Prof. Ellen van Wolde is Professor of Textual Sources of Judaism and Christianity. In 2016, she was co-leader of a university-wide research project on the nature of chance, which culminated in the publication of the book The Challenge of Chance. The authors emphasise the importance of the contextuality of chance, which manifests itself – in various scientific disciplines – as scale-dependence, language variation, random genetic mutations, historical contingency, as well as in the financial world and in psychology. She co-initiated the 'Week of Chance', which attracted a great deal of attention from newspapers, websites and radio stations.

Research results

CHPS: In a monograph, Frederik Bakker described how Epicurus and his followers treated meteorology, deviating from tradition by systematically providing multiple explanations and relying exclusively on sensory evidence. Paul Bakker and Michiel Streijger published the second volume of their edition of John Buridan's massive Latin *Physics* commentary. Kuni Sakamoto published a monograph on the important Renaissance scholar Julius Caesar Scaliger and his best-selling *Exotericae Exercitationes* (1557). In her prize-winning essay, Carla Rita Palmerino located in the Leuven professor Libertus Fromondus the source of one of Leibniz' late writings on the problem of the continuum. Christoph Lüthy, Carla Rita Palmerino and Hans Thijssen contributed essays to the volume *The Challenge of Chance* (eds. Landsman & van Wolde). Finally, Antonio Cimino co-published a collection of essays on *Rethinking Faith*, which examines the role that religion and faith play in the discussions by Nietzsche, Wittgenstein and Heidegger of the classical metaphysical motifs they criticise.

CCS: Joshua Furnal retraced the openness to modern ways of thinking in Catholic theology before the Second Vatican Council. Inigo Bocken revealed in Nicolas of Cusa's work a notion of *concordantia* that is useful for reconciling theology and modernity. Elisabeth Hense discovered spiritual sources in societal renewal movements, while Maaike de Haardt found spiritual and religious undertones in philosophical and practical forms of new cosmopolitanism. Christoph Hübenthal delineated public theology as two ways of apologetic communication, namely discourse and witnessing. With an eye to contemporary issues, Daniela Müller analysed the deeper motives and consequences of the persecution of the medieval Cathars.

CCL: Corien Bary's ERC project 'Perspective' found a fundamental semantic distinction between eventive and evidential speech reports. For the latter, that something was said is not at issue, while for the former, it is: the speech event itself possesses certain properties. Sammie Tareskeen investigated systematic redundancies in the way people speak, notably when employing colour terms. Marc Slors and Leon de Bruin proposed to view cultures as basic forms of extended cognition, which, because of our cognitive needs for stability, would help explain our resistance to cultural change. Ellen van Wolde, co-leader of the University-wide research project on the nature of chance, emphasised in *The Challenge of Chance* the importance of the contextuality of chance, which manifests itself – in various scientific disciplines – as scale-dependence, language variation, random genetic mutations, historical contingency, as well as in the financial world and individual psychology.

CCEP: Evert van der Zweerde suggested that democracy should be defined as a quality, rather than as a regime or culture, and as being subject to 'glocalisation': after all, the successful implementation of democratic 'qualities' depends on being able to adapt to specific circumstances. Annabelle Dufourcq's enquiry into the imaginary of animals led her to investigate the paradoxes of the concept of stupidity in contemporary philosophy. Philippe Van Haute and Herman Westerink examined the origins of Sigmund Freud's psychoanalysis, finding that Freud was originally less 'Oedipal' than hitherto assumed. Gert-Jan van der Heiden's work on witnessing showed that contemporary continental philosophy proposes two fundamentally different figures: the martyr and the survivor. Finally, the NWO-funded project on the impact of the letters of Saint Paul on contemporary thought documented the claim that faith or belief is not understood

KEY PUBLICATIONS

- Bakker, F.A. (2016). *Epicurean Meteorology: Sources, method, scope and organization.* (Philosophia Antiqua,142). Leiden: Brill.
- Bernts, T. & Berghuijs, J. (2016). *God in Nederland 1966-2015.* Utrecht: Ten Have.
- Bocken, I.M.K. (2016). A Theatre of Desire. The Philosophical Meaning of the Ignatian Exercises. In K. Schelkens (Eds.), *Conversion and Church. The Challenge of Ecclesial Renewal.* (pp. 89-105). Leiden: Brill.
- Brandenburg, D.D. (2016). Implicit attitudes and the social capacity for free will. *Philosophical Psychology, 29*(8), 1215-1228.
- Bruin, L.C. de & Michael, J. (2016). Prediction error minimization: Implications for Embodied Cognition and the Extended Mind Hypothesis. *Brain and Cognition.*
- Fortuin, N.P.M., Schilderman, J.B.A.M. & Venbrux, H.J.M. (2016). Death and the search for meaning: canonical, utilitarian and expressive thanatological cultural niches. *Mortality.*
- Furnal, J.R. (2016). *Catholic Theology after Kierkegaard.* Oxford: Oxford University Press.
- Hübenthal, C.H. (2016). Apologetic Communication. *International Journal of Public Theology, 10*(1), 7-27.
- Landsman, K. & Wolde, E.J. van (Ed.). (2016). *The Challenge of Chance: A Multidisciplinary Approach From Science And The Humanities.* Berlin, etc: Springer Verlag.
- Meijer, R. (2016). The Workers' Movement and the Arab Uprisings [Bespreking van de boeken *Bread, Freedom, Social Justice: Workers and the Egyptian Revolution, Egypt's Long Revolution: Protest Movements and Uprisings, L'UGTT, une passion tunisienne: Enquête sur les syndicalistes en révolution (2011-2014), Lineages of Revolt: Issues of Contemporary Capitalism in the Middle East., Migrant Labor in the Persian Gulf, The Arab Spring in the Global Political Economy, The Invisible Cage: Syrian Migrant Workers in Lebanon & Workers and Thieves: Labor Movements and Popular Uprisings in Tunisia and Egypt]. International Review of Social History, 61*(3), 487-503.
- Nieuwkerk, K. van, Levine, M. & Stokes, M. (Ed.). (2016). *Islam and Popular Culture.* Austin: University of Texas Press.
- Palmerino, C.R. (2016). "Geschichte des Kontinuumproblems or Notes on Fromondus's Labyrinthus? On the True Nature of LH XXXVII, IV, 57 r°-58v°" (winner of the Leibniz Essay Award 2016). *The Leibniz Review, 26*, 63-97.
- Terpstra, M.J. (2016). *Omstreden moderniteit. Over de gemeenplaats 'Dat is niet meer van deze tijd'.* Nijmegen: Wilde Raven.
- Vasterling, V.L.M. (2016). What is the aim of discussion? A provisional answer with the help of Habermas and Arendt. *Arts and Humanities in Higher Education.*
- Westerink, H. & Haute, P.I.M.M. van (2016). Sexuality and Its Object in Freud's 1905 Edition of 'Three Essays on the Theory of Sexuality'. *The International Journal of Psychoanalysis, 97*(3), 563-589.

Dissertations	**16**
Scientific publications	**185**
Professional publications	**69**

in opposition to reason, but rather in terms of trust and trustworthiness, and as a mode of existence.

RCM: Frans Wijsen, relying on Bakhtin's theory, developed an analytical approach that combines dialogical self-theory and discourse analysis. Ton Bernts and Joantine Berghuijs' survey, *God in Nederland 1966-2015*, described a dramatic decrease in church participation and indicated that spiritual currents are becoming less relevant. Michael Scherer-Rath, Hans Schilderman and their colleagues clarified loss of meaning in care settings, and found that spiritual interventions had a moderately beneficial effect on the quality of life of cancer patients. Sophie van Bijsterveld studied dissenting opinions on religious issues at the European Court of Human Rights, finding that church autonomy and religious privacy remain important in court rulings. Concluding their NWO project, Carl Sterkens and his colleagues identified religious beliefs that either provoke or reduce support for interreligious violence in Indonesia and the Philippines. Paul Vermeer examined factors explaining the success of conservative evangelical churches in the Netherlands. Much work was done in the field of thanatology: Brenda Mathijssen showed that cremated remains have social lives of their own, as the identity of the deceased determines the appropriateness of the place and time chosen for disposal of the ashes. Nienke Fortuin distinguished three thanatological cultural niches: canonical, utilitarian and expressive. With respect to graves, Anne Kjærsgaard and Eric Venbrux found that, paradoxically, photography contributes to a re-enchantment of the dead by integrating the deceased into the social time of the bereaved. Thomas Quartier classified different types of ritual-liturgical participation among German visitors to abbeys. Karin van Nieuwkerk's NWO project on 'Islam and Performing Arts' concluded with the volume 'Islam and Popular Culture'. Roel Meijer published on the history and relevance of the concept of citizenship (*muwatana*) in the Middle East. Martijn de Koning, finally, connected the current debate

about radicalized Muslims with that about secularism, examining the voices of Muslim public figures in this contested field.

Societal impact

The societal relevance of research in the humanities manifests itself primarily in active contributions to the public domain, which take the form of publications, lectures, media appearances and exhibitions, and engagement in public debates as well as advising and training professionals. The Institute's main instrument here is *Radboud Reflects*, which – through lectures, debates, workshops and festivals – seeks to make the world of scholarship and science that is philosophically enhanced accessible to a wide audience. Each year, *Radboud Reflects* organises more than a hundred events, which are attended by over 10,000 people and reach over 100,000 people through its website and social media. The Institute's researchers also communicate with pupils, senior citizens and professionals in the medical, theological and legislative worlds. Below is a concise impression of these activities.

Members of *CHPS* taught secondary school students, participants at summer or autumn schools (including Paul Bakker's, at Saint Anselm College, USA), students of the Radboud Honours Academy, and senior citizens. Paul Bakker, Cees Leijenhorst, Christoph Lüthy and Carla Rita Palmerino organised and participated in dozens of public events for *Radboud Reflects* in the Philosophical Café in Arthouse LUX, as well as the Radboud Ambassadors Lectures.

CCS and the Titus Brandsma Institute, under the leadership of Inigo Bocken, developed educational models for the Foundation course at Carmel College (40,000 students). Elisabeth Hense produced a book on projects related to sustainable agriculture and a related website (volle-oogst.nl). Daniela Müller and Maaike de Haardt spoke at large-scale conferences in Athens and Vienna, respectively. Researchers at *CS* also co-organised well-attended study days on Ignatian spirituality and theology and on education in Catholic schools as public theology. As for *CCL*, Jan Bransen delivered talks related to his book *Waar filosofen van houden* ('What philosophers like'). Leon de Bruin lectured at a recertification course for psychiatrists and psychologists, while Harmen Gijsen led a workshop for high-school students at the Gymnasium in Apeldoorn. Marc Slors was highly visible during philosopher Daniel Dennett's visit to the Netherlands, the culmination being his discussion with Dennett in the fully booked concert hall, the 'Vereeniging'. Ellen van Wolde co-initiated the 'Week of Chance', which attracted a great deal of attention from newspapers, websites and radio stations, and which led to a theatre performance, a KNAW symposium, and the official speech at the university's *Dies natalis*.

CCEP financed the Dutch translation of Souleyman Bachir Diagne's book *Philosopher and Islam*, for which Herman Westerink and Evert van der Zweerde wrote an epilogue. Veronica Vasterling organised a public symposium on gender and diversity in Antwerp. Marcel Becker visited many policy institutions, including city councils, discussing issues related to integrity. Jean-Pierre Wils contributed to the programme *Kann man Gott beleidigen?* ('Can you insult God?'), which was broadcast by Arte, and chaired the ethico-medical *Eid-Kommission* in Zurich. Evert van der Zweerde reached sizeable audience with public lectures on the philosophical and ideological background of Russia's current policies. He also continued to lead the 'Werkgroep Democratisch Laboratorium', which organised a public conference on the 'Refugee Crisis & Democracy' and produced a crowd-funded board game called DEMOS. Anya Topolski addressed present-day anti-Semitism in a number of publications.

Director Professor
Karin van Nieuwkerk

Prof. Karin van Nieuwkerk has been Professor of Islam in contemporary Europe and the Middle East since 2012. She studied anthropology and received her degree in Social Sciences at the University of Amsterdam. Her research interests centre on Islam, religious transformation processes, migration, gender and popular culture. She obtained a NWO project on Islam and the Performing Arts. Her current project focuses on people moving in and out of Islam. She is a board member of the Netherlands Interuniversity School for Islamic Studies (NISIS).

The societal impact of *RCM* was facilitated by KASKI, the Faculty's research centre for religion and society, and VERUS, the Netherlands organisation for Christian and Catholic education. Ton Bernts and Joantine Berghuijs' *God in Nederland* generated much media attention. Hans Schilderman, editor-in-chief of 'Handelingen', edited special issues on radical religion and life-orientation in higher education. Frans Wijsen and Carl Sterkens participated in activities organised by the Netherlands-Indonesia Consortium for Muslim-Christian Relationships, a non-governmental network of university and civil society organisations. Thomas Quartier published an acclaimed book on monastic spirituality, while Peter Nissen co-edited a popular book on dragons, which accompanied an exhibition at the Limburgs Museum and Ghent City Museum. Paul van der Velde contributed to the Buddha exhibition in Leiden and Amsterdam. Eric Venbrux did likewise for a forthcoming exhibition on Australian Aborigines at Geneva's ethnographic museum. Ria van den Brandt co-organised the 8th Radboud Holocaust Memorial Day. Roel Meijer gave various public lectures on the theme of citizenship (including some in the presence of EU officials), while Martijn de Koning participated in public debates on radicalisation and Islamophobia in national newspapers and on the radio.

Future research

At *CHPS*, Davide Cellamare will start a postdoc project on Cartesianism at Dutch universities. Lukas Wolf will start a joint PhD project with the University of Groningen. Chiara Beneduce will work on an edition of Henricus Bate of Mechelen's *Speculum*. Frederik Bakker and colleagues will publish a volume on *Space, Imagination and the Cosmos from Antiquity to the Early-modern Period*. Christoph Lüthy and Davide Cellamare will publish a database of all Renaissance Latin editions of Aristotle's works, and Antonio Cimino will organise a conference on *Contemporary European Thought and the Idea of Care*.

The systematic theologians at *CCS* will continue to probe into public theology, with Inigo Bocken and Christoph Hübenthal investigating the period between the Middle Ages and early modernity. Elisabeth Hense will investigate new realms of public spirituality. Joshua Furnal and Christiane Alpers will extract ideas from theologians such as Cornelio Fabro and Edward Schillebeecks to systematise public theology. Daniela Müller and her colleagues will work on 'Sacred Suicide', examining early-modern concepts of 'provoked' martyrdom in the history of Christianity and Islam.

At *CCL*, Marc Slors will complete a book on cognition and cultural scaffolding. Harmen Ghijsen will investigate implicit bias in the way we see things. Ellen van Wolde will further pursue her research line 'When mind meets history', and Corien Bary's ERC team will apply their computation tools to theoretical research questions about the relationship between narrative perspective and vocabulary distribution.

At *CCEP*, Anya Topolski will develop a European critical philosophy of race. Marcel Becker's work on the impact of digitalisation on our lives will zero in on the topic of privacy. Herman Westerink and Philippe Van Haute will reconstruct the history of Freudianism on the basis of different editions of Freud's *Drei Abhandlungen zur Sexualtheorie*. Evert van der Zweerde will conclude his research on 'glocal democracy' and Annabelle Dufourcq and Veronica Vasterling are preparing a project entitled 'Towards a new ontology of organic nature'.

Members of *RCM* will conduct empirical research on the evolving role of religion at the macro, meso and micro levels, with Frans Jespers and his colleagues focusing on the relationship of religion to human flourishing, Thomas Quartier planning an international survey among monks on experiences of the Eucharist, Ria van den Brandt and Peter Nissen engaging with newly discovered sources on Etty Hillesum, and Paul Vermeer and his colleagues placing their empirical study of evangelical churches in an international setting. Karin van Nieuwkerk will deepen her investigations into conversion and apostasy in Islam and start a project on masculinity in Egypt. Roel Meijer will continue to publish on the notion of citizenship in the Middle East, while Martijn de Koning will focus on Dutch Muslims who migrated to the UK.

Awards and grants

- Herman Westerink was appointed extraordinary professor at the University of Leuven.
- Harmen Ghijsen obtained an NWO Veni project.
- Christoph Lüthy, Jan Papy (Leuven) and Davide Cellamare won a FWO-NWO programme.
- Carla Rita Palmerino won the 2016 Leibniz Society Essay Competition, for her *'Geschichte des Kontinuumproblems or Notes on Fromondus's Labyrinthus?* On the True Nature of LH XXXVII, IV, 57r°-58v°'. <

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The Temptation of Saint Anthony by Hieronymus Bosch (1450-1516). Nelson-Atkins Museum of Art, Kansas City, USA. Credited to the painter in 2016.

Institute for Historical, Literary and Cultural Studies

The Institute for Historical, Literary and Cultural Studies (HLCS) is part of the Faculty of Arts. Its main objective is to create a stimulating environment for research in literature and literary theory, cultural studies, history, art history and archaeology. HLCS research is based on a common focus: 'Europe in a Changing World'.

The HLCS assembles, promotes and integrates humanities research from a wide range of disciplines in order to gain a deep understanding of the complexities of the past as well as those of the current state of Europe in a changing world. It focuses its research agenda on two major questions that address a range of key issues in contemporary humanities research and major current societal challenges in a mutually reinforcing way:

1. How and under which conditions do different kinds of loyalties, communities and categories of people emerge and disappear?
2. What do art and creativity mean for people and society?

CENTRE FOR PARLIAMENTARY HISTORY

Director: Professor Carla van Baalen

HLCS houses the Centre for Parliamentary History (known by its Dutch abbreviation, CPG), in which researchers study Dutch parliamentary history since the Second World War. Results from this research are published in the series 'Parlementaire Geschiedenis van Nederland na 1945' (Dutch parliamentary history since 1945) and the annals of parliamentary history rom 1999 onwards. *www.ru.nl/cpg*

Research facilities

- The Humaniora Library (155,000 volumes, 15,500 serial volumes, 750 serial subscriptions and 600 manuscripts)
- The Catholic Documentation Centre: archives and publications of Catholic institutions and individuals in the Netherlands, from 1800 to the present (www.ru.nl/kdc)
- The Centre for Art Historical Documentation manages a large collection of visual material and provides services in the field of image research and delivery of image material (www.ru.nl/ckd)
- Kunera: an online database of over 15,000 medieval pilgrim badges and ampullae representing religious and profane subjects (www.kunera.nl)
- BoschDoc: an online database with nearly 1,000 documents on the life and work of Hieronymus Bosch (boschdoc.huygens.knaw.nl)

Collaboration

HLCS focuses on establishing European research networks with prominent partners in its areas of expertise.

Prof. André Lardinois is one of the founders and chair of the Network for the Study of Archaic and Classical Greek Song, which is engaged in the study of archaic Greek lyric, iambic and elegiac poetry and song, with representatives in most European countries as well as in a number of major American universities (Berkeley, Harvard, Stanford and Yale). The aim of this network is to pool the resources of individual scholars, who now often work in isolation, by holding regular meetings, keeping in contact through a network website and a newsletter, and defining topics of common interest within archaic Greek poetry that groups of scholars in different countries can work on together.

Prof. Odin Dekkers and Dr Usha Wilbers are members of the core group of ESPRit, the European Society for Periodical Research, which was founded by periodical researchers from Austria (University of Salzburg), Belgium (University of Ghent), England (University of Salford, Manchester; Manchester Metropolitan University), the Netherlands (Radboud University), Scotland (Edinburgh Napier University), and the United States (New Jersey City University). The aim of the organisation is to bring together the resources of individual scholars from various disciplines who work with periodicals.

Staff

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Prof. C.C. van Baalen (p)
Prof. J.T.J. Bak (o)
Prof. M.L.M. van Berkel (o)
Prof. S.L. de Blaauw (p)
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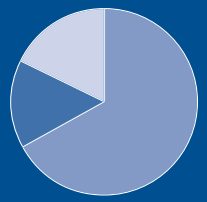
Tenured	
Full Professors	11.7 FTE
Associate Professors	2.4 FTE
Assistant Professors	16.3 FTE
Researchers	8.5 FTE
Non-tenured	
Researchers	7.8 FTE
Doctoral candidates	33.5 FTE

Research staff funding



Prof. Carla van Baalen is one of the founders of the European Information and Research Network on Parliamentary History (EuParl), which connects European research institutions and experts in parliamentary history. The network facilitates the exchange and dissemination of knowledge and promotes comparative studies on the development of parliamentary culture in Europe. Another aim is to help institutions become more visible beyond their national boundaries and to facilitate cooperation between the participating institutions.

Prof. Alicia Montoya and Dr Maaike Koffeman are board members of the Knowledge Centre France-Netherlands, which promotes, compiles and disseminates the results of Dutch research in the field of Franco-Dutch relations. The aim of the centre is to create fruitful, interdisciplinary collaboration within the academic community, as well as visualisation of existing expertise in the area of French-Dutch relations by means of an annual conference and publication of its results. The centre can be consulted whenever specific expertise is needed in the area of current or historical developments in the relationship between France and the Netherlands.

Research results

In his PhD dissertation, Coen van Galen put an end to a classic misconception about the Roman age: that only men were considered to be true citizens, while women were seen as mere extensions of their husbands or fathers. In the first century BC, new wedding conditions became popular, which ensured that the wife could be independent of her husband. She could begin an – albeit limited – career, she could divorce her husband, and she had a much better position for negotiation within the marriage. With this research, Van Galen showed that women were much more independent than had previously been thought.

Historian **Dr Anneleen Arnout** has received an NWO Veni grant for her research on the relationship between emotions and the urban environment. In her project 'Sensitive Cities: Amsterdam, London and Paris (1850-1930)', she investigates the way in which urban space influenced the emotional experience in three metropolises during the period of most intense urbanisation.

The global study performed by the Bosch Research and Conservation Project (BRCP) has shown that *The Temptation of St. Anthony* (at the Nelson-Atkins Museum of Art in Kansas City, USA) should be attributed to Hieronymus Bosch. The painting was held in storage for decades because it was classified as the work of a pupil or follower of Bosch. The new attribution is a significant addition to the small body of work produced by the famous painter. This discovery was announced by Prof. Jos Koldeweij and Dr Matthijs Ilsink at a press conference in Het Noordbrabants Museum, where a major exhibition of Hieronymus Bosch's work was held.

Did nations and nation states exist in the early modern period? In the field of nationalism studies, this question has created a rift between the so-called 'modernists', who regard the nation as a quintessentially modern political phenomenon, and the 'traditionalists', who believe that nations began to take shape before the advent of modernity. *The Roots of Nationalism: National Identity Formation in Early Modern Europe, 1600-1815*, edited by Dr Lotte Jensen, challenges current international scholarly views on the formation of national identities by offering a wide range of contributions which deal with early modern national identity formation from various European perspectives – especially in its cultural manifestations.

Catharina Halkes (1920-2011) was an exceptional figure in the second half of the twentieth century. As well as being one of the first female professors at Radboud University and a church administrator, Halkes was above all a champion of women's rights and a media personality. This is demonstrated in the biography on Halkes *Ik verwacht iets groots* (I expect great things), written by Prof. Marjet Derks and Annelies van Heist (Emeritus Professor at Tilburg University). Halkes' research focused on feminist theology, which was based on the principle that the dominant theology has been formulated by men and does not take the female perspective of thinking on faith, church history and exegesis into account. Prof. Halkes put feminist theology in the Netherlands on the agenda and now, with their biography, Profs. Derks and Van Heist have put her on the map.

Societal impact

The Institute for Historical, Literary and Cultural Studies targets three groups in society: pupils and teachers at secondary schools, people living in the Nijmegen region, and the general public who are interested in history, culture and literature. The research programme addresses the first group through a large number of lectures for secondary school pupils, which are given at schools or at

KEY PUBLICATIONS

- Adriaensen, B.Y.A. & Kunz, M. (Ed.). (2016). *Narcoficciones en México y Colombia.* Madrid/Frankfurt: Iberoamericana/Vervuert.
- Battilani, P., Gordon, B., Furnée, W.J.H., James, K.J., White, R. & Zuelow, G.E. (2016). Discussion: teaching tourism history. *Journal of Tourism History, 8* (1), 57-84.
- Bierl, A. & Lardinois, A.P.M.H. (Ed.). (2016). *The Newest Sappho: P. Sapph. Obbink and P. GC inv. 105, frs. 1-4.* Leiden: Brill.
- Braber, H.M. van den (2016). De Nieuwe Gids and its informal patronage system. *Journal of European Periodical Studies, 1* (1), 53-69.
- Corporaal, M.C.M., Cusack, C.T. & Beuken, R.H. van den (Ed.). (2016). *Irish Studies and the Dynamics of Memory. Transitions and Transformations.* Oxford: Peter Lang.
- Dijkstra, R. & Espelo, D.B. van (2016). Anchoring Pontifical Authority: A Reconsideration of the Papal Employment of the Title Pontifex Maximus. *Journal of Religious History*.
- Foubert, L.L. (2016). The lure of an exotic destination: the politics of women's travels in the Early Roman Empire. *Hermes-Zeitschrift Fur Klassische Philologie, 144* (4), 462-487.
- Haan, N. de (2016). Archeologia classica in Campania nel ventennio fascista: un chiaroscuro continuo. *Quaderni di Storia, 84*, 247-263.
- Jensen, L.E. (2016). 'See our succumbing Fatherland, overwhelmed by disaster, woe and strife'. Coping with crisis during the reign of Louis Bonaparte. *Dutch Crossing. a Journal of Low Countries Studies, 40* (2), 151-164.
- Kok, J. & Mandemakers, K. (2016). Life and Death of Singles in Dutch Cities, 1850-1940. *Journal of Urban History, 21* (1), 101-120.
- Martinez-Rubi, O., Kleijn, M. de , Verhoeven, S., Drost, N., Attema, J., Meersbergen, M. van , Nieuwpoort, R. van , Hond, R. de , Dias, E. & Svetachov, P. (2016). Using modular 3D digital earth applications based on point clouds for the study of complex sites. *International Journal of Digital Earth, 9* (12), 1135-1152.
- Roest, B. & Uphoff, J. (Ed.). (2016). *Religious Orders and Religious Identity Formation (ca. 1420-1620): Discourses and Strategies of Observance and Pastoral Engagement.* Leiden/Boston: Brill.
- Sintobin, T.M.J. & Sanders, M.P.J. (2016). Dit was zijn schrift. Over de wording van De verwondering. *Spiegel der Letteren, 58* (2), 185-213.
- Smelik, A.M., Toussaint, L. & Dongen, P. van (2016). Solar fashion: An embodied approach to wearable technology. *International Journal of Fashion Studies, 3* (2), 287-303.
- Verhoeven, M.C.J., Bosman, L. & Asperen, H. van (Ed.). (2016). *Monuments & Memory. Christian Cult Buildings and Constructions of the Past. Essays in Honour of Sible de Blaauw.* Turnhout: Brepols.

Dissertations	**17**
Scientific publications	**238**
Professional publications	**189**

Radboud University. The second group is reached through the various initiatives of the institute that address historical and cultural awareness of the Nijmegen-Arnhem region and encourage the use of historical, cultural and literary research in society, through involvement in a substantial number of local boards and initiatives. The third group, which is the most diverse, is targeted in a variety of ways. The three most successful approaches are 1) through exhibitions; 2) through publications in national newspapers, blogs and journals for a wide audience, *e.g.* through radio and television broadcasts; and 3) through translations of foreign-language literary and historical texts into Dutch.

In 2016 the Bosch Research and Conservation Project (BRCP), which was set up in 2010 by art historian Prof. Jos Koldeweij, came to fruition. The main outcome of the project was the exhibition *Jheronimus Bosch – Visions of genius*, of which Jos Koldeweij was curator, together with Dr Matthijs Ilsink. Koldeweij and Ilsink are also the authors of the catalogue that accompanied the exhibition. Held from 13 February to 8 May in the Noordbrabants Museum in 's Hertogenbosch, the exhibition attracted more than 400,000 visitors and was awarded 'Exhibition of the Year' by the prestigious British art magazine *Apollo*. The interdisciplinary group of scholars and scientists participating in the BRCP examined all of Bosch's paintings and his studio, plus the most important works attributed to Bosch in the past (using modern methods). Research results were published in a two-part academic monograph of more than a thousand pages, which describes which work is by Bosch and which is not. Source material on the painter has been made available for anyone who wants to know more about the life and work of the artist in Boschdoc, an online database with nearly 1000 documents. Boschdoc was awarded the Nederlandse Dataprijs 2016 (Dutch Data Award, category humanities and social sciences) for the accessibility and heritage value of the data and

Prof. Jos Koldeweij received the 2016 Radboud Science Award for his research on Jheronimus Bosch.

The publication *Kabinetsformaties 1977-2012* (Formation of new governments 1977-2012) offers an in-depth description and analysis of the formation of the fourteen coalition governments since 1977; it discusses political, procedural and strategic aspects as well as personal relations among the political leaders involved. With this new book, edited by Prof. Carla van Baalen and Dr Alexander van Kessel, the Centre for Parliamentary History (CPG) completes its research on the history of post-war government formations. Kabinetsformaties 1977-2012 was presented in the Upper House of the Dutch Parliament. In her speech on the occasion of the presentation of *'Kabinetsformaties 1977-2012'*, the Chairwoman of the Lower House, Khadija Arib, stated that the CPG's study on government formations was of great significance and that it was published at the right moment. She further stressed that it is important that the part of Dutch parliamentary history that normally remains backstage has now also been recorded so that lessons can be learned from it.

The University Library possesses around 550 books on architecture dating from the 16th until the 20th century. These are mainly rare books, which are not easy for the general public to access. Architectural historian Dr Jeroen Goudeau selected the most remarkable examples from this rich collection for an exhibition held in Museum Het Valkhof from 23 January to 29 May. The exhibition, which was the result of close collaboration between Goudeau, the University Library and Museum Het Valkhof, was accompanied by a publication that offers a concise yet comprehensive survey of the history of illustrated books on architecture on the basis of the collection in the University Library: *Denken in steen, bouwen op papier. Een kleine geschiedenis van het architectuurboek* (Thinking in stone, building on paper. A brief history of books on architecture).

The 'Stichting Versterking Herinnering WOII Gelderland' (Foundation for Reinforcement of Remembrance of WWII in Gelderland), an initiative of Radboud University, Heritage Gelderland and the regional bureau for tourism (Arnhem Nijmegen), under the direction of historian Dr Joost Rosendaal, aims to reveal the connections between historic places and events. The foundation intends to share information and experiences with other organisations, conduct research and develop a provincial heritage quality mark. With the project *Guilty Heritage* the foundation draws attention to buildings and places in the province of Gelderland that were used by Dutch collaborators with the Nazi's in World War II (in order to reinforce the remembrance of freedom).

Future research

Prof. Olivier Hekster was awarded an NWO Vici grant for 'Traditions of Power in Times of Transition'. In his work on the role of ideology in Roman antiquity, he focuses on the image of Roman emperors: how did these most powerful men in the most successful empire in Western history view themselves and how were they viewed by others? With funding from his Vici grant, Hekster will research the significant role that traditions play in the way in which people present, challenge and accept power. It is especially at times when political systems undergo change, such as in Roman times, that it is important to formulate power in traditional terms. Hekster's project will explore how this process works, taking Roman history from 50 BC to 565 AD as a reference.

The causes of death of the 700,000 inhabitants of Amsterdam who died between 1854 and 1940 can teach us about the history of our health. Under the guidance of Prof. Angélique Janssens, historical demographers working at the HLCS – together with staff at the Municipal Archives of Amsterdam – have started to fully digitise the registers listing causes of death. Containing

Director Professor Olivier Hekster

Olivier Hekster has been Professor of Ancient History at Radboud University since 2004. He obtained his doctorate degree *cum laude* with a thesis entitled Commodus. An Emperor at the Crossroads. Olivier Hekster focuses his research on the role of ideology in ancient Rome, specifically on Roman imperial representation. In 2015, he received an NWO Vici grant. He has been Lecturer in Ancient History at Wadham College Oxford, and Fellow and Tutor of Ancient History at Merton College Oxford, spent a year on a Humboldt Research Fellowship for Experienced Researchers at the Commission for Ancient History and Epigraphy in Munich, was a member of the Royal Netherlands Academy of Arts and Sciences' The Young Academy (2005-2010) and has chaired the international network 'Impact of Empire' since 2006.

data about so many individuals during such a long period, the registers are a unique source of information. The project is a form of Citizen Science: via the web platform Velehanden.nl (Many hands), volunteers help to collect and digitise the data. The period 1854-1940 was a crucial one in the development of public health. According to the theory of epidemiological transition, a radical shift from deaths caused by contagious diseases to those caused by ageing should be visible in this period. The main question in the project is whether this pattern can be seen in Amsterdam.

Historian Dr Anneleen Arnout has received an NWO Veni grant for her research on the relationship between emotions and the urban environment. Her project 'Sensitive Cities: Amsterdam, London and Paris (1850-1930)' investigates the way in which urban space influenced the emotional experience in three metropolises during the period of most intense urbanisation. It examines how transforming urban space elicited and intensified emotional experiences. The main research questions are: 1) what specific emotions did urban citizens associate with what types of places? 2) how did changes caused by the process of urbanisation affect the spectrum of emotions experienced by urban dwellers? and 3) how did these evolving experiences differ among people of different class, race, gender and age?

Carla van Baalen, Professor of Parliamentary History, and Paul Bovend'Eert, Professor of Constitutional Law, have been appointed to the research team that will conduct historical research on the royal purse. The third team member is Professor of Public Administration Mark van Twist. The team, which was appointed by Prime Minister Mark Rutte and is chaired by Prof. Carla van Baalen, has been tasked with conducting historical research into the way the monarch's income was determined in the period between 1963 and 1973. In this period, the question of the Royal House's finances was resolved thanks to new legislation which included the Act on Financial Regulations for the Royal House (Act of 22 November 1972, Official Gazette 701). Under its mandate, the research team will perform archival research and conduct interviews with individuals who were involved in the subject being investigated. ‹

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European Central Bank in Frankfurt, Germany.

The Business & Law Research Centre

The Business & Law Research Centre – *Onderzoekcentrum Onderneming & Recht (OO&R)* – is a cooperative venture between the Faculty of Law and fifteen prominent, mostly international, law firms and Dutch multinationals.

The mission of the Centre is:

- to conduct high-quality (national and international) academic research in Business and Law
- to enhance understanding of the theories which apply to Business and Law in the context of social, economic, political and financial developments
- to encourage a practical approach to academic research, particularly by analysing the fundamental principles and foundations of (business-oriented) private law
- to explore and initiate applications of academic research (*e.g.* in the area of national and international rules, regulations, principles and best practices)
- to educate and supervise Masters students and young researchers.

The four key research programmes at the Centre are:

1 Business and Patrimonial Law
2 Finance, Security Rights and Insolvency Law
3 Company Law
4 Financial Law

An overarching theme of research in all programmes involves European Private law, comparative law and private international law.

The Centre, which was established in 1991, is recognised as a research school by the Royal Academy of Arts and Sciences (KNAW). In 2009, the KNAW accreditation was renewed. In 2014 the Centre was evaluated by an International Peer Review Committee. The committee considered research conducted by the Centre to be excellent and highlighted the success of the Centre in strengthening its international profile. It also provided support for the institutional collaboration with partners in practice and endorsed the societal relevance and applicability of research outcomes.

The Centre, which offers a comprehensive Research Masters programme to gifted students (certified by the Accreditation Organisation NVAO), is actively involved in a wide range of postgraduate educational and professional training programmes.

Research facilities

The Centre houses a collection of books, journals and electronic publications on international and domestic Business and Law that is unique in the Netherlands.

Collaboration

The Centre combines academic excellence with the expertise and practical experience of its partners. This unique collaboration has led to cross-fertilisation between legal practice and the academic world. The Centre has regulations which dictate that all parties involved guarantee academic independence. The following partners participate in the Centre: AEGON, Akzo Nobel, Allen & Overy, APG Asset Management, De Brauw Blackstone Westbroek, Clifford Chance, Freshfields Bruckhaus Deringer, Houthoff Buruma, ING Groep, Loyens & Loeff, NautaDutilh, Pels Rijcken & Droogleever Fortuijn, Rabobank Netherlands, Stibbe and Stichting Eumedion.

The Centre encourages international cooperation in all of its research programmes. There is close collaboration with the following chairs and research institutes: the Chair in Corporate Finance (Nijmegen School of Management), the Chair in Civil Law, Catholic University of Leuven (Belgium), the Max Planck Institute for Comparative and International Private Law (Hamburg, Germany), the Jagiellonian University (Krakow, Poland), the Nottingham Trent University (UK), the Network for Studies on Pensions, Ageing and Retirement (Netspar, Tilburg) and the Commercial Law Centre, Harris Manchester College, University of Oxford (UK).

Staff

Prof. S.E. Bartels (o)
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Prof. B. Bierens (e)
Prof. C.D.J. Bulten (o)
Prof. D. Busch (o)
Prof. D.R. Doorenbos (o)
Prof. N.E.D. Faber (o)
Prof. J.H. Gerards (o)
Prof. M. Heemskerk (e)
Prof. J.J. van Hees (o)
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Prof. S.C.J.J. Kortmann (o)
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Prof. V.P.G. de Serière (o)
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Prof. G. van Solinge (o)
Prof. J.B. Spath (o)
Prof. N. van Tiggele-van der Velde (o)
Prof. P.M. Veder (p)
Prof. L.G. Verburg (o)
Prof. H.L.E. Verhagen (o)
Prof. W.J. Zwalve (o)

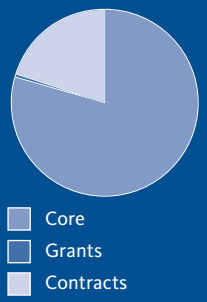
Tenured

Full Professors	7.44 FTE
Associate Professors	2.06 FTE
Assistent Professors	2.04 FTE
Researchers	0.97 FTE
Lecturers	0.2 FTE

Non-tenured

Researchers	0.3 FTE
Lecturers	3.47 FTE
Doctoral candidates	15.87 FTE

Research staff funding



Within the framework of International Working Groups (IWGs) established by the Centre in financial law (Capital Markets Union), insolvency law and European Private law, there is structural collaboration with leading academics and practitioners from universities and institutions in over 20 countries. The Centre also plays an active role in various projects of the European Commission and international GO/NGOs (*e.g.* the IMF and INSOL Europe).

- Prof. Carla Sieburgh regularly conducts visiting research at the Department of Law of the European University Institute.
- Jan Lokin (LL.M.) completed a visiting research position at the Max Planck Institute for Comparative and International Private Law in Hamburg, Niels Pannevis (LL.M., MSc) at the Department of Civil Law, University of Heidelberg and Roderic ter Rele (LL.M.) at the Department of Civil Law, Catholic University of Leuven.
- Prof. Danny Busch has been appointed as a visiting professor in Milano and Genova.
- Prof. Danny Busch and Mirik van Rijn (LL.M.) received a research grant from the European Central Bank, Frankfurt (Germany).
- The Research Centre received several international PhD students (for example, from Leuven and Krakow).

Research results

Important research results were found within the context of an International Working Group (IWG) on the Capital Markets Union. EU Commission President Juncker set out as one of his key priorities the need to build a true single market for capital for all 28 (soon to be 27) Member States. The IWG, which consists of leading scholars and practitioners with broad experience in the field of capital markets law and investment practice, has examined the making of a Capital Markets Union from a legal and/or economic perspective (with international comparisons). The research results will be published by Oxford University Press. Key issues such as financing innovation, facilitating companies' ability to raise funds on the capital markets, fostering retail and institutional investment, *etc.*, are examined alongside case-studies.

A strong area of research that the Centre is traditionally engaged in is international and comparative insolvency law. A permanent network of insolvency experts from 20 countries across the globe contribute to the Oxford International and Comparative Insolvency Law Series. In 2016 the manuscript of a comprehensive volume on 'Ranking and Priority of Creditors' was published. This volume deals with what many would regard as the *raison d'être* of insolvency law: the creditors' claims. To run insolvency proceedings effectively, insolvency law must enforce 'collectivisation' on the debtor's creditors. Their claims must be 'translated' from the largely bilateral world of debtor/creditor law to the world of collective insolvency proceedings which are designed to resolve the debtor's general default. This book analyses the treatment of various categories of claims and the allocation of control rights among creditors and various other actors in insolvency proceedings.

The collapse of the Lehman Brothers group in September 2008 triggered a shockwave in global financial markets and it is often seen as the defining moment of the financial crisis. Many issues encountered in bankruptcy proceedings opened against entities belonging to the Lehman Brothers group were unprecedented in terms of their scope and complexity. Substantial efforts were made to address these issues in the absence of pre-existing public know-how. In collaboration with key parties involved in the proceedings and independent third party experts, the Centre has prepared a volume containing main lessons from the Lehman proceedings. This book will be published early in 2017 by Oxford University Press.

Another major topic within the international research scope of the Centre is agency law in commercial practice. This research project analyses the interaction of agency law and specific commercial contexts. The comparative approach provides innovative perspectives and insights, as well as practical guidance on solving commercial problems. A book was published by Oxford University Press in 2016 in collaboration with the Commercial Law Centre of the University in Oxford during an international seminar at Brasenose College, Oxford.

European Law is also increasingly important for private law. In his book *European Law and National Private Law*

Prof. Carla Sieburgh (Professor of Civil Law,) explores Civil Law and in particular the way it is influenced by European Law. Her focus is on Contract Law, Liability Law and Compensation Law. She explores solutions to current problems in the principles of European Law and Civil Law.

KEY PUBLICATIONS

- Busch, D., Macgregor, L. & Watts, P. (2016). Agency and principal dealing under the Markets in Financial Instruments Directive. In D. Busch, L. Macgregor & P. Watts (Eds.), *Agency Law in Commercial Practice* (pp. 141-175). Oxford: Oxford University Press.
- Faber, N.E.D., Vermunt, N.S.G.J., Kilborn, J.J., Richter, T. & Tirado, I. (2016). *Ranking and Priority of Creditors* (Oxford International and Comparative Insolvency Law Series, 3). Oxford: Oxford University Press.
- Hartkamp, A.S. (2016). *European Law and National Private Law. Effect of EU Law and European Human Rights Law on Legal Relationships between Individuals.* Cambridge: Intersentia.
- Jansen, C.J.H. (2016). *De wetenschappelijke beoefening van het burgerlijke recht tussen 1940 en 1992* (Serie Onderneming en recht, 93). Deventer: Wolter Kluwer.
- Jong, B.J. de (2016). The Distinction between Public and Private Companies and its Relevance for Company Law. Observations from the United Kingdom and the Netherlands. *European Business Law Review, 27* (1), 1-23.
- Maatman, R.H., Ewijk, C. van, Heemskerk, M. & Nijman, Th.E. (2016). *Pensioen 2020* (Serie onderneming en recht, 91). Deventer: Wolters Kluwer.
- Solinge, G. van & *et al*. (2016). *Nederland, het Delaware van Europa? Voordrachten en discussieverslag van het gelijknamige congres van het Van der Heijden Instituut op 20 en 21 november 2015* (Serie vanwege het Van der Heijden Instituut te Nijmegen, 135). Deventer: Wolters Kluwer.
- Tweehuysen, V. (2016, Mei 11). *Het uniciteitsbeginsel in het goederenrecht.* RU Radboud Universiteit (XIII, 363 pag.) (Deventer: Wolters Kluwer).

Dissertations	**8**
Scientific publications	**126**
Professional publications	**84**
Annotations	**108**

(published in 2016), Arthur Hartkamp addressed the various sources of European law, as well as the influence of fundamental rights on private law. In it particular attention is devoted to a review of national private law regulation in the light of European legislation.

Societal impact

Legal research nearly always relates to legal practice and is therefore by its nature societally important. The Centre cooperates closely with – and advises – external partners such as law firms, courts, government bodies, ministries, NGOs and European organisations.

Many publications – mainly papers in professional journals and case notes – are written with legal practice in mind. Academic publications also provide a solid foundation for legal practice. One aspect of the Centre's mission is to make academic research more practice-oriented, for example by preparing best practices, legislative proposals and EU directives. Researchers at the Centre regularly participate in national and international public advisory bodies. The results of this advisory work are generally made available to judges, lawyers, politicians, students and the general public. Many researchers at the Centre contribute to the Centre for Post-academic Legal Education, the leading provider of post-academic legal education in the Netherlands.

The Centre has influenced public debate on a wide variety of topics which are of direct relevance to financial and commercial legal practice. Research projects and seminars relating to the appeal of the Netherlands as a country of incorporation, the European Banking Union, price-sensitive information in capital markets, outsourcing in the financial sector, new insolvency legislation and current issues of pension law are some examples.

The Centre plays an active role in consultations launched by Dutch and European legislators. It has been commissioned to carry out two research projects by the Dutch Cyber Security Council and the Dutch Ministry of Security and Justice:

- 'Cyber Security and harmonised duties of care': this project was established to offer recommendations in order to strengthen the legal position of consumers in the case of a lack of Cyber Security.
- 'Foreign investments and national security': the aim of this project is to analyse to what extent shareholder positions in Dutch operating companies can provide access to (confidential) information and grant influence on decisions which may have an impact on national security.

Future research

Research collaboration within the context of the Oxford International and Comparative Insolvency Law Series will continue within the context of a new project on the treatment of secured creditors in insolvency proceedings. The course of insolvency proceedings and the prospects of corporate rescue are significantly influenced by security rights granted to pre-commencement financiers of the debtor. The all-embracing nature of such security packages often enables secured creditors to block a composition or going concern scenario, which could otherwise have preserved viable businesses in financial distress. An IWG of insolvency experts will be analysing the position of secured creditors in insolvency proceedings (*e.g.* enforcement rights, ranking and participation rights). New domestic legislation of participating countries designed to promote corporate rescue and introduce new pre-insolvency enforcement routes (*e.g.* pre-packaged arrangements) will also be discussed.

The appointment of Prof. Guido Ferrarini (University of Genoa) to the Van der Grinten chair of the Centre strengthens international collaboration in the field of financial law. A new research project has been started by Prof. Guido Ferrarini and Prof. Danny Busch on 'Corporate governance in the financial sector'. The recent appointment of Louise Gullifer (International Commercial Law) will result in new research in the field of commercial law and corporate finance.

New research opportunities which are currently being initiated include topics such as the private law treatment and legal protection of big data (in collaboration with researchers in the Digital Security Group of the Institute for Computing and Information Sciences at the university), the liability of directors and supervisory directors, cross-border conversion of companies and financing the supply chain.

Awards and acknowledgements

- Prof. Hans Schulte Nölke has been appointed to the Academia Europaea.
- Prof. Claartje Bulten has been appointed to the Dutch government's advisory body Sociaal-Economische Raad (SER; Social-Economic Council). ‹

Director Dr Ben Schuijling

Ben Schuijling is the Director of the Business & Law Research Centre (OO&R). He is an associate professor of Private Law and a specialist in the field of secured transactions law and insolvency law. Among other positions, he is editor of Jurisprudentie Onderneming & Recht (JOR), the leading Dutch case-law journal on commercial law.

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Research Centre for State and Law

Researchers at the Centre for State and Law – *Onderzoekcentrum voor Staat en Recht* (SteR) –study the basic principles of public law. They critically analyse national, European and international developments in constitutional, administrative and criminal law. All of the Law Faculty's seven public law and meta-juridical departments participate in SteR.

SteR researchers focus on:

- The significance of the foundations underlying the national legal order.
- The national legal order's interaction with other legal systems, particularly the influence of European and international law in an emerging multi-layered legal order.
- The role of public law in the context of shifting roles of public authorities in a changing public domain.

SteR research is characterised by:

- The broad scope of its legal-dogmatic approach, with a strong emphasis on its relevance to legal practice.
- A focus on meta-juridical research. This includes empirical and philosophical reflection, which is considered invaluable for a thorough grasp of public law problems.
- A balance between national and international legal research, with a strong focus on national legal research strengthened by comparative law.

SteR research is conducted within two research programmes

The legal-systematic programme **Principles of Public Law**, headed by Prof. Van Kempen (Criminal Law) focuses on 1) the significance of national sovereignty for the Dutch legal order and its interaction with other legal orders, in particular European law; 2) fundamental rights; 3) general principles of public law, notably: the balance of powers, democracy, principles of fair administration, core principles of criminal law and access to fair justice.

The thematic programme **Migration Law**, headed by Prof. Guild (Migration Law) and Prof. Terlouw (Sociology of Law), externally known as the Centre for Migration Law (CMR). CMR research focuses on migration, citizenship and protection of minorities. Since 2015, the CMR has been recognised as a Jean Monnet Centre of Excellence. Its interdisciplinary approach and international staff – who include lawyers, sociologists, anthropologists and political scientists – are unique in Europe.

Collaboration

SteR participates in numerous international projects and networks, including the Odysseus Network of Experts in European Migration and Asylum Law, which is coordinated by the Université Libre de Bruxelles (Belgium), the academic Netzwerk Migrationsrecht (Germany), and the Glasgow Refugee, Asylum and Migration Network (GRAMNet) (UK). It also has close ties with Santa Catarina, Florianopolis (Brazil), the Max Planck Institute for Foreign and International Criminal Law (Freiburg, Germany), the Scottish Institute Policing Research (Dundee) and National Taiwan University. Prof. Guild and Dr Minderhoud are experts in the Network on Free Movement of Workers and Social Security Coordination, which is funded by the European Commission. Furthermore, there are contacts with academics, professionals and governments in over 50 countries worldwide through the International Penal and Penitentiary Foundation, of which Prof. van Kempen has been Secretary General since 2010.

In the Netherlands, SteR collaborates with the Council for the Judiciary, the Ministry of Security and Justice, as well as several courts and municipalities. Within the university, SteR researchers collaborate with researchers from the Nijmegen School of Management in the interdisciplinary network 'EUROPAL', which focuses on the Europeanisation of Policy and Law. Prof. Terlouw is chair of the VSR (Association for the Socio-legal study of Law). The Research Masters programme has led to close collaboration with the University of Groningen.

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Prof. B.P. Vermeulen (p)
Prof. H.C.F.J.A. de Waele (o)

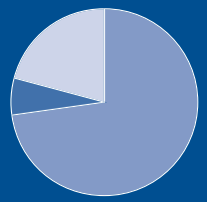
Tenured

Full Professors	5.1 FTE
Associate Professors	3.44 FTE
Assistent Professors	3.09 FTE
Researchers	0.78 FTE
Lecturers	0.78 FTE

Non-tenured

Researchers	6.03 FTE
Lecturers	4.26 FTE
Doctoral candidates	11.76 FTE

Research staff funding



Research results

The refugee crisis has figured prominently in the news and it has led to mainly nationally oriented responses. This creates mounting pressure on the concept of European citizenship. In 2016 the CMR programme celebrated its 20th anniversary with the conference 'Migration on the move', which partly reflected on the past, but also for a large part looked at the future of (European) citizenship.

Brexit and discussions in other Member States with respect to the EU make it more important than ever to pay close attention to the effectiveness and legitimacy of the EU. In this light, SteR paid considerable attention to the theme of sovereignty during its annual research day. In addition, Dr Rusu, Ms. Looijestijn-Clearie and Mr. Veenbrink organised the conference 'Boosting the enforcement of EU competition law at the domestic level' in June. This will result in an edited volume as well as a follow-up conference (in 2017). In December, a EUROPAL expert seminar took place to mark the start of Dr Krommendijk's research project on the dialogue between national courts and the European Court of Justice (ECJ), with keynote speeches by Prof. Bobek (ECJ), *Dr Mayoral and Prof. Wind (Copenhagen), and Prof. Tridimas (King's College London)*.

Furthermore, SteR organised numerous seminars in 2016, including a seminar by Prof. Gerards and Dr Glas on procedural dialogue within the ECHR System, with contributions by, among others, Leach (Middlesex) and Lambert Abdelgawad (Strasbourg). Prof. Dute instigated a seminar on euthanasia and physician-assisted suicide. Prof. van Kempen co-organised (with Prof. Lappi-Seppälä and Mr. Vesterbacka) the conference 'Overuse in the criminal justice system: on criminalisation, prosecution and imprisonment', which was held in Helsinki, Finland from 14-17 July. Prof. Terpstra co-organised and co-chaired (with Prof. Fyfe; Dundee) a panel session on police reform in Western Europe, ESC-Conference, Munster, Germany, 22-24 September. Prof. Buruma organised the symposium 'The good Judge' on 9 December 2016, which concluded with his inaugural lecture 'What is a good Judge? A mentality history (1900-2020)' on his appointment to the chair of the Centre for Post-academic Legal Education (CPO) at the university.

Dr Betty de Hart (Associate Professor) received an ERC Consolidator grant for her research proposal on regulating 'mixed intimacies'. She studies how regulations on 'racial' mixed marriages have been developed in Europe. She intends to revise current notions about mixed marriages in Europe. She argues that prohibition of interracial marriages was not just a phenomenon in the USA.

Societal impact

SteR cooperates closely with – and advises – external partners such as government bodies, ministries, courts, law firms, NGOs and European organisations. One of the Centre's key aims is to engage in dialogue with those in legal practice, for example by preparing best practices, legislative proposals and EU directives, as well as participating in national and international advisory bodies. The results of SteR's work are made accessible for judges, lawyers, politicians, students and the general public.

One example of great societal relevance is research on the regulation of cannabis (Prof. Van Kempen and Dr Fedorova), which was the subject of much discussion in the Dutch parliament and in the press. Another good example is the Handbook on Dutch migration law (Nederlands Migratierecht), which was presented by the CMR. As a Council of Europe rapporteur on migration issues, Dr Strik conducted research on the responsibilities towards migrants en route to the EU. Other noteworthy completed projects include the WODC project (Dutch Ministry of Justice) on public order by Dr Broeksteeg and Dr de Jong. In addition, Dr Böcker, Prof. de Groot-van Leeuwen and Prof. Laemers completed a WODC project on the transition of tasks from the civil judge to the administrative judge. Prof. Terpstra completed three projects on the national police (WODC), police officers and the role of mayors in police work (Politie & Wetenschap).

KEY PUBLICATIONS

- P.H.P.H.M.C. van Kempen & M.I. Fedorova, Internationaal recht en cannabis II. Regulering van cannabisteelt en -handel voor recreatief gebruik: positieve mensenrechtenverplichtingen versus VN-drugsverdragen, Deventer: *Wolters Kluwer* 2016, pp. XVIII + 373.
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- Dissertation Madeline Garlick: *Cum Laude* Solidarity Under Strain. Solidarity and Fair Sharing of the Responsibility for the International Protection of Refugees in the European Union.
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- H. de Waele, 'Entrenching the Area of Freedom, Security and Justice. Questions of institutional governance and judicial control', in: M. Fletcher, E. Herlin-Karnell & C. Matera (eds.), *The EU as an Area of Freedom, Security and Justice,* London: Routledge 2016, pp. 485-508.
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Dissertations	**8**
Scientific publications	**126**
Professional publications	**88**
Annotations	**153**

Director Professor Roel Schutgens

Roel Schutgens was appointed as a Full Professor in Jurisprudence in 2010. After his study of Dutch Law at Radboud University Nijmegen (*cum laude*, 2004), he was a PhD Fellow at the Department of Constitutional and Administrative Law in Nijmegen from 2004 to 2009. He obtained his PhD *cum laude* in 2009 with the thesis Onrechtmatige wetgeving (Unlawful Legislation), a study on the various forms of judicial review of legislation within the Dutch legal system. He has been the chairman of the SteR board since December 2015. Roel Schutgens' research interests include state liability, legislation, judicial review, and general constitutional law. He is a member of the board of *Themis*, the oldest Law Journal in the Netherlands and he is a deputy judge at the Gelderland District Court.

More generally, SteR researchers participated in numerous debates and lectures for the general public, as well as appearances in the media. Examples include a debate in LUX about the Ukraine referendum, Brexit, the Wilders case, the Pastafari Church, police infiltration and constitutional review. Several SteR researchers, as well as supporting staff, organised 'Food for Thought' for student refugees at the asylum seekers centre at Heumensoord, which included lectures and a photo exhibition. Numerous SteR researchers contributed to the Centre for Post-academic Legal Education (CPO), the leading provider of post-academic legal education in the Netherlands.

Future research

SteR will focus on the following socially urgent themes: institutional integrity; digitisation; modernisation of environmental law; overuse of the criminal justice system; security, international law and drugs; autonomy within the EU; and fundamental rights in the externalisation of migration policy. Several PhD positions were created in line with these themes. The CMR and the department of European Law launched two complementary PhD projects on Borders and Sovereignty, both concerning the externalisation of EU asylum policies. The CMR is also working on a new research proposal in this area. The departments of constitutional and administrative law, in cooperation with the departments of criminal law and jurisprudence will focus their research on the subject 'law and public integrity', starting two PhD projects and preparing an international conference, which will take place in 2019. In close cooperation with OO&R, SteR launched a PhD project on state liability for breach of trust.

Grants and awards

- Dr de Hart received an ERC Consolidator grant for her research proposal regulating mixed intimacies.
- Dr Krommendijk was awarded a Veni grant for his research on the dialogue between national courts and the ECJ.
- Dr Fresnoza-Flot was appointed as a Radboud Excellence Initiative Fellow to research marital break-up of 'mixed' couples involving Filipino migrant women in Europe.
- Dr Garlick defended her PhD on 'Sharing responsibilities for protection refugees' *cum laude*.
- Dr Glas was awarded the 2016 Max van der Stoel Human Rights Award for her PhD dissertation.
- Ms. Poppelaars received a Christine Mohrmann stipendium.
- Ms. Poméon received the Hanneke Steenbergen thesis prize for the best master thesis in the field of migration law.
- Ms. Geilman and Ms. Parisus received the Radboud University Medal for organising the lecture series for refugee students 'Food for Thought'. ‹

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IMR researchers focus on multidisciplinary analysis of complex societal issues.

Institute for Management Research

The Institute for Management Research (IMR) is the research institute of the Nijmegen School of Management (NSM). Its mission is to carry out state-of-the-art research into complex problems of governance and management. The complexity of the problems studied calls for a combination of knowledge and expertise from multiple disciplines, and for collaboration with societally relevant actors.

The IMR hosts researchers from business administration, economics and business economics, geography, planning and environmental sciences, as well as political science and public administration. IMR researchers combine scientific excellence with societal relevance. This is reflected in the institute's motto: creating knowledge for society.

The core of the IMR is formed by a number of 'Hot Spots' – collaborative networks of researchers from different disciplines with a joint interest in a specific research topic. Two overarching structures – the IMR Academy and the Doctoral School – ensure the cohesion of work at the institute.

Hot Spots

Research at the IMR is concentrated in multidisciplinary Hot Spots, where academics bundle their expertise on specific issues and societal problems.

Europeanisation of Policy and Law (EUROPAL)

The European Union exerts increasingly strong influence on its member states and beyond. It affects them through legislation, case law, financial incentives and informal norms. They have to comply with EU laws and policies, sometimes to the extent that policy areas become almost completely 'Europeanised'. At the same time, state and non-state actors seek to influence EU decision-making, seizing the opportunities the EU offers to them. The EUROPAL Hot Spot analyses these dynamic and complex processes of Europeanisation. Coordinator: Prof. Mastenbroek.

Governance and Innovation in Social Services (GAINS)

Societal problems such as the self-reliance of multi-problem families, the elderly and other vulnerable groups in society call for new solutions. The challenge is to design social services in such a way that these problems are properly addressed. The researchers at the Hot Spot GAINS focus on co-creation with societal actors. Coordinator: Dr Helderman.

Gender and Power in Politics and Management (GENDER)

Many organisations struggle with issues such as gender equality, diversity and inclusion. Progress towards these goals requires organisational change. Our vision for change is based on tailor-made conceptualisations of gender equality, diversity and inclusion that are grounded in cutting-edge research. The GENDER Hot Spot supports organisations in designing successful policies and practices in these areas. Coordinators: Profs. Benschop and Van der Vleuten.

Global-Local Divides and Connections (GLOCAL)

The GLOCAL Hot Spot brings together a group of scholars engaged in important topics related to the themes of borders, conflict and development. Our scholars work on diverse research topics, from economic migration to state building in post-war contexts to the politics of development and foreign aid. Coordinators: Dr L. Smith, Dr J. Smits and Dr Swedlund.

Innovation and Entrepreneurship in Business Ecosystems

The Innovation and Entrepreneurship Hot Spot aims to provide knowledge for entrepreneurs, firms and policy makers about how innovative ecosystems should be designed, supported and managed in order to create value both for those involved and for society at large. Coordinator: Dr Hillebrand.

Integrated Decision-Making (ID)

The ID Hot Spot focuses on developing and testing theories and methods for studying complex decision-making, using empirical testing with lab and field experiments, surveys and games. These scientific theories and methods help to generate knowledge that supports decisions and to translate this knowledge into effective intervention strategies. Coordinators: Profs. Rouwette and Marchau.

Staff

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Prof. J.M.M. Bloemer (o)
Prof. R. ten Bos (o)
Prof. T. Brandsen (p)
Prof. A.M.A. van Deemen (p)
Prof. S. Dühr (p)
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Prof. E. van der Krabben (p)
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Prof. A.C.R. van Riel (o)
Prof. E.A.J.A. Rouwette (o)
Prof. E.-M. Sent (o)
Prof. S. van Thiel (o)
Prof. J.A.M. Vennix (o)
Prof. J.A. Verbeek (o)
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Prof. M.S. de Vries (o)
Prof. G.U. Weitzel (o)
Prof. M.L.J. Wissenburg (o)
Prof. S.M. Zeisberger (o)

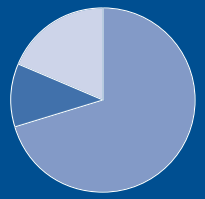
Tenured

Full Professors	12.6 FTE
Associate Professors	9.2 FTE
Assistant Professors	24.9 FTE
Researchers	0.7 FTE
Lecturers	0.7 FTE

Non-tenured

Researchers	10.0 FTE
Lecturers	1.6 FTE
Doctoral candidates	45.5 FTE

Research staff funding



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- Mees, H., Crabbé, A., Alexander, M., Kaufmann, M., Bruzzone, S., Lévy, L. & Lewandowski, J. (2016). Coproducing flood risk management through citizen involvement: insights from cross-country comparison in Europe. *Ecology and Society, 21*(3).
- Qiu, J. & Weitzel, G.U. (2016). Experimental Evidence on Valuation with Multiple Priors. *Journal of Risk and Uncertainty, 53*(1), 1-20.
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- Simons, T., Vermeulen, P.A.M. & Knoben, J. (2016). There's No Beer without a Smoke: Community Cohesion and Neighboring Communities' Effects on Organizational Resistance to Antismoking Regulations in the Dutch Hospitality Industry. *Academy of Management Journal, 59*(2), 545-578.

Dissertations	**17**
Scientific publications	**229**
Professional publications	**132**

Research facilities

The IMR houses two labs (the Visa Skills and Decision Labs). These labs facilitate top-level research using advanced research methods, in particular research on decision-making. The labs are increasingly used by external parties.

- In the Visa Skills Lab, group-based decision-making – for example in brainstorming, scenario development, priority-setting, and voting procedures – is studied. This allows researchers to involve multiple stakeholders in exploring problems and developing intervention strategies and to evaluate interventions. For example, researchers working on the ID Hot Spot used the lab for a modelling project in cooperation with the municipality of Nijmegen.
- The Decision Lab supports research on individual and group decision-making and makes it possible to test theories, for example in behavioural economics. Issues such as financial decision-making, market design, negotiations, and strategies for conflict resolution are addressed.

The IMR hosts several large databases. Significant developments in 2016 include:

- The Global Data Lab (GDL) launched the GDL Area Database, which provides free downloadable indicators on health, education and labour at the level of sub-national regions, covering 20 million people in 110 Low and Middle Income Countries (LMICs). Coordinator: Dr J. Smits. Researchers at the GLOCAL Hot Spot created an extension of the GDL Area Database with new indicators and countries/years.
- In 2016, three datasets were created by researchers at the EUROPAL Hot Spot: the Ukraine referendum dataset (Dr K. Jacobs), which was commissioned by the Dutch Foundation for Electoral Research; Europeanisation of the Dutch civil service in cooperation with the Universities of Utrecht and Leiden (Prof. Mastenbroek); and a data set on state aid notification procedure (Dr Zwaan).

- Researchers at the GENDER Hot Spot developed and continued to use datasets resulting from the European projects MAGEEQ, QUING, STAGES, EGERA and GARCIA. These quantitative and qualitative datasets, which enable theory-driven comparative research, will be used to generate new, interdisciplinary theories.
- The researchers at the GLOCAL Hot Spot developed two datasets: a qualitative data set for 'Enhancing Local Peace Committees' and a database on Regional Trade Organisations in the world.

Collaboration

Researchers at the Institute collaborate with various national and international colleagues.

- Nationally, there are formal collaborations with all Dutch universities, several Universities of Applied Sciences notably HAN and AVANS, as well as the national research institutions TNO and Deltares.
- Internationally, the Institute cooperates with many universities, including Oxford, Zürich, ETH Zürich, Innsbruck, Copenhagen, Antwerp, Hasselt, Brussels, Bologna, Loughborough, the Swedish National Defence University as well as research institutes *e.g.* the Fraunhofer Institute and the Scalabrini International Migration Institute.
- Outside Europe there is collaboration with the Universities of Dayton, Victoria, Phnom Penh, Carleton, Yunnan, Ghana, Gadjah Mada, Ciudad Juárez, Witwatersrand and Sri Lanka.

Examples of institutional collaborations:

- Dr M. Van Leeuwen collaborates with the Ministry for Peace and Reconciliation under the Cross (Mi-PAREC) of Burundi on the Local Peace Committees project, which is financed by the NWO Applied Research Fund for Security & Rule of Law. This project involves facilitating stakeholder debate on the strategic choices involved in transitional justice in Burundi and DR Congo.
- Dr P. Beckers and José Muller MSc. cooperate with the International Organization for Migration (IOM), Društvo Odnos, Slovenia, Leone Moressa Foundation, Italy, Menedék, Hungary, African Young Professional Network, the Netherlands and Foundation for Refugee Students UAF on the project The Skills2Work. The aim of the project is to create better conditions for the early and successful labour market integration of the beneficiaries of international protection. This work is funded by the EU Asylum, Migration and Integration Fund (AMIF).

Research results

A selection of results achieved in 2016:

- Dr Carton and Dr Samsura are developing a so-called Carbon Game. In this video board game (on the map table), players have to reduce their greenhouse gas emissions in order to minimise global warming to less than two degrees. But every reduction has consequences for the player's economy and no player can reach the two-degree objective without the help of others. All eight players need to negotiate and work together to find a strategy they can agree on. This game demonstrates the complex challenges and compromises facing the climate negotiators during the Paris Agreements.
- The outcome of the Ukraine referendum held in the Netherlands was not affected by a massive protest vote. The motives for voting for or against were connected to concerns about corruption in that country and some voters wished to support the Ukrainian population. Social dissatisfaction only seems to have played a limited direct role in the final decision. These are some of the results of a study by Dr Jacobs (National Referendum Investigation 2016), on behalf of the Dutch Electoral Research Foundation (SKON). A survey was held among 2000 citizens.
- Prof. Knoben launched an ongoing study on the economy in the Arnhem-Nijmegen region. He presented the results of the first Kwartaalbarometer ('Quarterly Economic Barometer') during the Economic Board's opening event. The Economic Board is a collaborative venture involving the Dutch government, universities and industrial partners in the region Arnhem – Nijmegen – Wageningen.

Dr Roos Pijpers (Assistant Professor of Social Geography) obtained an NWO Vidi grant to study the consequences of the decentralisation of elderly care for responsiveness to the care needs of migrant elderly and LGBT elderly people. This research is among the first to explicitly focus on spatial justice issues in the area of the diversity of ageing experiences and care needs.

A selection of conferences organised or co-organised by IMR researchers:

Corporate Responsibility Conference

In this annual conference, interactive workshops allowed students, PhDs, alumni and other interested parties to engage in discussions with representatives of the international business community and NGOs as well

as representatives of ING, Annonna Advisors, Shell, Transparency International and Unilever.

ECPR Research Sessions

The Department of Public Administration and Political Science hosted the European Consortium for Political Research's Research Sessions. The conference included small-scale workshops that gave researchers the opportunity to collaborate on research projects that will ultimately result in joint publications.

CICAM 50th Anniversary 1966-2016

The 50th anniversary of the Centre for International Conflict – Analysis & Management (CICAM) was celebrated with the conference 'Images of the Enemy in the 21st Century.'

Examples of grants achieved in 2016:

- Dr Pijpers successfully obtained an NWO Vidi grant to study the consequences of the decentralisation of elderly care for responsiveness to the care needs of migrant elderly and LGBT elderly people. This research is among the first to explicitly focus on spatial justice issues in the area of the diversity of ageing experiences and care needs.
- Prof. Akkerman decided to carry out her NOW Vici project 'A dissatisfied employee, a dissatisfied citizen?' at NSM. The aim of the project is to reveal how the expression of dissatisfaction by employees is suppressed and what consequences this has for the behaviour of employees.
- Together with a consortium of academic and societal partners, Dr Meijerink has obtained funding for the 'All Risk: Implementation of new risk standards in the flood protection' programme. The programme, which was led by Prof. M. Kok of Delft University of Technology, studies ways to predict and prevent the risk of flooding. The funding was granted by the technology foundation STW.

Awards and acknowledgements

Prof. Jonker has been appointed chair of the Sustainable Business Models programme. The aim of this programme is to generate new knowledge and to develop new methods for accelerating the transition to sustainable business models in the Netherlands. It is a joint initiative of business association De Groene Zaak, the scientific network Het Groene Brein and NWO.

Prof. B. van der Heijden was re-elected as a member of the Advisory Group for the Marie Skłodowska-Curie actions. The mission of this group is to provide consistent, consolidated advice to the Commission services regarding Marie Skłodowska-Curie actions on skills, training and career development. Prof. Van der Heijden has been elected as Vice-chair for the second time.

The Scientific Board of the Masaryk University in Brno, Czech Republic has decided to confer the honorary degree of Doctor Honoris Causa to Prof. De Vries for his international work on behalf of the development of Public Administration in general and his contribution to the development of the Masaryk University in particular.

On 18 February 2016, Alex Lehr was awarded his PhD *cum laude*. In his thesis 'Spillovers and conflict in collective bargaining' he used survey data and bargaining experiments in order to test economic and sociological theories about the impact of information about other negotiations on conflicts in collective bargaining.

Dr Heukelom has been awarded the Young Researcher Award of the European Society for the History of Economic Thought (ESHET). This award recognises scholarly achievements of historians of economic thought at an early stage in their career. The prize is awarded to scholars below the age of 40 in recognition of outstanding publications in the history of economic thought.

Director Professor Sandra van Thiel

Prof. Sandra van Thiel has been Professor of Public Management at the Department of Public Administration since 2012. Her research focuses on semi-autonomous public organizations at different levels of government and in various countries. Sandra van Thiel previously worked at Erasmus University Rotterdam (Public Administration) and Utrecht University (Sociology). She is also a frequent consultant to public sector organizations. She has coordinated a parliamentary inquiry for the Dutch Senate and is currently a member of the evaluation committee on the formation of the national police force. Sandra van Thiel is Editor in Chief of the International Journal of Public Sector Management.

Societal impact

IMR researchers are creating societal impact in various ways. They cooperate with societal partners in a number of projects and events. A striking example is 'NatuurCollege on Tour', which was organised by the Department of Geography, Planning and Environment in cooperation with NatuurCollege. On 13 December, Princess Irene van Lippe-Biesterfeld spoke about 'Sustainability from within'. Societal partners with which projects are conduct include: the Council for Health and Society; the Court of Audit; the Municipalities of Nijmegen, Oss and Rotterdam; the Dutch Inspectorate of Education; the Dutch Ministry of Public Health, Welfare and Sports; the National Police; UN-Women; the Council of Europe; the European Parliament; Rabobank; Parkinson-Net; Kiesraad; the Netherlands Study Centre for Technology Trends (STT); Het Groene Brein; Rijnstate Hospital Arnhem; the Confederation of Netherlands Industry and Employers (VNO-NCW); the Dutch Ministry of the Interior and Kingdom Relations; Euregio Rijn-Waal; the Knowledge Platform Security and Rule of Law; UN-Habitat Congo; the Gapminder Foundation; and the Overseas Development Institute.

Besides cooperation on research projects, several IMR researchers contribute to training courses for the public sector: for example, GENDER researchers contributed to the RMA Masterclass on Diversity and Inclusion and GAINS researchers contributed to the RMA post-Masters course on Strategy and innovation in cure and care. Several IMR researchers are also member of societal advisory bodies, notably:

- Prof. Leyenaar, The Council for Public Administration
- Prof. Sent, Member of the Senate of the Netherlands
- Prof. Leroy, Committee member of the Health Council of the Netherlands.

These and other IMR researchers are regularly consulted by public authorities. For instance, on 20 July 2016 the Health Council of the Netherlands published the report 'Considering health in environmental policy'. The Council has advised State Secretary Sharon Dijksma to tighten the standards in the Environment and Planning Act as a way of reducing the disease burden caused by environmental factors. Early in November, the Ministry of Public Health, Welfare and Sports sent the conclusions of the evaluation of the National Prevention Programme 'Alles is Gezondheid' (conducted by Dr Bekker and Dr Helderman, together with Maastricht University) to the Dutch Parliament, successfully arguing for extension of the programme.

IMR researchers also appear regularly in social media, radio and TV and newspapers. For instance:

- Prof. Sent presented five lectures on behavioural economies for the University of the Netherlands (available online).
- Prof. Verbeek commented on the results of the Italian referendum (December 7, radio BNR Nieuws).
- On 7 May, Dr M. van Leeuwen was interviewed by the TV show Nieuwsuur about the explosive situation in Burundi.
- Dr Van Houtum published opinion articles in the Volkskrant and NRC newspapers, and several columns in the Gelderlander, in particular on the EU's border policy and the current migration debate.

A societal mark of recognition was granted to Prof. Jonker, who on Tuesday 6 September, a.k.a. Sustainable Tuesday, received a *Duurzaam Lintje* ('sustainable ribbon') from Princess Laurentien. This is the only decoration for sustainability worldwide.

Future research

Two examples of a project that is due to start in 2017:

- The Sterk Bestuur ('strong government') programme of the Province of Gelderland has commissioned Dr Van Genugten to examine intermunicipal collaboration. This study is part of an intensive partnership between the Province and Radboud University, with a focus on knowledge exchange.
- The Good Market, How It Does and Doesn't Work: 'Macro-Virtues' (Templeton Foundation) This project involves exploring trends in values related to free markets by analysing dominant discourses in economic thinking. Three groups of countries are compared: Northern European countries, including Germany, the Netherlands and Denmark; Anglo-Saxon countries, including Great Britain and the United States; and Latin European countries, including France, Spain, and Italy. It is conducted by Prof. De Jong and Dr Heukelom. ‹

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Radboud Social Cultural Research

Within Radboud Social Cultural Research (RSCR) academic work focuses on developments in society with a multidisciplinary perspective. Descriptive and explanatory research is carried out on the central themes of inequality, cohesion and modernisation in both Western and non-Western societies. RSCR research has a comparative focus and employs innovative theoretical approaches, up-to-date analytical methodologies and original strategies for acquiring information.

RSCR – a research institute of the Faculty of Social Sciences – changed its name from 'Nijmegen Institute for Social and Cultural Research' (NISCO) into 'Radboud Social Cultural Research' in 2016. This new title reflects the international context of the institute. The institute consists of two research groups: Cultural Anthropology and Development Studies (CAOS) and Sociology. In 2016, the group working on Gender and Diversity joined the institute. To advance knowledge on the dynamics of societal phenomena, RSCR researchers often examine topics from a comparative perspective (across different societies), but anthropological and gender research also regularly focuses on relevant issues in single communities or societies. Closely associated with RSCR is the Research Masters programme in Social and Cultural Sciences. This programme offers high-quality training in theory building and analytical methods for conducting comparative research on the RSCR themes inequality, cohesion, and modernisation.

Inequality

The main focus within this theme is on differences in access to – and control over – resources that affect peoples' opportunities, *e.g.* in education, success in organisations and the labour market, as well as in family and identity formation and health. Social inequality is studied from both an intra-generational and an inter-generational perspective. Researchers examine the effects of social, cultural and economic resources on socio-economic achievement and consider how differences between and within countries are affected by structural conditions such as wealth and unemployment, the cultural climate, and local and national policies. Various aspects such as individuals, families, organisations, social groups and country contexts are thought to affect outcomes. Moreover, researchers study how social categories such as gender, ethnicity, class and age co-construct inequality from an intersectionality perspective.

Cohesion

Within this theme researchers describe and explain differences in social participation and connection to formal organisations (companies, clubs and political parties), as well as to informal social networks, such as families, ethnic communities and in friendships. Developments in the relationship between an individual's social and cultural resources and pro-social attitudes (support, giving intentions) and anti-social behaviours (criminality, discrimination) are explored, focusing on variations in and among societies at different stages of development and with different welfare-state regimes. Aspects of inclusion and belonging are also studied within the formal contexts of organisations and communities. Furthermore, comparisons are made to show which social groups have intolerant attitudes towards migrants and refugees, taking differences in economic, cultural and demographic contexts into account. Moreover, the attitudes and behaviours of migrants are studied in relation to their social and cultural integration.

Modernisation

Researchers at RSCR study economic, cultural, social and technological developments, and particularly those that are associated with the modernisation of opinions in Dutch and other societies. A great deal of attention is paid to belief systems, constructing identities and meanings derived from religion, to conceptions of citizenship, inclusion, justice and altruism, and to the implications of these concepts for participation in work and family domains. RSCR researchers also focus on modernisation processes in developing countries and their effects on inequality and poverty, as well as on developments in social and political participation. Further, reactions to modernisation processes are the subject of research on the role of governments, civil society organisations and individual citizens.

Staff

Prof. K. Breedveld (e)
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Prof. R.N. Eisinga (o)
Prof. G.L.M. Kraaykamp (o)
Prof. M. Lubbers (o)
Prof. A.H.M. van Meijl (o)
Prof. P.L.H. Scheepers (o)
Prof. M.J. Spierenburg (o)
Prof. M.H.J. Wolbers (p)

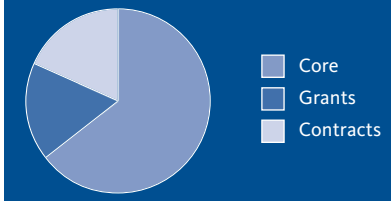
Tenured

Full Professors	3.1 FTE
Associate Professors	1.1 FTE
Assistant Professors	7.3 FTE

Non-tenured

Researchers	4.0 FTE
Doctoral candidates	12.9 FTE

Research staff funding



Research facilities

Within RSCR the collection of high-quality data is greatly valued, as it provides excellent opportunities for multidisciplinary comparative research and cooperation. Researchers therefore contribute to the academic community through their involvement in several data collections. Data facilities include both longitudinal collections – on Dutch individuals and their life courses and networks (Family Survey Dutch Population (FSDP), Netherlands Longitudinal Life-course Survey (NELLS), Social and Cultural Developments in the Netherlands (SOCON)) – as well as cross-national collections that contain information related to a wide range of topics (*e.g.* the European Social Survey (ESS) and the New Immigrant Survey Netherlands (NIS2NL)). Within the Anthropology Department small-scale data are collected in the Netherlands and in non-western societies using ethnographic field research. Large-scale data are often collected with additional funding from the Netherlands Organisation for Scientific Research (NWO). These are transparently documented and deposited at the Royal Netherlands Academy of Arts and Sciences' Data Archiving and Networked Service (DANS). RSCR-generated data have been widely used by colleagues both nationally and internationally.

Academic integrity

Within RSCR high standards of academic integrity are maintained. Since 2014, the Institute has established a system that annually archives information related to all peer-reviewed academic publications. This makes replication and verification possible, and annually a security check is carried out on a selection of publications with respect to fraud, plagiarism and data construction. Within RSCR, there is a long-standing tradition of providing the academic community with well-documented open-source data (Crime-NL, ESS, FSDP, NELLS and SOCON) to improve academic transparency and integrity. Freely accessible data makes it possible to control and repeat research results, thus promoting integrity. This tradition has been widely recognised as best practice and both data and publications are carefully archived together with source information at the institute and at DANS-KNAW.

In 2016, **Prof. Marieke van den Brink** has been appointed Professor of Gender and Diversity. She studies the position and functioning of gender and diversity in organisations as well as the opportunities for and barriers that prevent indirect, unconscious exclusion of specific groups from the labour market. She chairs Radboud Gender & Diversity Studies in which over 100 scientists from a range of disciplines cooperate.

Collaboration

Members of RSCR participate in various Dutch research schools in order to advance national and international alliances and provide education to PhD scholars. This is done in the Research School for Resource Studies for Development (CERES), the Interuniversity Centre for Social Science Theory and Methodology (ICS), and the Netherlands Research School for Gender Studies (NOG). Within the Netherlands research is carried out with the European Research Centre on Migration and Ethnic Relations (ERCOMER), the Netherlands Institute for Social Research (SCP) and Statistics Netherlands (CBS). Internationally, scholars at RSCR cooperate with researchers from various top institutes, such as the Social Science Research Center (WZB) in Berlin; Pacific Studies Research Group University of Bergen, Norway; Ohio State University, USA; London School of Economics, Centre de Recherche et de Documentation sur l'Océanie, Aix-Marseille Université; as well as with several researchers at the German universities of Bamberg, Cologne, Göttingen, Heidelberg, Munich and Münster, the Danish University of Aalborg, the Stockholm Resilience Centre and the Swedish Royal Institute of Technology, the University of Jyvaskyla, Finland, the Australian University of Melbourne, the British universities of Cambridge, Essex, Exeter, Oxford and St. Andrews, and the South African universities of Cape Town, Stellenbosch and Johannesburg. In 2016, RSCR hosted Prof. Luibheid from University of Arizona, Prof. Li from University of Toronto, Dr Sauer from Bielefeld University and Prof. Strohmeier from Upper Austria University.

RSCR staff also participates in a variety of academic networks, such as the Development Policy Review Network; the European Association for Gender Research, Education and Documentation (ATGENDER); the European Association of Social Anthropologists (EASA); the European Association of Development Research and

Training Institutes (EADI); the European Consortium for Sociological Research (ECSR), the European Consortium for Pacific Studies (ECOPAS); the European Group of Organisation Studies (EGOS); the European Institute for Gender Equality (EIGE); the European Network for Research Expertise on Economic change, Quality of Life and Social Cohesion (EQUALSOC); the ESA Research Network (28) on Sport Sociology; European Research Network on Transitions in Youth (TIY); the European Society for Oceanists (ESfO); the Association for Social Anthropology in Oceania (ASAO); the Network of Excellence Enhancing the Interest in Science in a Developing Europe (EISDE); the ISA Committee on Social Stratification and Mobility (RC28); the International Civil Society Forum on Conflicts (INFOCON); and the Programme on Ecosystem Change and Society (PECS).

Research results

Results are reported within the three major themes of research at RSCR.

In the field of inequality, research explored health inequalities between members of ethnic majority and ethnic minority communities. This included how ethnic inequalities in health may be exacerbated or mitigated by national healthcare policies. Results showed that migrants report lower levels of health than native citizens. Higher healthcare expenditures seem to reduce socio-economic differences in health, but increase health differences between migrants and native citizens. Results also indicate that policies specifically directed at improving migrants' health mainly affected the well-being of second- generation migrants.

Research on gender inequality in evaluation decisions in a Swedish bank and a Dutch professional services firm showed how strengths and weaknesses are discursively constructed. Four subtle patterns in the evaluation of male and female employees were distinguished in which men's strengths are inflated and their weaknesses downplayed, while women's strengths are downplayed and weaknesses inflated. This research reveals how gender inequalities are reproduced in seemingly gender egalitarian contexts when women and men are considered for higher positions.

In the field of cohesion, researchers explored how anxieties circulate and are highlighted in various settings and by different people, using the 'notorious' Amsterdam Diamantbuurt as a research setting. The focus was on the iconic stereotype of troublesome 'Moroccan youth' in order to trace how anxious discourses move from the national stage, to a neighbourhood, and then into the narratives of Moroccan and Dutch residents. While younger women contest discourses that frame male peers as inherently disposed to crime, older residents hold different discourses. They articulate anxieties that differ markedly from the narratives of the younger generation. Clearly these age-specific views feed generationally specific senses of belonging.

A second area of research focused on national celebrations and commemorations that are believed to increase national cohesion. It addressed to what extent parents, schools, and integration into religious groups affect participation in national celebrations in the Netherlands. Findings showed that parental behaviours in particular are crucial for participating in such celebrations. Schooling and integration in religious groups only affect specific forms of national celebrations and commemorations.

Modernisation processes were discussed in an article on biosphere reserves (social-ecological systems that combine biodiversity conservation and socio-economic development with knowledge generation and dissemination). Several case studies on West Africa highlighted the importance of early stakeholder

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- Bekele, A.D., Beuving, J.J. & Ruben, R. (2016). Food choices in Ethiopia: Does nutritional information matter?. *International Journal of Consumer Studies, 40*(6), 625-634.
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- Jaffe, R.K. & Koning, A. de (2016). *Introducing urban anthropology*. London: Routledge.
- Jansen, L., Weber, T., Kraaykamp, G.L.M. & Verbakel, C.M.C. (2016). Perceived fairness of the division of household labor: A comparative study in 29 countries. *International Journal of Comparative Sociology, 57*(1-2), 53-68.
- Jansen, W.H.M. & Driessen, H.G.G.M. (2016). The lost child: Age and gender in ritual in southern Spain. *Journal of Ritual Studies, 30*(2), 25-40.

KEY PUBLICATIONS

- Kamstra, J., Pelzer, B.J., Elbers, W.J. & Ruben, R. (2016). Constraining is enabling? Exploring the influence of national context on civil society strength. *Voluntas: International Journal of Voluntary and Nonprofit Organizations, 27*(3), 1023-1044.
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- Kraaykamp, G.L.M. & Notten, N.J.W.R. (2016). Parental cultural socialization and educational attainment: Trend effects of traditional cultural capital and media involvement. *Research in Social Stratification and Mobility, 45*, 63-71.
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- Mourits, R.J. & Kempen, L.A.C.M. van (2016). How do the middle class and the poor grow apart? An empirical test of the psychological well-being pathway in middle-income countries. *European Journal of Development Research, 28*(5), 893-915.
- Rommes, E.W.M. & Podesta, L.M. (2016). Depicting the Dutch: Sex inequalities on non-fiction television programs and their explanations. In K. Ross & C. Padovani (Eds.), *Gender equality and the media: A challenge for Europe* (Routledge Studies in European Communication Research and Education Series,). (pp. 136-144). New York; London: Routledge, Taylor & Francis Group.
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- Verbrugge, B.L.P. (2016). Voices from below: Artisanal- and small-scale mining as a product and catalyst of rural transformation. *Journal of Rural Studies, 47* (Part A), 108-116.
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Dissertations	**5**
Scientific publications	**124**
Professional publications	**98**

engagement in order to build knowledge for achieving sustainable development. Differences between stakeholders and their different needs and perceptions about nature conservation complicate implementation processes, sometimes resulting in conflicts about the objectives and zonation of biosphere reserves. It is therefore argued that a dialogue must be pursued, formalised, ritualised, and translated both in terms of biosphere reserve management and in terms of political support.

A quantitative study highlighted the fact that in the last three decades Dutch church attendance dropped considerably, while the number of volunteers in non-religious organisations decreased at a much lower rate. This is an unexpected development, given the positive association between religious involvement and volunteering. It was hypothesised that this phenomenon is counterbalanced by educational expansion. Results revealed that this is the case, although with a fairly modest magnitude.

Awards and acknowledgments

RSCR Director Kraaykamp received grant funding for the Radboud Research Initiative proposal Vibrant Societies. Further, two grant proposals were rewarded within the Radboud Excellence Initiative (Sauer, Mickucka). Koster officially received an ERC Starting Grant for his project on Participatory Urban Governance, and Meuleman received an NWO Veni grant for research on Cultural Connections. Also, within the Sociology group, an NWO Talent grant proposal for the project 'Where are the Muslim Feminists?' was successful. Kinsbergen received grant support from Wilde Ganzen for a 3-year project on Private Development Initiatives. Van den Brink and Blommaert received funding for a project on the Recruitment of Women in Company Boards by the Ministry of Education, Culture and Science and Rommes for a project on Caring

Connections. Spierings was elected president of the Dutch society for Women's Studies, and Spierenburg became vice-chair of the UN Ecosystem Change Programme.

Societal impact

RSCR encourages scholars to engage in a variety of activities (sitting on advisory boards, making contact with policy makers, cooperation with stakeholders, professional publications, and exposure in the media) to ensure that academic knowledge is made more widely available. Researchers participate in public debates – and appear in the media – on topics such as migration, cultural diversity, radicalism, (educational) inequality, poverty, gender and diversity, sexuality, care, effectiveness of aid, and opinions among European citizens. Moreover, they advise public and private institutions and act as consultants. For instance, advice was given on behalf of the European Parliament, European institute for Gender Equality, the Dutch Ministries of Social Affairs and Education, Stichting Lezen, VSNU and WODC. RSCR scholars also gave advice on international surveys (such as the European Social Survey/CUPESSE) and national data collection (NDSW and Statistics Netherlands).

As an expert in the field of migration, Lubbers gave several presentations and advised the Ministry of Social Affairs and the National Committee 4 and 5 May. Van den Brink was an active member of the Young Academy (KNAW). Breedveld served as an expert in the field of sports in various ways: as a consultant for the Dutch Parliament, the Giro d'Italia in Nijmegen, the Ministry of Health, Welfare and Sport and NOC/NSF. Schulpen advised the Ministry of Foreign Affairs and several private aid organisations and appeared widely in the media discussing international development cooperation. Spierenburg was a member of the UNESCO advisory committee on biosphere reserves and chairs the advisory board of the African Study Centre. In collaboration with the Netherlands Institute for Social Research (SCP), Kraaykamp composed a report on opinions in Europe that attracted ample media attention. Scheepers was a member of the Scientific Advisory Board on data collection at Statistics Netherlands and served as a member of the KNAW National Science Agenda on cohesion.

RSCR staff have also co-organised conferences on, for example, cultural education, informal caregiving, migration, sexual abuse, shifting solidarities, and Yemen. Moreover, researchers played a leading role in initiating two Radboud summer school courses: on gender in society, and on debt and inequality. Scheepers edited a textbook on research methodology that has been adopted in various universities and vocational colleges, and De Koning co-authored a relevant textbook on Urban Anthropology. Te Grotenhuis gave several very popular lectures on methodological innovations and Verbakel held a lecture for the University of the Netherlands on partner choices.

Future research

In 2016 RSCR welcomed researchers from gender and diversity studies. Prof. Van den Brink chairs this group and is expected to initiate research on the themes of gender in organisations and the inclusion of minorities in society. Two PhD students and an assistant professor will be recruited to work on these topics in 2017. It also is expected that Prof. Spierenburg, the newly appointed professor of developmental studies, will further inspire research and education within CAOS and search for external funding and partnerships. A PhD student will be attracted to support her research programme. Both appointments will strengthen RSCR's intention to further stimulate cooperation between sociology, anthropology and gender research.

Director Professor Gerbert Kraaykamp

Gerbert Kraaykamp is Professor of Empirical Sociology at Radboud University. His research interests mainly relate to issues of educational inequality, parental socialization and health. He has published widely on these topics, both nationally and internationally. Prof. Kraaykamp is a board member of the Interuniversity Center for Social Science Theory and Methodology (ICS), a member of the CUPESSE advisory board and co-initiator of several large-scale data collections (NELLS, FSDP, and SOCON). Currently, he is Dutch National Coordinator of the European Social Survey (round 8) on behalf of the Netherlands Organisation for Scientific Research (NWO). In 2016 this resulted in the book publication "Trust, Life Satisfaction and Opinions on Immigration in 15 European Countries", together with the Netherlands Institute of Social Research (SCP).

RSCR proved successful in acquiring funds for doing research last year. For example, an ERC Starting Grant was obtained within the CAOS group, and a NWO Veni and Talent grant within the Sociology department. The financing of the Radboud Research Initiative on Vibrant Societies makes it possible to attract three more PhD students in 2017. Projects are expected on female leaders, on poverty and depths, and on volunteering in and outside the Netherlands.

Research within the CAOS group mainly focuses on issues related to cultural diversity and its consequences for socio-economic inequality. PhD students (partially funded by NWO) are working on these themes and associated publications are expected. In 2016 research capacity in the ERC project led by De Koning on Migrant Parenting and Citizenship was complete with the hiring of three PhDs and three postdoc researchers. It is expected that in 2017 the first research output will be achieved. The ERC Grant-funded project led by Koster on Participatory Urban Governance will continue in 2017 with the hiring of new research personnel. Cooperation with the Sociology group (Scheepers) on ethno-religious conflicts in South-East Asia (Indonesia and the Philippines) will be extended, and Kinsbergen will start her postdoc research on private aid initiatives for Stichting Wilde Ganzen.

Various sociological research projects are closely related to RSCR themes of inequality and cohesion. Topics that are investigated by PhD students include the relationship between unemployment and radicalism, integration and opinions of recent migrants, feminism in Muslim countries, female advantage in education, inequalities in late careers and the relationship between life events and sports participation. In the Sociology group the Veni project led by Spierings (started in 2016), is beginning to produce research results. An additional postdoc will be appointed to work with Spierings on the topical theme of Islamic Religiosity and Democratic Attitudes. Also, Meuleman will start her Veni project in the beginning of 2017 and a replacement postdoc will be hired. Two PhD students and a postdoc will continue working on the NORFACE MIFARE project led by Lubbers on migrants' welfare-state benefit dependency and attitudes. It further is expected that collaboration between the Department of Sociology and the SCP will result in a publication on behalf of the Dutch Ministry of Foreign Affairs in 2017. ‹

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Behavioural Science Institute

The Behavioural Science Institute (BSI) conducts research on human behaviour. The work of the Institute is both fundamental (to understand behaviour) and applied to societal challenges (to influence behaviour). A distinctive feature of the BSI is an integrative approach to human behaviour that transcends the traditional disciplinary boundaries of psychology, education and communication science.

The BSI, which is the largest research institute in the Faculty of Social Sciences, is accredited as a research school by the Royal Netherlands Academy of Arts and Sciences (KNAW). A two-year Research Masters programme in Behavioural Science (www.ru.nl/education/masters/behavioural-science/) is taught within the BSI Graduate School, which is officially recognised by the Netherlands Organisation for Scientific Research (NWO).

BSI researchers investigate the nature and development of human behaviour. They study the ways in which it is influenced by 1) individual factors (cognitive, affective, motivational and psychophysiological processes), 2) social-contextual factors (home, school, peer groups, work and the media), and 3) the dynamic interplay between these factors. In addition, they study reverse associations and explore how human behaviour influences individual factors and the social context. Both normative behaviour and psychopathology are researched, involving laboratory experiments and field studies, large-scale longitudinal studies and randomised controlled trials. Methods include observations, self-reports, physiological measurements, neuroscientific measurements and genetic analyses. New technology such as smartphones, wearables and virtual reality are increasingly used.

The three main research themes of BSI are:

Development and Learning

We all keep developing and learning throughout our lives. Within BSI, the biological, cognitive, and behavioural processes related to *life-long learning* are investigated. Fundamental research carried out in this theme provides insight into how people learn, revealing the underlying processes (*e.g.* plasticity) that support cognitive, social, emotional, and motor development. The focus is on the development of infants, motor learning, language acquisition, peer relations, teaching, coaching and training. Researchers look at various contexts and factors that shape development, including family, school, workplace, community, culture, media, and also at physiological and genetic influences. Many of these factors are investigated using longitudinal designs that monitor target groups over several months and sometimes years. This research has implications for primary and secondary education, prenatal consulting and early child care, interventions in schools, and assistance for students with special needs or developmental disabilities. The aim is to produce insights that directly and indirectly help all members of society (young and old) to live fulfilling and productive lives.

Psychopathology, Health and Well-Being

Physical and mental health are influenced by a combination of genes, nurture and lifestyle. At the BSI research focuses on encouraging behaviours that lead to a healthier lifestyle and a feeling of well-being on the one hand, and treatment of mental disorders on the other. Researchers look at both internalising and externalising psychopathologies, such as anxiety, depression, burnout, ADHD, addictive behaviours (smoking, alcohol, drugs) and eating disorders. Genes, neurobiological processes, behaviour and environment are all taken into account. Promotion of health and well-being involves looking at food choice, self-control, coping strategies, need satisfaction, mindfulness, sport and exercise, work-life balance, sleep and recovery. For psychopathologies the roles of implicit and explicit processes, cognitive bias, motivation and reward are also considered. Both preventive and curative interventions are developed and tested. Behaviour and interventions are not only studied in a clinical setting, but also in families, schools and at work. Research interests cover the whole lifespan: from babies, children, adolescents, students, families and working life to the elderly.

Staff

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Prof. M.A. Buijzen (o)
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Prof. H.P.J.M. Dekkers (p)
Prof. H.C.M. Didden (e)
Prof. A.J. Dijksterhuis (p)
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Prof. R.C.M.E. Engels (p)
Prof. S.A.E. Geurts (p)
Prof. I. Granic (p)
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Prof. H.L.I. Nijman (e)
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Prof. A.G. Sanfey (p)
Prof. R.H.J. Scholte (e)
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Prof. B. Steenbergen (o)
Prof. B.G. Tiemens (e)
Prof. M.J.P.M. Verbraak (e)
Prof. L.T.W. Verhoeven (o)
Prof. J.M. Vink (o)
Prof. R. Vonk (p)
Prof. C. de Weerth (p)
Prof. D.H.J. Wigboldus (o)
Prof. C.L.M. Witteman (o)

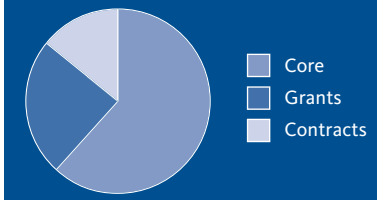
Tenured

Full Professors	9.4 FTE
Associate Professors	6.3 FTE
Assistant Professors	19.4 FTE
Researchers	0.7 FTE

Non-tenured

Researchers	18.6 FTE
Doctoral candidates	62.9 FTE

Research staff funding



Social Processes and Communication

Because much behaviour is altered by external factors, it is important to examine the influence of the social context on intra-individual processing. Researchers working on this theme investigate how social interactions are related to individual mental health and well-being. They look at interpersonal relationships, group dynamics and media influences. Interaction between automatic and controlled aspects of social behaviour is studied, for example in face perception, decision-making and creativity, and attitudes towards others. One goal is to define the key factors that distinguish the positive and negative features of close relationships (*e.g.* social support and conflict). This aspect is studied in the family context, in schools and in the workplace. Another topic of interest in this theme is exploring group processes relating to aggression, social status, leadership, prejudice and social norms. In addition, research is carried out on the efficacy and impact of media campaigns (*i.e.* advertising and marketing) and social media. This information is used to promote healthy and effective behaviour via the social and media environments that target groups operate in.

BSI research takes place in the following seven research groups: *Communication and Media; Developmental Psychopathology; Experimental Psychopathology and Treatment; Learning and Plasticity; Social Cognition; Social Development;* and *Work, Health and Performance*. These groups all work on the three main themes described above.

Research facilities

The most important resource for the BSI is the availability of participants. For this, the institute has established a large network of schools, healthcare and youth care institutions and governmental institutions. Much of the research is conducted at these locations, using mobile technology. Laptops, tablets, smartphones and wearable devices enable researchers to gather data outside the classic lab setting.

The institute also has in-house facilities that are used to test participants under more standardised conditions:

- A Virtual Reality Lab for immersive, three-dimensional computer-generated environments
- A Sport Lab for behavioural and psychophysiological measures during exercise
- Different types of Eye-trackers for measuring visual attention and eye movements
- Stabilometric platforms for research on freeze-approach-avoidance behaviour
- Observational labs with one-way screens and multiple cameras
- A Computer Lab with 22 identical cubicles for computerised experiments
- A Bar Lab for observational studies of social behaviour in a natural setting
- Through its participation in the Donders Centre for Cognitive Neuroimaging (DCCN), the BSI has full access to neuroimaging facilities.

Collaboration

Researchers within the BSI collaborate with a large number of national and international partners. The Institute's strategy is to link a number of these renowned scholars to Nijmegen as international fellows. They visit at least once a year to give workshops, lectures and to work on joint publications. Some of the PhD students working at the BSI conduct part of their projects in the labs run by these fellows.

There are formal collaboration arrangements with a large number of universities around the world (*e.g.* Australian Catholic University, Indiana University, University of Virginia, and Concordia University of Montreal), research laboratories (*e.g.* Addiction Swiss, Haskins Laboratories), many Dutch Universities, and various institutes for applied research (*e.g.* Trimbos Institute, TNO Applied Research and the Netherlands Youth Institute).

One example of longstanding collaboration is that with the Institute for Mental Health Research of the University of Texas' Department of Psychology. It covers multiple topics, including the effects of administering testosterone on the efficacy of therapy for patients with SAD, and mood-congruent memory training for those with depression. The BSI also works with the National Technical Institute for the Deaf at the Rochester Institute of Technology. Societal partners Kentalis and NTID finance this collaboration, which focuses on teaching deaf students. There is also formalised collaboration with the SOCCCO group at the University of Cologne. BSI members and SOCCCO members meet as a group once a year, and there are four collaborative research programmes.

BSI researchers also work with many societal partners. They collaborate with a large number of schools, health care and youth care institutions, as well as governmental institutions and NGO's. Examples are Pro Persona, Pluryn, the police academy and NOC NSF. The BSI hosts the ZonMw-funded *Academic Centre Youth Nijmegen*, which is a consortium of 14 knowledge, policy and clinical institutions in the Nijmegen region. The aim is to improve the prevention and care of internalising problems in youth.

BSI has also taken the lead in the Games for Emotional Health (GEMH) consortium, a multidisciplinary network that incorporates international award-winning game designers and scientists. The GEMH Consortium is partially funded by an NWO Creative Industries grant. It includes veteran game designers in Silicon Valley such as Josh Whitkin (*Sims* series), Robin Hunicke (*Journey*) and Evan Hirsch (Ubisoft, Walt Disney, and Microsoft Live Labs). GEMH also runs an International Exchange Fellowship Program between BSI and University of Southern California (USC) in which graduate students from both universities conduct yearly visits and collaborate to design and evaluate applied games for use in improving mental health.

Awards and acknowledgements

- Dr Inge Molenaar received an NWO Veni grant for the project *Facilitating Self-Regulated Learning in Adaptive Educational Technologies.*
- Prof. Bert Steenbergen *et al.* received a FondsNutsOhra grant for the projects 'Iedereen sport op maat' (Everyone trains according to their needs) and 'Zelfstandig sporten voor DCD kinderen (Independent fitness training for children with a Developmental Coordination Disorder)'.
- Dr Junilla Larsen *et al.* received a FondNutsOhra grant for the project 'Gezonde (op)Voedingspraktijken' (Healthy diet and upbringing practices).
- Prof. Isabela Granic, Dr Anna Lichtwarck-Aschoff and Aniek Wols MSc received an NWO Research Talent Grant.
- Dr Marieke van Rooij *et al.* received a ZonMw Off Road grant and a Stimuleringsfonds Applied Games grant for further development of anxiety reducing games.
- Dr Willem Frankenhuis *et al.* received a Robert Wood Johnson Foundation grant for the project *A Strength-Based Approach to Enhancing Productivity and Health in the Context of Adversity.*
- Dr Anouk Scheres *et al.* received an NRO grant for the project Learning by Moving.
- Prof. Carolina de Weerth *et al.* received a Horizon 2020 grant for the project *Effects of Nutrition and Lifestyle on Impulsive, Compulsive, and Externalising behaviours.*
- Dr Lelia Samson received a Radboud Excellence Fellowship on invitation of Prof. Moniek Buijzen.
- Prof. Ron Scholte *et al.* received a ZonMw grant for the project 'Monitoren van het verloop van de hulp aan multiprobleemgezinnen met de OBVL-K' (Monitoring help delivered to families with multiple problems using a short questionnaire).
- Dr Inge Molenaar *et al.* received a grant from the NRO breakthrough programme, for the project *Investigating effects of tablet technologies in primary education.*
- Dr Esther Rozendaal received a Research Fellowship Grant from the American Academy of Advertising.
- Hannah Niermann MSc and Carla Ziebertz MSc won the Christine Mohrmann Stipendium for excellent female junior researchers.
- Dr Constance Vissers received a grant for the project *Musical Endorsement for children with primary language impairment* and for the project *Theory of Mind treatment for children with specific language impairment and deaf/ hard of hearing children.*
- Dr Willem Frankenhuis received the Boyd McCandless Award from the American Psychological Association.
- Prof. Harry Knoors *et al.* received the Premio Tarra Motivazioni Award from the University of Genua for the book *Educating Deaf Learners.*

Dr Junilla Larsen (Assistant Professor) tries to understand whether and how (social) environmental factors influence the eating behaviour and BMI of children and adolescents. Her main research interest is to identify how parents' own dietary behaviour and food parenting practices influence children's dietary intake and, related to this, to develop and test promising interventions for preventing obesity in children.

Research results

Development & Learning

Neural and cognitive underpinnings of word decoding processes involved in learning to read were revealed in people learning Dutch as a first and second language. The results of these studies are used to build ICT-based interventions.

Behavioural data relating to children with Developmental Coordination Disorder showed a developmental delay in predictive control of movements, which was substantiated by neurophysiological data. The findings advance insights in the aetiology of Developmental Coordination Disorder and are used to determine the content of treatment programmes.

Training of working memory in a game format (Braingame Brian) for children with Specific Language Impairment (SLI) was shown to be effective. This was confirmed in a randomised clinical trial that showed large positive effects on trained executive functions, as well as on syntactic proficiency in children with SLI.

It was found that daily skin-to-skin contact in premature infants has various beneficial effects on the health of infants and their mothers, as indicated by cortisol physiology, responses to stress, and the quality of maternal behaviour. This work also suggested that the beneficial effects might extend to full-term infants.

Neuropsychological processes underlying the behavioural correlates of ADHD were investigated. This work highlighted the unique characteristics, rather than the failures, of ADHD. For example, results suggest that rather than a failure to understand the perspective of others, children and adolescents with ADHD are less motivated by fairness in social situations than controls.

Psychopathology, Health and Well-Being

Three randomised controlled trials (with over 400 children) on the effectiveness of an applied video game (MindLight) for preventing childhood anxiety showed significant relief of anxiety symptoms, and showed the game was as effective as cognitive behavioural therapy (the most widely-recognised evidence-based treatment for anxiety).

The International Cannabis Consortium includes 16 research groups from Europe, the US and Australia. The Consortium recently finished the first and largest meta-analyses for lifetime cannabis use (N~33,000) and identified four genes that were associated with lifetime cannabis use.

It was found that testosterone reduces social avoidance behaviour in patients with social anxiety disorder. This result has led to clinical trials that test how testosterone can enhance the effects of exposure therapy for patients with social anxiety disorder.

Two studies on cognitive bias trainings for smokers were conducted, showing that computerised nicotine-avoidance trainings can successfully reduce smoking behaviour.

In an applied approach to providing personalised medicine, researchers were able to derive prediction models based on information that is routinely collected in the daily clinical practice of mental health care institutions. This is a first step towards decision-support systems designed to improve treatment.

It was investigated to what extent exercise is an effective intervention for reducing fatigue. Fatigued students were randomly assigned to a low-intensity running group or to a 'wait list' control group. Among the 'exercisers' there was a larger decrease in fatigue and this effect was sustained after three months. This result confirms the value of low-intensity exercise for those suffering from chronic fatigue.

In a longitudinal study, employees with both clinical and non-clinical burnout symptoms, as well as healthy controls were involved. After 1.5 years, there was a reduction of burnout symptoms among the clinical burnout group, but this was still not at the level of the healthy control group. The burnout group continued to report cognitive problems and their cognitive performance was still slightly impaired. This means that employees with clinical burnout 'got better, but were not completely well'.

The relationship between stress and subsequent sleep – as well as the role of rumination – among PhD students around a 'stressful' thesis defence was investigated. This was done by means of a longitudinal diary study. Day-level stress was related to day-level rumination, which in turn was related to subsequent sleep quality. The results showed that rumination plays a role in the relationship between stress and sleep quality.

It was examined how not responding to appetitive stimuli (such as chocolate bars) can lead to the devaluation of these stimuli. In a series of six experiments in which a go/no go paradigm was used, various potential underlying mechanisms were tested and it was concluded that the effect was driven by response inhibition. Other potential explanations were effectively ruled out.

A series of anti-smoking warnings on packs of cigarettes were compared, and it was found that questions (Why is smoking bad for your lungs?) led to more self-persuasion and less defensiveness than mere statements (Smoking is bad for your lungs). Participating smokers actually waited longer before lighting their first cigarettes after reading questions rather than statements.

Social Processes and Communication

Support was found for the claim that character development is a central mechanism which can explain viewer responses to Morally Ambiguous Characters (MACs) in narrative content. A mixed-method design, consisting of a qualitative content analysis and an experiment, was used to investigate character development in two morally ambiguous movie narratives: *Leon and American Psycho*.

Together with scholars from the Eindhoven University of Technology and Breda University of Applied Sciences, location-based advertising (LBA) was studied in a virtual reality lab experiment. It turns out that LBA is particularly likely to be effective when the ad is not only location-congruent, but also relevant to consumers' goals.

In several studies the participant roles of bullying in early adolescence were validated, and the behavioural, social cognitive, and adjustment correlates associated with these roles were demonstrated. In a meta-analysis, the remarkable stability of peer victimisation across childhood and adolescence was documented.

Twitter was used to obtain real-time insights into the public's political agenda. Through time series analyses of 142,421 tweets, it was found that TV election debates had a persistent influence on audience issue salience, but not on party salience. In other words, whenever politicians discuss political issues, people start tweeting about these issues, but not about parties.

The effects of overconsumption on the evaluation of consumer brands were investigated. It was found that participants who drank large quantities of mineral water indeed rated brands associated with mineral water more negatively. However, these effects were not found across other types of brands.

Societal impact

The aims of the BSI are both fundamental (to understand behaviour) and applied to societal challenges (to influence behaviour). BSI's strategy is that on the one hand fundamental research is translated into practical prevention guidelines and interventions, for example on addiction, food choice, stress, reading acquisition, anxiety and depression. These interventions, in turn, are subjected to scientific investigation, if possible in randomised controlled trials. On the other hand, a fundamental understanding of topics related to societal issues, such as adolescent alcohol consumption and children's reading problems, plays an important role in the research agenda of the institute. Increasingly, knowledge or reports of actual interventions are disseminated to a broad audience via ICT products, such as apps or websites. Researchers also regularly appear in the media and publish the results of their scientific work in professional magazines. Many BSI researchers also work in a practical institution or company. The institute's strategy is that most research conducted at BSI will stem from societal questions and/or be designed to tackle societal issues. Four examples of this strategy are:

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Dissertations	**27**
Scientific publications	**531**
Professional publications	**138**

1. A symposium on *The Young Consumer* was organised in September 2016, aiming at professionals who have young people (children, adolescents, and young adults) as a target group. The symposium was organised in collaboration with the Radboud Centre for Social Sciences (RadboudCSW) and academic consultancy company Bitescience.com. BSI scholars hooked up with practitioners in the field to present an academic yet applied approach to 'hot topics' in youth-directed communication such as positive and responsible persuasion, age segmentation, character marketing, storytelling, co-creation and tailored communication. The symposium, which was attended by over a hundred people, received a very positive evaluation. It is expected that there will be a follow-up in the spring of 2018.

2. STW-funded research on sleep and performance in elite athletes, carried out in close cooperation with NOC*NSF and several industrial partners, resulted in invited workshops and master classes for staff members of different sports associations (*e.g.* swimming, sailing and hockey) as well as expert groups (*e.g.*, coaches, sports physicians, physiotherapists and sport psychologists). Research results were integrated in official recovery protocols (fact sheets), and media interviews were given, for example on Dutch radio (NPO 1). In December 2016 collaboration between NOC*NSF, Mline and Radboud University was established to initiate a new externally funded PhD project on power napping.

3. Child abuse and other traumatic experiences in children are unfortunately common and they often lead to serious psychological problems. Nevertheless, therapists are often afraid to ask children about their trauma history. In 2016, the website www.rakevragen.nu was launched to help therapists working with children and adolescents. The website explains how to ask about traumatic experiences and how to assess the symptoms of post-traumatic stress disorder (PTSD). It also points

out the most common pitfalls and how to prevent them. Additional videos of children speaking about their PTSD treatment and giving advice to their therapists are also provided.

4. In 2016 several effects of teachers' attitudes about (groups of) students were established. With gender-related Implicit Association Tests (IATs) that were developed with partners from the VU in Amsterdam and student surveys involving Turkish-Dutch and German-Dutch bilingual children, it was found that teachers have differential group-specific attitudes towards children, which may negatively affect students' socio-emotional and cognitive development. This line of research is important in the context of the adaptive and differentiated teaching that is promoted in current educational debates and teacher education curricula.

Future research

BSI will continue to deliver top-level behavioural research with societal relevance in the years ahead. All grants acquired will fund research that is closely linked to societal problems, leading to innovative new projects. BSI will continue to invest in fundamental research and in new ideas through the annual BSI Graduate School round, in which promising candidates are selected to start their own PhD project. The BSI has many research lines, many of which focus on health behaviour. Interesting future prospects for some of these research lines are:

Different aspects, contexts, and types of learning will be studied, not only at the behavioural level but increasingly at the neurophysiological level via EEG registration. Based on this knowledge, remediation programmes will be developed and tested in practice (at schools and rehabilitation centres). Use of ICT (apps) will be increasingly used to aid the learning process.

The positive and constructive side of mediated communication will be investigated extensively. Research will include positive media psychology, health communication, constructive journalism and social marketing. Results will inform the public debate and help design effective mediated interventions. Technological developments in the media landscape – especially the emergence of artificial intelligence – will both generate a great need and provide a great opportunity for basic and applied communication research.

Two ongoing longitudinal studies will continue. The Nijmegen Longitudinal Study, now in its 17th year, and Basic Influences in Baby Development, now in its 11th year. These studies focus on social development across childhood and adolescence and the impact of early life factors on later behaviour and health. The Donders Centre for Cognitive Neuroimaging (DCCN) and other universities in the Netherlands and abroad are involved in these projects. Another focus will be on psychobiological and neurocognitive research on development from pregnancy until young adulthood in community and vulnerable populations (*e.g.* preterms, ADHD patients and those with stressful backgrounds).

Regarding serious games for mental health, the vision for the next five to ten years is to design, evaluate and disseminate these evidence-based games as widely as possible. Key game mechanics that are most effective at reducing psychopathology will be defined. The aim is to translate this knowledge to game designers and scientists alike so that games can be tailored for specific needs, varied populations and diverse psychopathologies. The plan is to radically change the scale of the impact at a population level by partnering with commercial industry game designers who can reach the homes, schools and communities that may otherwise be hard to reach via traditional academic channels.

Director Professor
Toon Cillessen

Toon Cillessen has been Professor of Developmental Psychology at Radboud University since 2006. He previously held appointments at Duke University and the University of Connecticut. His research interests include the development of social competence, aggression and antisocial behaviour, peer influence, and quantitative methods for developmental research (focusing on sociometry, social networks and longitudinal data analysis). He is a Consulting Editor for the journals Developmental Psychology, International Journal of Behavioural Development, Journal of Applied Developmental Psychology, Journal of Research on Adolescence, Merrill-Palmer Quarterly and Social Development.

Research on the therapeutic value of administering hormones such as testosterone and oxytocin will be expanded. The use of learning enhancers such as dicycloserine during behaviour therapy will also be investigated. Computerised training programmes that target automatic cognitive processes will be developed. Such training programmes can be used as add-on treatments for anxiety, depression, and substance abuse. The idea is to implement them in various clinical settings.

In recent years, the circumstances under which people select the most creative ideas from a pool of ideas were investigated. In the near future, creativity among high school students will be analysed to see which type of education encourages creativity most effectively. Creativity training for high schools is being developed, with the intention of later extending this to more general creativity training. Various organisations (including the Dutch Ministry of Education) have expressed interest.

Research on 'stress and recovery' as well as 'motivation and performance' will be strengthened in several ways. The relationship between sleep and performance is the topic of a new project that will investigate the consequences of power napping on recovery and performance in elite athletes. Secondly, research will cover the influence of work and non-work related smartphone use on health, well-being and performance. These studies have the potential to lead to interventions that can improve both well-being and performance. ‹

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Centre for Language Studies

The Centre for Language Studies (CLS) carries out top-level research in linguistics, psycholinguistics, language and speech technology, as well as communication in a stimulating academic environment. There is a strong focus on innovation and an interdisciplinary approach.

Research at CLS takes place in two programmes:

- Researchers working within the *Language in Mind* programme consider language to be a window into the cognitive functioning of the brain. They aim to explain how the architecture of the language system interacts with human language processing skills. Using data from native and foreign language acquisition, from language production and comprehension, as well as from spoken and signed languages, they develop and test comprehensive theories about language processing on the one hand and the structure of the language system on the other, employing a wide variety of research methods.
- Researchers working within the *Language in Society* programme see language as a social tool that is essential for society, studying it in its historical, cultural and social context. They focus on language contact, sociolinguistic variation, and the interactional foundations of language. In addition, they study various aspects of functional communication, including language use in the classroom and other multilingual contexts, language and speech technology designed to improve text production and communication with the disabled, as well as persuasive communication.

Each programme consists of eight smaller groups led by principal investigators. These thematically coherent groups create platforms for discussing research plans and results, facilitating communication between and among junior and senior researchers, and helping to support academic integrity. Researchers also regularly meet other groups at monthly CLS colloquia and lab lunches, as well as at meetings where themes that transcend groups are discussed.

Research facilities

CLS research is largely empirical, using large databases, as well as experimental and computational methods and techniques. As a result, facilities such as experimental laboratories with appropriate equipment, powerful computers and sophisticated software – as well as enriched written, spoken, and multimodal (sign) language databases – play an essential role. The Executive Board has established Linguistics as a key focal area of research for the university. Thanks to a structural investment in CLS research by the Board, there is a state-of-the-art language laboratory, including a web experimentation site, instruments for eye tracking and electroencephalography and for measuring conscious language behaviour, facilities for making observations with video recordings, and a high-end computing cluster with large storage facilities. Moreover, there is a technical group, which supports researchers when they are creating computer programmes, implementing experiments, and conducting statistical analyses.

Collaboration

Widespread international collaboration among CLS researchers has contributed to the growing success of international recruitment in recent years: 29 percent of lecturers have come from abroad to work in Nijmegen, as have 44 percent of PhD students.

CLS is engaged in long-standing collaboration with the Max Planck Institute for Psycholinguistics (MPI) and with the Donders Institute for Brain, Cognition and Behaviour. Together with MPI and the Donders Institute, CLS participates as a partner in the International Max Planck Research School. CLS researchers also collaborate with colleagues at the Donders Institute and the MPI in the Baby Research Centre as well as with partners in the national Language in Interaction Consortium.

Examples of formal (international) collaboration in 2016:

- Collaboration in HealthNar, a programme established to strengthen and consolidate the emerging field of

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Prof. P.A.J.M. Coppen (p)
Prof. H.H.J. Das (o)
Prof. A.F.J. Dijkstra (p)
Prof. M.T.C. Ernestus (p)
Prof. J.P.M. Fikkert (p)
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Prof. A. Özyürek (p)
Prof. R. Schoonen (o)
Prof. N. van der Sijs (p)
Prof. W.P.M.S. Spooren (o)
Prof. L.A.L. van de Wijngaert (o)

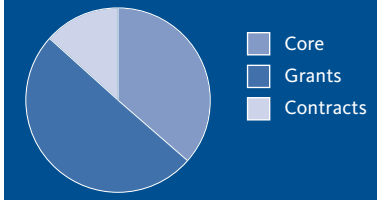
Tenured

Full Professors	8.1 FTE
Associate Professors	5.4 FTE
Assistant Professors	9.5 FTE
Researchers	3.3 FTE

Non-tenured

Researchers	22.3 FTE
Doctoral candidates	38.7 FTE

Research staff funding



narrative communication in healthcare, with the University of Antwerp (Belgium), the University of New South Wales, Sydney (Australia), Universität Linz (Austria), Universität Augsburg (Germany), Edith Cowan University, Perth (Australia) and Bowling Green State University, Ohio (USA). The aim is to build a multidisciplinary research exchange network dedicated to using narratives in relation to health, by bringing together renowned international scholars working on health psychology, media psychology, health communication, the arts and interactive communication. HealthNar was founded by the International Research Staff Exchange Scheme (IRSES).

- Collaboration with the University of Arizona (USA), University of Alberta (Canada), University of Victoria (Canada) and the University of Canterbury (New Zealand) in the project 'Speech reduction across languages and dialects', which is funded by the National Science Foundation (USA).
- Collaboration with Aarhus University (Denmark), the University of Antwerp (Belgium), Vienna University of Economics and Business (Austria), Copenhagen Business School (Denmark), Aalto University (Finland) in 'Linguists for Business Research Initiatives' (LIBRI), an international network of linguists collaborating to advance cross-disciplinary aspects of research on the role of language and communication in business and organisational settings.
- Collaboration in COMMIT/, a public-private ICT research community that brings together scientific research, non-profit organisations and companies in ICT projects within the nine most important economic sectors in the Netherlands in order to research and develop pioneering products and services. Within COMMIT/ more than 110 partners, including universities, technology institutes and more than eighty large and small businesses, work together in fifteen public-private projects that play an important role at an international level. COMMIT/ contributes to strengthening the Dutch 'top' sectors and helps to maintain the competitive edge of the Netherlands as a knowledge economy.

Dr Sharon Unsworth (Associate Professor) has been awarded a Vidi grant for 'The priming mind of the bilingual child: Simultaneous acquisition, simultaneous activation'. Young children can easily learn two languages at the same time, but to what extent do they keep these two languages separate? The overall goal of this project is to investigate how two languages interact in the mind of the young child.

Research results

Kobie van Krieken studied the coverage of criminal events in newspapers. These often consist of narratives that combine characteristics of journalistic discourse with elements of literary fiction. The function of these stories is not so much to inform readers about what happened, but to create an immersive reading experience. Journalists see this form of journalism as a way of competing with online news media. They make strategic use of language in various ways to describe criminal events – within the boundaries of non-fiction – from the perspective of eyewitnesses. Quotes play a crucial role in this genre: they serve to dramatise the story, but also to emphasise its truthfulness. Reading a crime news narrative is not free of consequences: unlike traditional news articles, news narratives cause readers to virtually experience the crimes that are described from close up.

For adults who become severely hearing-impaired later in life there may be subtle changes in the way they articulate sounds, depending on the duration of hearing loss. Xaver Koch and Esther Janse, in collaboration with the division Hearing & Implants of Radboud university medical center, investigated the production of vowels and of /s/-like sounds in words like 'Sue' and 'shoe' in hearing-impaired adults who were candidates for cochlear implantation. Speech recordings of hearing-impaired patients and age-matched hearing controls were made at several time points: just before the patients got the implant, and immediately after, as well as three months after the cochlear implant had been activated. Even though sound contrasts in patients were diminished relative to normal-hearing controls prior to cochlear implantation, the sound contrasts improved immediately once patients' hearing was restored. However, the longer the period someone had spent as hearing-impaired, the more difficult it was to restore the sound contrasts. These results thus confirm the importance of auditory input for the adult speech production system.

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- Bank, R., Crasborn, O.A. & Hout, R.W.N.M. van (2016). The prominence of spoken language elements in a sign language. *Linguistics : an International Review, 54*(6), 1-25.
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- Croijmans, I.M. & Majid, A. (2016). Not all flavor expertise is equal. The language of wine and coffee experts. *PLoS One, 5*(5).
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Dissertations	**14**
Scientific	**286**
Professional publications	**72**

Linda van Meel studied the Dutch of Turkish-Dutch and Moroccan-Dutch young people, who use sounds, words and constructions that rarely occur in the speech of 'native' Dutch speakers, such as the 'sharp' pronunciation of the /z/, which originates from Moroccan languages. Constructions which 'native' Dutch speakers hardly make ('errors') can also be found in adults learning Dutch as a foreign language. Turkish-Dutch and Moroccan-Dutch youngsters are often judged on their use of non-Dutch words and sounds. However, 'native' Dutch people are usually unaware that their compatriots also have typical regional Dutch accents and exhibit the same deviations from the standard language as 'native' Dutch speakers. They also adjust their speech to their conversation partner: their Dutch is closer to the standard language when they speak with a 'native' Dutch conversation partner and has more of an ethnolectal accent when they speak with someone from their own background.

A computer analysis of the texts of more than 400 Dutch versions of Little Red Riding Hood dating from the 18th century up to the present provides new insights into the evolution of this fairy tale. Folgert Karsdorp and Antal van den Bosch found an explanation for the way in which a network of stories arises and grows, how you can discover relationships and why certain versions prevail. A text already used by many authors will be used more often by others, as will a text with more appeal because of strange or striking elements or a famous author, an effect that diminishes with time. All the versions refer back to two original ones: the German version by the Brothers Grimm and the French version by Charles Perrault. The German version is primarily a story for children, with the underlying message that you should always listen to your parents. The French version is just as moralistic, but was intended more for the young women at the Court of Versailles in the 17th century (to warn them of sweet-talking, two-legged wolves). This is a rougher version, hinting at rape, and it lacks a happy ending.

Ambonese Malay is a language that uses neither stress nor pitch to give meaning to words. This was discovered in research done by Raechel Maskikit-Essed and Carlos Gussenhoven. That there is a language without word prosody, as it is called in linguistics, had never previously been established. Until now, all known languages were thought to give significance to words by using stress (*e.g.* Dutch and Spanish), or pitch (*e.g.* Igbo and Chinese) or both (*e.g.* Norwegian, Swedish and Limburgish). Ambonese Malay is spoken by about 250,000 people on Ambon and the nearby Maluku Islands.

Societal impact

Disseminating knowledge to the general public, raising awareness of the essential role of language and communication in society and developing 'products' based on research all play an important role at CLS. Researchers at the Centre bring together externally funded projects that involve language and speech technology in the Centre for Language and Speech Technology (CLST). Through CLST, CLS collaborates with many societal and commercial partners.

The website DoofGewoon.nl (lit. 'Deaf normal') was created to inform parents of deaf children about what else there is in the lives of deaf children and deaf adults apart from their hearing loss. The site, which presents information about deaf culture, multilingualism and sign language, contains contributions by parents and deaf people. Being deaf turns out to be rather normal. Onno Crasborn was one of the initiators of this site, which was created by sign language researchers from CLS, the University of Amsterdam, as well as FODOK, Dovenschap and NDJ, which are Dutch organisations for the deaf.

Over the last decade there has been a marked increase in the use of English as the medium of instruction in higher education throughout the world, with a growing number of educational institutions offering English-taught programmes to cater to the growth in international students. In many countries, this presents challenges for teachers whose native language is not English. Berna Hendriks, Frank van Meurs and Nanette Hogervorst investigated the effect of lecturers' degree of accent on Dutch students' attitudes towards them and students' perceptions of their clarity and comprehensibility. As expected, the students found instructors with a moderate accent less comprehensible than those with a slight accent and native instructors. Unexpectedly however, slightly accented instructors were evaluated as more capable and more likeable than native English instructors or native Dutch instructors teaching in Dutch. Students seem to appreciate lecturers who are making an effort more than anything else.

Based on the words you use on Twitter, a computer can tell what kind of person you are. Florian Kunneman and Wessel Stoop demonstrate this on the website 'You Are What You Tweet'. In order to do so, they recorded for a large number of tweets whether they had been written by males or females, young or old, but also if they are for example aggressive or sarcastic. They then subjected the results to *machine learning algorithms*, computer programmes that can automatically learn patterns from large amounts of data. The site shows to a wider audience what the possibilities of language interpretation are nowadays, what techniques language technologists use, and what the computer can tell us about us and our language. It also shows that the technology used is not yet perfect: the computer occasionally gets it wrong.

Future research

Sharon Unsworth has been awarded a Vidi grant for 'The priming mind of the bilingual child: Simultaneous acquisition, simultaneous activation'. Young children can easily learn two languages at the same time, but to

Director Professor
Antal van den Bosch

Antal van den Bosch has been Professor of Language and Speech Technology at Radboud University since 2011. He obtained his doctorate degree *cum laude* with a thesis entitled *Learning to pronounce written words. A study in inductive language learning*. He previously worked at Tilburg University and later as Professor of Memory, Language, and Meaning. He is guest professor at CLiPS,
the Computational Linguistics and Psycholinguistics Research Centre at the University of Antwerp, *humanities integrator* at the Netherlands eScience Center, the national hub for the development and application of domain-overarching software and methods for the scientific community, a Fellow of ECCAI, the European Coordinating Committee for Artificial Intelligence, and of the Donders Institute for Brain, Cognition and Behaviour. In 2012, he was elected as a member of the Dutch Royal Academy (KNAW).

what extent do they keep their two languages separate? The overall goal of this project is to investigate how two languages interact in the mind of the young child. More specifically, it will investigate cross-linguistic influence at the lexical and syntactic levels, in language comprehension as well as language production.

Esther Janse and Mirjam Ernestus are partners in the Horizon2020 European Training Network 'Enriched communication across the lifespan' (ENRICH). Reduced ability to listen or speak creates a significant barrier to social inclusion throughout people's lives. Hearing aids and speech synthesis can help address this, but their use requires greater listener effort. The fundamental objective of ENRICH is to modify or augment speech with additional information to make it easier to process. The consortium consists of eight beneficiaries and seven partners from academia, industry and clinical practice in nine countries. A comprehensive training programme will equip fellows with the necessary cross-disciplinary knowledge and research techniques as well as with experience of entrepreneurship and technology transfer in order to translate research findings into meaningful products and services that will facilitate spoken language communication in the decades ahead.

Kazuki Sekine was awarded a Marie Curie Individual Fellowship for 'Neural bases of multimodal integration in children'. Under the supervision of Asli Özyürek, he will conduct brain imaging studies to provide direct measures of the cognitive process underlying the comprehension of co-occurring multimodal semantic information from speech and gesture. His aim is to examine the neurocognitive processing of semantic information from gesture and speech in children and adults. A practical spin-off of this research will be providing information to caregivers and teachers about how to use gestures to foster children's language acquisition.

Many scientific breakthroughs depend on the availability of advanced research facilities. Such facilities tend to be expensive and take a long time to build. The Royal Netherlands Academy of Arts and Sciences asked researchers to describe 'dream' facilities that they believe could produce scientific breakthroughs within a decade or more. The Academy Agenda for Large-scale Research Facilities is the outcome of that process. One of 13 items placed on this agenda is the Advanced Video Analysis Tool (ADVANT), a shared facility in which multimodal interaction data can be played, stored, transcribed and annotated. It can be used to answer a wide variety of research questions in the humanities and social sciences. Detailed levels of transcription and annotation can be delivered as video (image) and audio (sound), both automatically and manually. All data (raw, transcribed and annotated) can be searched as video and audio, including multi-level searches. ADVANT is being developed by CLS researchers Antal van den Bosch and Wyke Stommel, in collaboration with colleagues from Groningen University, Utrecht University and NIVEL, the national institute for health services research in the Netherlands. ‹

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A vestibular chair makes it possible for the subjects to rotate around independent computer-controlled axles while performing cognitive or motoric tasks.

The Donders Institute is dedicated to increasing understanding of the basis of human cognition and behaviour – in health and disease – in the brain.

Donders Institute for Brain, Cognition and Behaviour

Comprehending the brain and how it enables our thoughts, emotions and actions has sparked curiosity for centuries. It is also essential if we are to be able to answer fundamental questions about human beings. Recent technological and theoretical advancements are delivering unprecedented insights into the way the brain works, also making it possible to answer more applied questions.

The Donders Institute is home to more than 700 researchers from more than 35 countries who share the common goal of contributing to advancing brain-, cognitive- and behavioural sciences through investigator and curiosity-driven research, and improving health, education, nutrition, and technology by applying advances in this field. The DI's mission is to be a leading international research centre in the field of systems level cognitive neuroscience. This includes conducting excellent interdisciplinary research at the unique interface between genetic, molecular and cellular processes at one end of the spectrum and computational, system-level neuroscience with cognitive and behavioural analyses at the other end. Within this wide interdisciplinary range the Institute focuses on four research themes:

- Language and Communication
- Perception, Action and Control
- Plasticity and Memory
- Brain Networks and Neuronal Communication

Established researchers head Principal Investigator (PI) groups of varying sizes, composed mainly of young upcoming scientists. They tackle research projects both at the level of the single PI group and by forming highly interactive, collaborative cross-faculty projects and by international networks. They are thus able to answer research questions that are too complex to be answered by single groups.

This interdisciplinary, cooperative culture – combined with excellent multidisciplinary research – is also at the core of the Donders Graduate School, which integrates an internationally recognised Research Masters programme with ambitious PhD training. The Masters programme is structured in four tracks that are fully aligned with the four research themes of the Donders Institute, thus integrating young students optimally in the research. The PhD training programme supports young scientists by providing general academic skills while helping them move towards their own independent lines of research.

Research facilities

The Donders Institute has access to state-of-the-art equipment and highly competent technical staff, which allows researchers to carry out the most advanced work.

To understand human brain function and dysfunction at the cognitive and behavioural level a large number of laboratories are used, with set-ups for baby and toddler studies, an artificial intelligence laboratory, and numerous sensorimotor facilities, including a fall simulator, a vestibular sled and chair, 'reach-in' 3D visualisation and force-feedback virtual reality equipment.

To measure human brain function with precision while individuals perform specific cognitive tasks, the Institute employs a comprehensive set of neuroimaging tools comprising four research-only MRI scanners, including a joint-venture high-field system that is housed at the Erwin L. Hahn Institute, a whole-head MEG system, several multi-channel EEG and near-infrared spectroscopy systems. These neuroimaging facilities are complemented by equipment enabling modulation of human brain function such as several transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) laboratories.

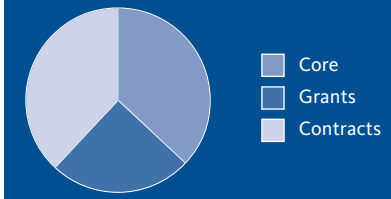
Tenured

Full professors	29.59 FTE
Associate professors	13.39 FTE
Assistant professors	29.57 FTE
Researchers	24.63 FTE

Non-tenured

Researchers	139.02 FTE
Doctoral candidates	226.56 FTE

Research staff funding



To decipher underlying biological mechanisms the Institute also uses a broad range of other laboratories on campus, covering all levels from molecular biology to animal behaviour. State-of-art techniques are available that are at the forefront of sequencing technology developments, including large data sets of patient cohorts and neural stem-cell cultures. The central animal facility provides animal MRI, PET, CT/SPECT and a great variety of behavioural tasks for rodents. In 2016 a light-sheet microscope was installed, which makes it possible to image a whole brain without cutting it open. In addition, several other technologies are available, such as 2-photon microscopy, multi-unit *in vivo* electrophysiology and optogenetics – just to mention a few – and these are being further developed locally within the context of the Radboud Research Facilities and Radboudumc Technology Centres.

These experimental tools are complemented by high-performance computing facilities, which enable advanced data analyses, data modelling and simulations for which the Institute is well known. This computer infrastructure also supports very large-scale studies, creating large databases of several thousands of individuals for brain-imaging genetics and patient cohorts.

Prizes and awards (selection in alphabetical order)

- Harold Bekkering was elected as a member of the Royal Netherlands Academy of Arts and Sciences (KNAW).
- Han Brunner was awarded the Carter Medal of the Clinical Genetics Society Great Britain.
- Han Brunner and Joris Veltman were awarded this year's King Faisal International Prize in medicine.
- Roshan Cools was elected as a member of the Academia Europaea.
- Peter Desain and his team have been awarded First Prize in the Assistive Technology Challenge. He also was elected as a member of the Netherlands Academy of Technology and Innovation.
- Christian Doeller was elected as a member of the Memory Disorders Research Society (MDRS) and he received the Radboud Science Award.
- Jason Farquhar and his team made it to the second position in the BCI race of the Cybathlon at ETH in Zurich.
- Guillén Fernández received the 2016 Hermesdorf Award International. This award is granted to Radboud University researchers whose work has received special attention in the media.
- Corina Greven received the Kramer-Pollnow Young Investigator's Award.
- Nanda Lambregts Rommelse was awarded the Kramer-Pollnow Prize.
- James McQueen was elected as a Fellow of the Association for Psychological Science.
- Sina Radke was awarded with the Heinz-Heckhausen Jungwissenschaftler-Preis by the Deutsche Gesellschaft für Psychologie.
- Johanna van Schaik received the NRO award for promising researchers in education sciences.

Grants

- NWO Veni grants were awarded to Marisa Casillas (MPI), Koen Haak, Rick Helmich, Joost Rommers and Tessa Verhoef (MPI). Linda Geerligs joined the Donders Institute after receiving an NWO Veni grant.
- NWO Vidi grants were awarded to Andre Marquand and Sharon Unsworth (Affiliated Research Fellow, CLS).
- John van Opstal received an ERC Advanced Grant.
- Christian Doeller received an ERC Consolidator grant.
- Janneke Jehee received an ERC Starting Grant.
- José Marques received a grant from FOM projectruimte.
- Mariya Manahova obtained a Research Talent grant from NWO.
- Johan Kwisthout received an NWO EW TOP grant.
- Janny Stapel was awarded a Rubicon grant.
- Rick Helmich and Alex Garanto both received a ZonMw Off-Road grant.
- Adjmal Sarwary was awarded an STW Take-off grant.

Collaboration

Research carried out at the Donders Institute is conducted in a collaborative national and international setting. In Nijmegen the Centre for Language Studies at the Radboud University and the Max Planck Institute for Psycholinguistics are affiliated institutes. In Germany the Institute collaborates with the University of Duisburg-Essen on the operation of a joint research centre for high-field MRI, the Erwin L. Hahn Institute, in Essen. The Donders Institute also signed collaboration agreements with two other preferred partners: with the Brain and Mind Institute of the Western University Ontario (Canada) and with the Brain Mind Institute of the Ecole Polytechnique Fédérale de Lausanne (Switzerland).

Furthermore, the Institute collaborates in research consortia with leading institutes, industrial partners and other potential users of its research. Joining forces in this way extends research beyond the Institute and increases the societal impact of research results. The Institute participates in a large number of high-quality, innovative consortia, including:

- An NWO Gravitation Grant *Language in Interaction*, which is coordinated in Nijmegen, brings together 50 researchers from eight universities and one research institute in the Netherlands.
- Large EU consortium grants, including: Matrics, PREPARE and Eat2BeNICE. Eat2BeNICE is a consortium of 20 partners that investigates links between nutrition, the microbiome, and impulsive and compulsive behaviour. This is an EU Horizon 2020 project in the field of Nutrition (€12 million).

- Several EU (Marie Curie) training networks, such as Healthpac (led by the Donders Institute), Childbrain, MiND and BrainTrainMat.
- Regionally and nationally funded projects that bring together Dutch universities and private- sector partners. Examples are BriteN, NeuroCIMT and NESTOR. The NESTOR consortium will develop a prosthesis that stimulates the brain of blind people via micro-electrodes which will be connected to a camera. It has been selected as part of the financing programme Perspective for Top-Priority Sectors.
- Other consortium projects: BIG and Cognomics, with the Donders Institute, the Radboudumc, and the Max Planck Institute for Psycholinguistics as initiating partners.
- The Institute is a collaborating partner in the Human Brain Project, which was selected by the EU as one of two flagship projects, and it contributes to the US Human Connectome Project.
- An agreement between the Radboud University and Wageningen University and Research for collaboration in the field of Cognition and Nutrition.
- The Parkinson Precision Project, a major public-private partnership between the Donders Institute, Radboudumc, Radboud University and Verily Lifescience.

See the Institute's website for more details about all of these collaborations.

Societal impact

The research carried out at the Institute has considerable potential for benefiting society in five areas: Health & Healthcare, Food & Cognition, Learning & Education, Neurotechnology & Big data and Public & Policy. A key aim is to disseminate expertise and knowledge to a wide range of stakeholders.

- To inform the *general public*, Donders researchers appear regularly on national television, in numerous national and international newspapers, on radio at large festivals and on many websites. In the blog 'DondersWonders', researchers at the Institute write non-specialist articles on neuroscientific topics for the general public. With two blogs per week in Dutch and English, and over 150,000 views in 2016, this clearly has considerable impact. Furthermore, to educate a wider public about the latest research done at the Donders Institute and increase awareness about how neuroscience works, an Open Day was organised in September. With over 2500 visitors from Nijmegen and surroundings, the Donders Open Day was a great success. Finally, the public is informed about research news and events at the Institute through various social media.
- To inform the *scientific community*, Donders researchers took the active lead in workshops and in organising international conferences.
- Donders scientists disseminate new findings and knowledge to *industry*, mostly through numerous mutually beneficial collaborations with commercial partners varying from smaller companies that manufacture technical devices (such as Noldus and Otticon) to large multinationals (*e.g.* Philips, Siemens, Heinz and Danone). The institute is a member of 'ICT for Brain, Body & Behaviour' (i3B), a European network of ICT companies and knowledge institutes in the field of brain, cognition, physiology and behaviour that aims to connect business and encourage innovation through joint R&D projects. The Institute is also involved in Radboudumc Technology Centres and 'Radboud Research Facilities'. The latter is an initiative by the province Gelderland to stimulate the regional economy through innovation by small and medium-size enterprises that apply scientific knowledge and access these facilities.

Director Professor David Norris

Prof. Norris has been Director of the Donders Institute's Centre for Cognitive Neuroimaging since January 2009. In July 2001 he was appointed Principal Investigator of the research group MR Methods for Cognitive Neuroscience at the Donders Institute and in 2003 he became Professor of MR Physics for Cognitive Neuroscience at the University. He is also an external scientific member of the Max Planck Institute for Psycholinguistics (2014). His research interests include improving brain imaging techniques, fMRI of cortical layers and spectroscopy of brain metabolites. Prof. Norris is also one of the directors of the Erwin Hahn Institute in Essen and a member of the medical faculty at the University of Duisburg-Essen.

- Donders researchers are actively involved in several *spin off initiatives*. In 2016, several new initiatives led to new spinoff companies, including Neurant and Mind Trace. These initiatives enhance knowledge transfer to society and enable close collaborations with various societal stakeholders.
- Five vouchers, each worth €5000 were made available to support Donders scientists in working out a creative innovative idea that specifically contributes to the societal relevance of the Donders Institute. With these vouchers, the Institute encourages researchers to engage in innovation and increase the societal impact of their research.
- Research is well embedded in *clinical care* within the Radboudumc and beyond. Implementing new findings in clinical practice is part of the daily work of Donders clinicians, as is the education of peers, patients and patient organisations through lectures, meetings and forums. Donders researchers are actively engaged with patient organisations and participate in developing diagnostic and treatment guidelines and standards of care. Clinical Donders researchers not only strive to translate fundamental insights into advance care, they also innovate the way care is delivered, *e.g.* through e-health applications (example: the project 'Depression treatment at distance' that is part of the INTERREG programme Germany-Netherlands).
- Donders researchers actively participate in *educational development*. In 2016 the Donders Education Hackathon was organised as was as the conference 'Donders meets education 2016: Focus & Flow in the classroom' in collaboration with RadboudCSW.
- Through participation in public debate Donders researchers contribute to *regional and national policies* by discussing the impact of neuroscientific insights on economic and social development. They also play a key role in guiding and organising platforms for the ethical thinking needed to apply new neurotechnologies, for example regarding robotics. At the national level, researchers at the Institute serve on committees of research policy organisations such as the Netherlands Organisation for Scientific Research (NWO), the Royal Netherlands Academy of Arts and Sciences (KNAW), the National Initiative Brain and Cognition, and the Rathenau Institute. Researchers at the Institute collaborate with *external partners* in areas such as psychiatry (*i.e.* those working in the Pompe Clinic in Nijmegen), with the Netherlands Forensic Institute (NFI) the Police Academy, and the Dutch Department of Education. <

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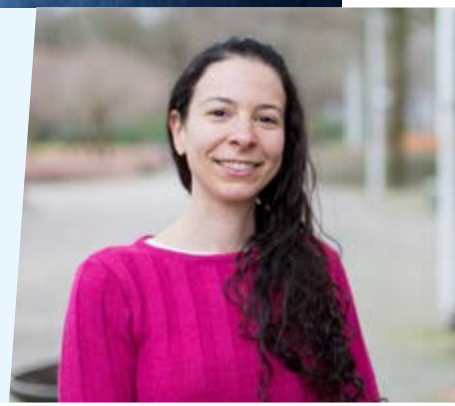
THEME 1

Language and Communication

Prof. James McQueen (speaker)

Dr Vitória Piai (post-doc, Aspiring Principal Investigator) focuses on language function in healthy and neuropathology patient populations, such as those suffering from stroke, brain tumour, epilepsy and neurodegenerative disorders (*e.g.* dementia, Parkinson's). She applies a range of behavioural and neuroimaging methods and pays special attention to the intersection of language and other functions, such as executive control, (semantic) memory, and motor control relation to speaking.



The goal of the Language and Communication theme (LC) is to understand the uniquely human capacity for language. The LC theme is therefore strongly interdisciplinary, combining research in neuroscience, psychology, linguistics, genetics and computational cognitive science. This approach is necessary to get to grips with the human language faculty in all of its complexity. Explanations are thus sought at multiple levels (linguistic, behavioural and neurobiological), and ultimately at the interfaces between these levels.

LC research focuses on three objectives: *a)* to understand core processes of language and communication (*e.g.* how we speak, understand speech and learn language), and to determine how these processes relate to other cognitive domains (*e.g.* our abilities to perceive and remember); *b)* to determine how language is rooted in the 'language-ready' human brain; and *c)* to understand the balance between the universality and the variability of language and language processes (*i.e.* to determine to what extent abilities are the same across all the world's languages and across all speakers of any given language).

An important feature of this theme is the substantial involvement of the two affiliated institutes: the Max Planck Institute for Psycholinguistics and the Centre for Language Studies.

Research results

A study on neuroimaging genetics used a biology-driven strategy to relate variations in genomic loci, which were previously identified as being active in early embryonic development, to the structure of subcortical brain regions. In a study on >13,000 healthy adults, significant associations were found between targeted single nucleotide polymorphisms and hippocampal volume. This biology-driven approach generates testable hypotheses related to the functional biology of identified associations.

Another study linked previous phonetic, behavioural and neuroscientific work by examining the electrophysiological signatures of speech recognition. Behavioural research has shown that fully-realised forms ("yesterday") have a processing advantage over reduced forms ("yeshay"). Greater oscillatory power in the alpha (8–12 Hz) band, reflecting increased cognitive load, was observed for reduced forms. Greater oscillatory power in the gamma (30+ Hz) band, reflecting a spread of activation through the semantic network, was observed for full forms. These results confirm the processing advantage for full forms and open the door for further research on the oscillatory processes underlying language processing.

Related work explored oscillatory dynamics in the beta and gamma frequency ranges, measured during sentence-level comprehension. A magnetoencephalography experiment compared comprehension of Dutch subject- and object-relative clauses. The results support the view that beta oscillations reflect the maintenance of the neural network configuration responsible for representing sentence-level meaning.

Two studies illustrate work of the theme on prediction. In one, participants listened to incomplete sentences and provided the final word by naming a picture. Pictures were named faster when they could be predicted from the sentence than when they could not. When naming trials were interwoven with trials where sentences had to be read, reading times were faster for predictive than for non-predictive sentences. This suggests that encouraging prediction in production encourages the use of predictive contexts in comprehension. In the other

Staff

Prof. A.F.J. Dijkstra (p)
Prof. S.E. Fisher (e)
Prof. P. Hagoort (o)
Prof. J.M. McQueen (p)
Prof. A.S. Meyer (e)
Prof. A.P.A. Roelofs (p)
Prof. H.J. Schriefers (o)

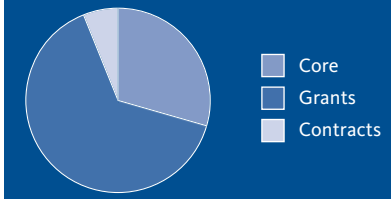
Tenured

Full professors	2.65 FTE
Associate professors	0.47 FTE
Assistant professors	0.83 FTE

Non-tenured

Researchers	6.98 FTE
Doctoral candidates	12.39 FTE

Research staff funding



KEY PUBLICATIONS

- Becker, M., Guadalupe, T., Franke, B., Hibar, D. P., Renteria, M. E., Stein, J. L., Thompson, P.
- M., Francks, C., Vernes, S. C., & Fisher, S. E. (2016). Early developmental gene enhancers affect subcortical volumes in the adult human brain. *Human Brain Mapping, 37*(5), 1788-1800.
- Drijvers, L., Mulder, K., & Ernestus, M. (2016). Alpha and gamma band oscillations index differential processing of acoustically reduced and full forms. *Brain and Language, 153-154,* 27-37.
- Hintz, F., Meyer, A. S., & Huettig, F. (2016). Encouraging prediction during production facilitates subsequent comprehension: Evidence from interleaved object naming in sentence context and sentence reading. *Quarterly Journal of Experimental Psychology, 69*(6), 1056-1063.
- Lewis, A.G., Schoffelen, J.-M., Schriefers, H., & Bastiaansen, M. (2016). A predictive coding perspective on beta oscillations during sentence-level language comprehension. *Frontiers in Human Neuroscience, 10*(85).
- Willems, R.M., Frank, S. L., Nijhoff, A.D., Hagoort, P., & Van den Bosch, A. (2016). Prediction during natural language comprehension. *Cerebral Cortex, 26*(6), 2506-2516.

Dissertations	**8**
Academic publications	**71**
Professional publications	**1**

study, a computational model first determined two measures of word prediction (entropy and surprisal) in three stories, which participants then heard in an MRI scanner. Sensitivity to entropy and surprisal was reflected in different brain regions in the language network, suggesting that prediction during comprehension can occur at multiple levels of processing. This study demonstrates the power of combining computational linguistics with cognitive neuroscience.

Future research

Researchers working on the LC theme will continue to pursue its key objectives in 2017. An important vehicle for this is the NWO 'Language in Interaction' Gravitation grant, which supports a national consortium of researchers including many LC members. PhD and postdoctoral projects already funded by the grant will continue next year. The consortium has recently identified five fundamental questions about language science. New projects designed to answer these questions will begin in 2017. ‹

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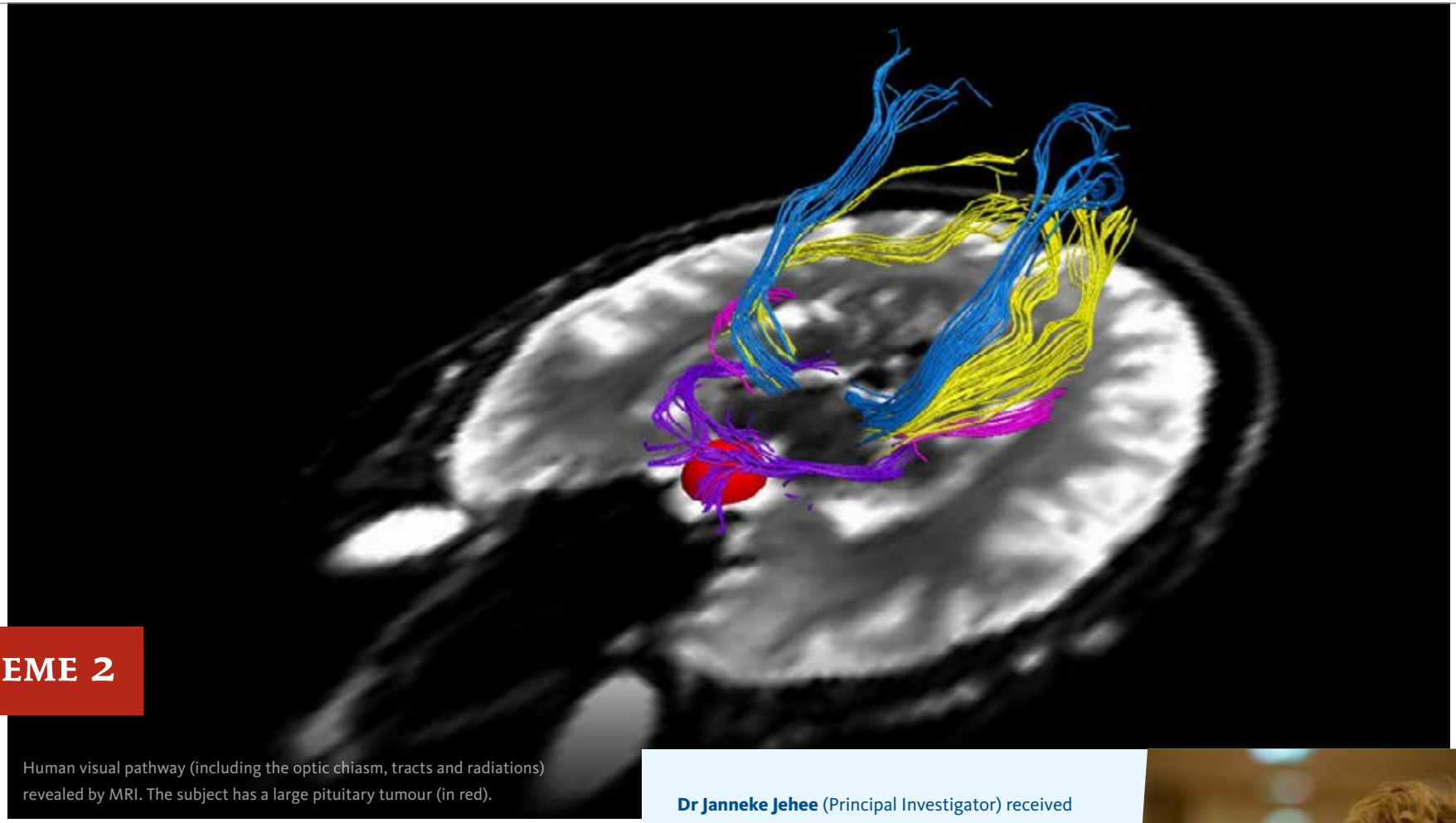

THEME 2

Human visual pathway (including the optic chiasm, tracts and radiations) revealed by MRI. The subject has a large pituitary tumour (in red).

Perception, Action and Control

Prof. Alan Sanfey (speaker)

Dr Janneke Jehee (Principal Investigator) received an ERC Starting Grant. She investigates how visual information is represented in the brain, and how visual representations are adjusted to better serve behavioural demands. She uses both theoretical (modelling) and experimental approaches, including functional brain imaging (fMRI), neural decoding techniques and visual psychophysics.

The mission of the Perception, Action and Control (PAC) theme is to understand the relationship between the brain and the cognitive mechanisms of perception-action integration across a variety of domains, namely perceptual inference, sensorimotor functions, cognitive control, decision-making and social interactions. The following topics are broadly investigated: initial integration between perception and action (during sensorimotor integration), how it is regulated (during decision-making) and how it is exploited (during social interactions), in both health and disease. For sensorimotor integration, researchers examine how sensory processing and motor performance interact within the perception-action cycle. At the level of decision-making, researchers study how the perception-action cycle is regulated on the basis of cognitive, motivational, and emotional factors. During social interactions, researchers study how perception and action are integrated when people are directly interacting with others. Across each of these levels, research also focuses on understanding neurological and psychiatric populations, as well as on the potential social implications of this research. PAC researchers address these issues at the system level; from genes to neuromodulators, from single neurons to brain circuits, and from individual organisms to multiple interacting agents. Multiple techniques are combined, from electrophysiological and neuroimaging methods to clinical and psychopharmacological studies, from genetic and neurobiological methods to developmental and psychophysical studies, and from computational modelling to theoretical analyses. This multidisciplinary and multi-level approach creates the opportunity for a variety of analytical and theoretical perspectives, providing a fertile ground for effective interactions between fundamental and clinical neuroscientists.

Research results

Researchers working on this theme were very productive in 2016. Summarising some important representative findings in the perceptual domain, a study showed that during saccadic eye movements, the image on the retinas is – contrary to subjective experience – highly unstable, outlining how the brain distinguishes the image perturbations caused by saccades and those due to changes in the visual scene. Another publication demonstrated that that true binaural hearing integration in bimodal listeners is only possible when there is sufficient spectral overlap. Using high-field fMRI, another group showed, in collaboration with researchers working on theme 4, that feedback signals evoked by a visual illusion selectively activate the deep layers of the primary visual cortex, demonstrating the potential for non-invasive *in vivo* recordings of neural activity with laminar specificity in humans. Examining learning, a study provided the first behavioural and electrophysiological evidence for influencing reversal learning with exogenous oscillatory electric field potentials. In terms of higher order processes, in a large longitudinal study it was found that puberty shifted emotional control from subcortical brain structures to the prefrontal cortex, with testosterone playing a key role. Finally, researchers developed a suite of tools to quantitatively compare the organisation of brains across species, making it possible to identify homologs of human brain areas for language and social cognition in the macaque brain. On the clinical side, research demonstrated the feasibility of wearing smart glasses for improving gait in people with Parkinson's Disease. Other studies showed that balance capacity in stroke patients can be improved by targeted dynamic balance training, shedding light on the learning potential of

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Prof. ir. A.F.M. Snik (e)
Prof. I. Toni (p)
Prof. R.A. Wevers (o)
Prof. R.J.A. van Wezel (p)
Prof. M.A.A.P. Willemsen (o)

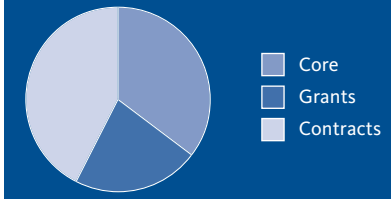
Tenured

Full professors	13.36 FTE
Associate professors	8.57 FTE
Assistant professors	11.73 FTE
Researchers	12.66 FTE

Non-tenured

Researchers	73.48 FTE
Doctoral candidates	103.72 FTE

Research staff funding



KEY PUBLICATIONS

1 Zhao, Y., Nonnekes, J., Storcken, E.J.M., Janssen, S., van Wegen, E.E.H., Bloem, B.R., Dorresteijn, L.C.A., van Vugt, J.P.P., Heida, T., & van Wezel, R.J.A. (2016). Feasibility of external rythmic cueing with the Google Glass for improving gait in people with Parkinson's Disease. *Journal of Neurology, 263*(6), 1156-1165.

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3 Stolk, A., Verhagen, L., & Toni, I. (2016). Conceptual alignment: How brains achieve mutual understanding. *Trends in Cognitive Sciences, 20*(3), 180-191.

4 Saksens, N. T. M., Krebs, M. P., Schoenmaker-Koller, F. E., Hicks, W., Yu, M., Shi, L., den Hollander, A. I. (2016). Mutations in CTNNA1 cause butterfly-shaped pigment dystrophy and perturbed retinal pigment epithelium integrity. *Nature Genetics, 48*(2), 144-151.

5 Tyborowska, A., Volman, I., Smeekens, S., Toni, I., & Roelofs, K. (2016). Testosterone during puberty shifts emotional control from pulvinar to anterior prefrontal cortex. *The Journal of Neuroscience, 36*(23), 6156-6164.

Dissertations	**31**
Academic publications	**753**
Professional publications	**20**
Patents	**1**

stroke patients. Donders Institute researchers demonstrated for the first time the *in vivo* potential for splice modulation therapy for a retinal disorder, and in other work used morphological studies in mice to describe mutations in alpha-catenin as a novel cause of macular dystrophy. Finally, the first stem-cell centre-facilitated paper, showing the molecular genetic defect for the most frequent variant in Stargardt disease, was published in 2016.

Future research

Researchers will continue to focus their work as described in the mission. There will be greater emphasis on efforts to align the work of the basic and applied scientists in order to generate and test models of normal and abnormal function, as well as efforts designed to examine the potential relevance of PAC research to public policy.

Other studies will test the neural development and predictive value of defensive stress reactions among children who develop typically, as well investigate the long-term effects of perceptual learning treatment in children. Another group will examine how different learning processes enable the dramatic developmental changes young children display in their action performance and in their understanding of others. Research will strongly focus on connecting different levels of analysis to increase understanding of how various top-down factors (expectation and attention) modulate sensory processing. There will be efforts to extend the comparative neuroscience programme, which was established to study the organisation of the great ape brain (gorillas and chimpanzees). Finally, the first gene therapy trials for inherited retinal dystrophies will commence, laying the basis for RetinaNET. ‹

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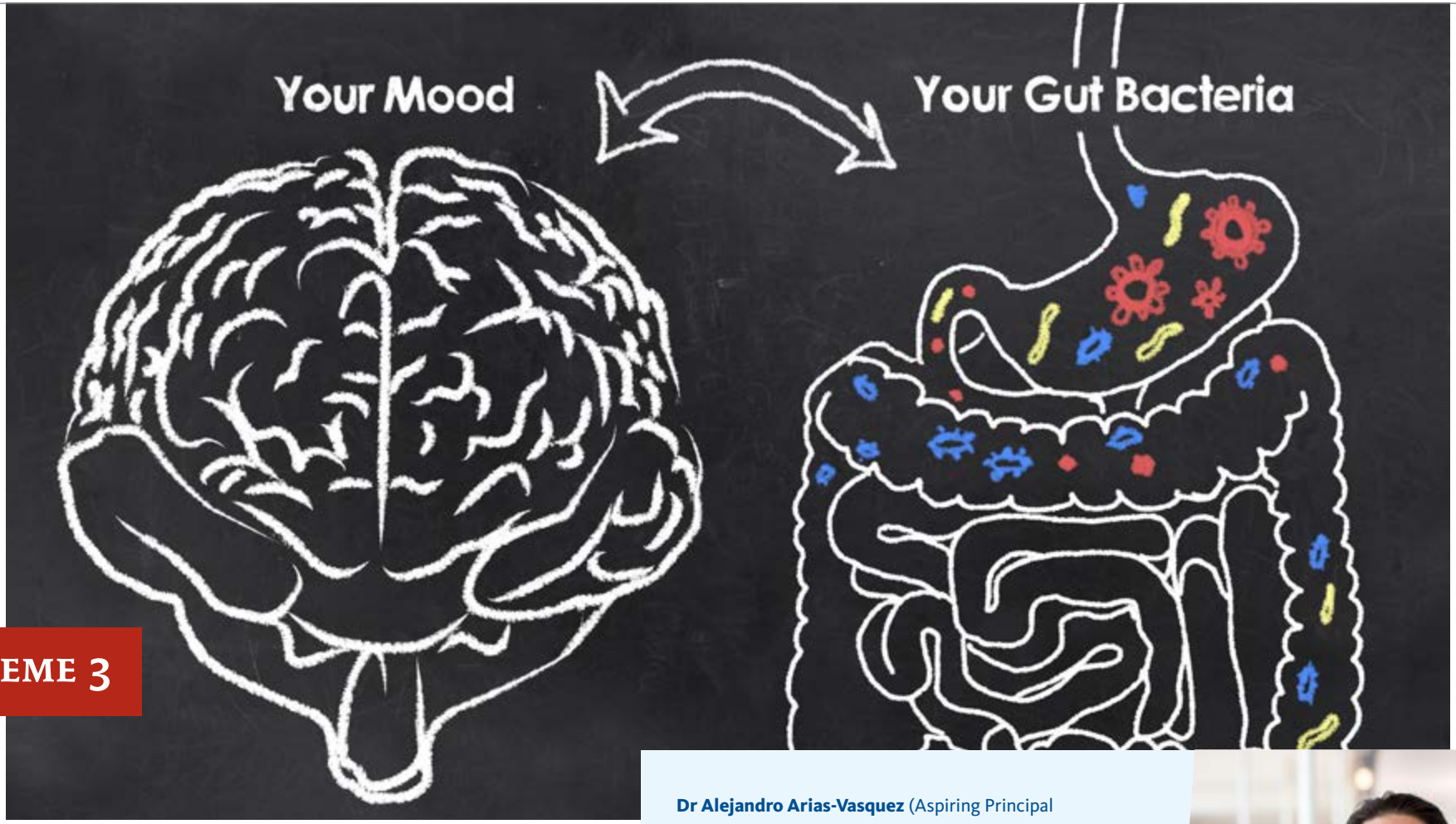
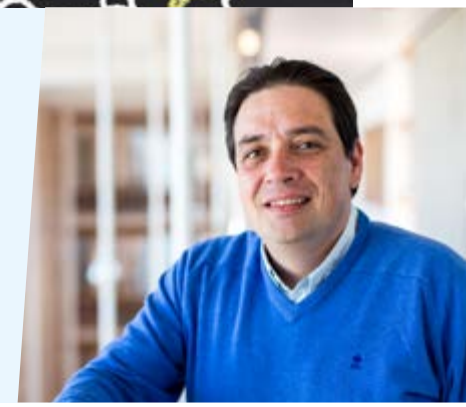


THEME 3

Plasticity and Memory

Prof. Indira Tendolkar (speaker)

Dr Alejandro Arias-Vasquez (Aspiring Principal Investigator) is searching for genes involved in the variation of brain traits as well as for genes involved in the risk of complex neuropsychiatric diseases. He participates in the world's biggest brain imaging genetics consortium, the ENIGMA consortium (enigma.loni.ucla.edu). His group has detected, for instance, an association between the SORL1 gene (a candidate gene for Alzheimer's disease) and hippocampal volume in healthy young adults.



Researchers within the Plasticity and Memory (PM) theme tackle the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. More specifically, the mission is to unravel how neuroplasticity supports adaptation to external and internal challenges, as well as learning and memory throughout the life span. The theme combines a focus on major mental health problems across the life span with the ability to have an impact on other areas such as education.

Research is closely integrated with the Radboudumc research themes 'Neurodevelopmental disorders', 'Stress-related disorders', and 'Alzheimer disease'. It is divided into three subthemes: *a)* development, studying the mechanisms and consequences of normal and abnormal neurodevelopment, including neurodevelopmental disorders and intellectual disability; *b)* adaptation, focusing on the neurobiological effects of external and internal challenges, such as environmental factors, stress and brain damage, as well as their behavioural and emotional consequences, with a clinical focus on affective disorders; *c)* learning and memory, investigating the neural and cognitive mechanisms underlying normal and impaired learning and memory as well as translating these mechanisms into clinically and educationally relevant constructs. The clinical focus of this subtheme is cognitive disorders.

Researchers working on this theme have created powerful networks – making it possible to use state-of-the-art genetic, epigenetic and genomics techniques – and translating them to a variety of animal models as well as human functional neuroimaging approaches, experimental psychology and neuropsychological research. Finally, fundamental research at the human system level is combined with clinical applied research, both in fine-tuned mechanistic as well as large-scale patient cohort studies.

Research results

In a study that received major attention in the international press (Guillén Fernández received the Hermesdorf Award International for this work), researchers have shown that physical exercise performed four hours after learning improves memory retention and increases hippocampal pattern similarity during retrieval. A multi-centre study dissected the system-level machinery underlying this effect in rodents, while a study involving humans revealed that the release of catecholamines related to physical exercise after learning has the same memory stabilising effect in humans. In a large genome-wide association study, meta-analysis researchers showed that early-onset bipolar disorder (≤21 years old) has a significant genetic covariation with attention-deficit/hyperactivity disorder. Further, with respect to developmental neuroplasticity, researchers showed that perinatal reduction of functional serotonin transporters results in developmental delay.

Future research

Alejandro Ariez Vásquez will extend his work on the human microbiome and he has recently received funding from two large EU grants. Hans van Bokhoven and his colleagues will start compound screens using multi-electrode arrays applied to neurons derived from induced pluripotent stem cells from patients with specific neurodevelopmental disorders. Guillén Fernández will continue to tackle two directions of memory, one focusing on knowledge acquisition with special attention paid to the developing brain and another one designed to create clinical tools that reveal individualised assessment of the pathophysiological mechanisms underlying mood and anxiety disorders. Funded by a larger EU-grant, Judith Homberg will continue to investigate whether d-Cycloserine (DCS), a partial NMDA receptor agonist, can facilitate the extinction of drug-related memories. Roy Kessels will establish a network dedicated to

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Prof. A.E.M. Speckens (o)
Prof. J.A. Veltman (o)
Prof. G.J. van der Wilt (o)

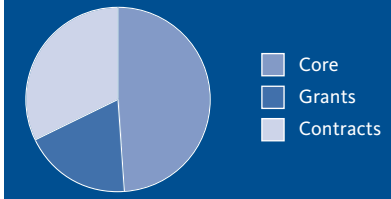
Tenured

Full professors	9.26 FTE
Associate professors	3.83 FTE
Assistant professors	12.51 FTE
Researchers	9.66 FTE

Non-tenured

Researchers	38.30 FTE
Doctoral candidates	63.80 FTE

Research staff funding



KEY PUBLICATIONS

1 Benevento, M., Iacono, G., Selten, M., Ba, W., Oudakker, A., Frega, M., Keller, J., Mancini, R., Lewerissa, E., Kleefstra, T., Stunnenberg, H.G., Zhou, H., van Bokhoven, H., &. Nadif Kasri, N. (2016). Histone methylation by the Kleefstra syndrome protein EHMT1 mediates homeostatic synaptic scaling. *Neuron, 91*(2), 341-355.

2 Kroeze, Y., Peeters, D., Boulle, F., van den Hove, D. L. A., van Bokhoven, H., Zhou, H., & Homberg, J. R. (2016). Long-term consequences of chronic fluoxetine exposure on the expression of myelination-related genes in the rat hippocampus. *Translational Psychiatry, 5*, e642.

3 van Uden, I. W. M., van der Holst, H. M., van Leijsen, E. M. C., Tuladhar, A. M., van Norden, A. G. W., de Laat, K. F., Claassen, J.A., van Dijk, E.J., Kessels, R.P., Richard, E., Tendolkar, I., & de Leeuw, F.-E. (2016). Late-onset depressive symptoms increase the risk of dementia in small-vessel disease. *Neurology, 87*(11), 1102-1109.

4 Thapar, A., Martin, J., Mick, E., Arias Vásquez, A., Langley, K., Scherer, S.W., Schachar, R., Crosbie, J., Williams, N., Franke, B., Elia, J., Glessner, J., Hakonarson, H., Owen, M.J., Faraone, S.V., O'Donovan, M.C., & Holmans, P. (2016). Psychiatric gene discoveries shape evidence on ADHD's biology. *Molecular Psychiatry, 21*(9), 1202-1207.

5 Takeuchi, T., Duszkiewicz, A.J., Sonneborn, A., Spooner, P.A., Yamasaki, M., Watanabe, M., Smith, C.C., Fernández, G., Deisseroth, K., Greene, R.W., & Morris, R.G. (2016). Locus coeruleus and dopaminergic consolidation of everyday memory. *Nature, 537*(7620), 357-362.

Dissertations	**26**
Academic publications	**569**
Professional publications	**40**

communicating new insights into the neural and cognitive underpinnings of Korsakoff patients.

An international imaging consortium working on the effects of electroconvulsive therapy used to treat resistant depression will be coordinated by researchers from Bergen and UCLA as well as Indira Tendolkar. She and her colleagues have received funding from the INTERREG V programme' to develop e-based cognitive intervention for people suffering from depression, in collaboration with partner clinics in Kleve and Essen in Germany. ‹

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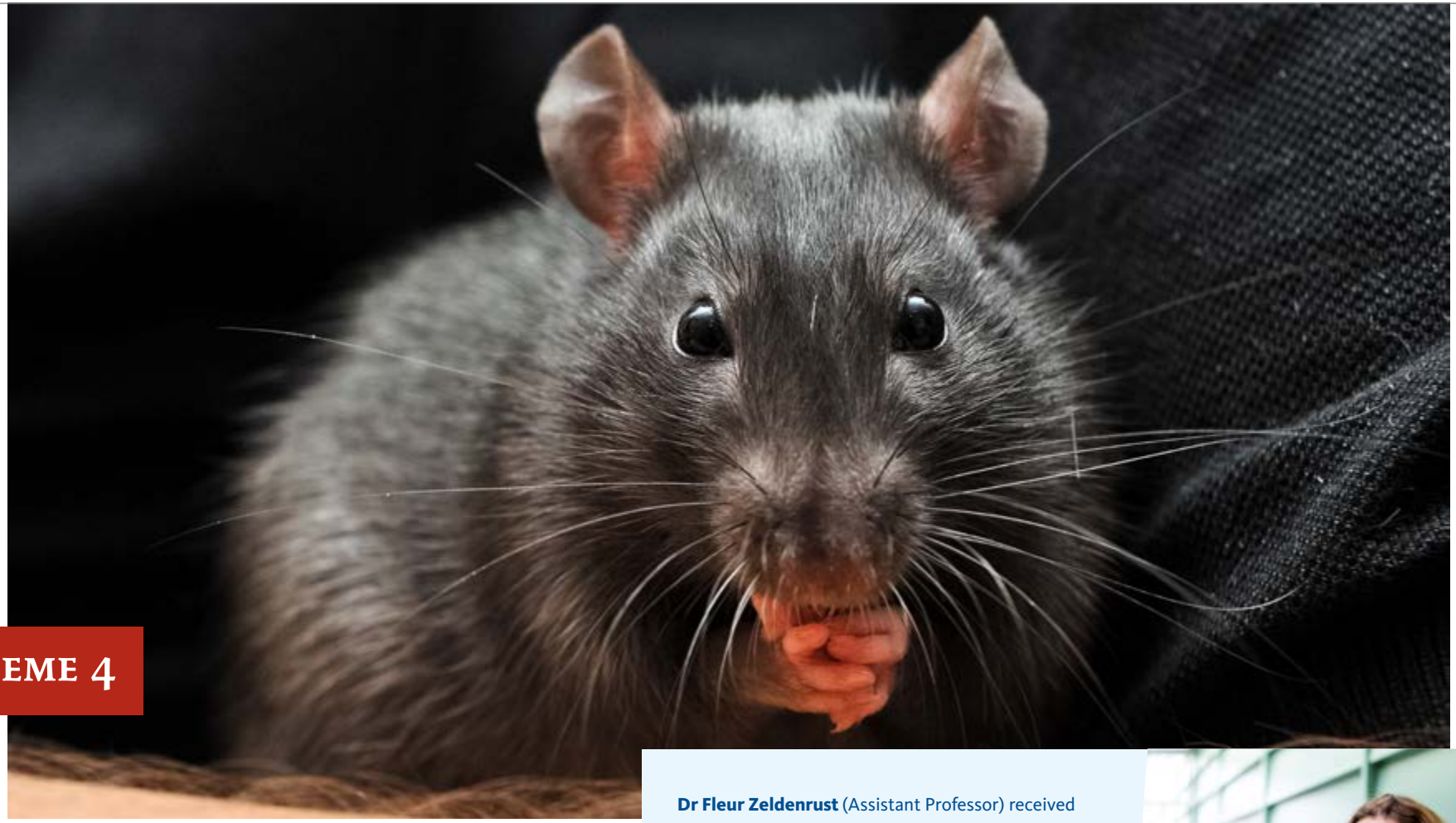

THEME 4

Brain Networks and Neuronal Communication

Prof. Tansu Celikel (speaker)

Dr Fleur Zeldenrust (Assistant Professor) received an NWO Veni grant. She studies the mutual influence of body movements and previous experiences. In her research on these interactions she uses mathematical models and computer simulations, which she compares with measurements on rodent whiskers.

The mission of researchers working on the Brain Networks and Neuronal Communication (BNNC) theme is to characterise and understand how groups of neurons interact and which mechanisms are involved in influencing behaviour and cognition. The research focuses on the network perspective, with the aim of understanding neural coding and communication at various levels. Vertical integration is approached experimentally by applying and developing state-of-the-art methodologies, spanning the full range from recording individual neurons in animals to human imaging of brain networks. The experimental methods are complemented by developing advanced analysis techniques, which also embrace the various levels. Theoretically, computational principles for neuronal coding and communication are developed using computational models ranging from synaptic communication to network dynamics.

It is becoming increasingly clear that cognition and behaviour need to be understood at the level of dynamic network interactions that involve several brain regions. Likewise, it is now also recognised that pathologies in neural communication may underlie neurological and psychiatric disorders. Researchers working on the BNNC theme are therefore involved in numerous clinically-related projects.

The aim of researchers working on this theme is to make theories, method developments and state-of-the art techniques available to the wider community. This is achieved through various proactive dissemination and educational initiatives, including making toolboxes and databases publically available.

Research results

With the increased accessibility of high throughout sequencing, the statistical properties of gene sets now make it possible to study biological processes as molecular networks, from genes to macromolecular complexes. A novel framework now provides a statistical backbone for any gene-set analyses, from single neurons in the brain to the tissue level across the body [1].

Information processing in the brain starts in single neurons, where each neuron generates action potentials based on the input they receive from other neurons. New research now shows that this transformation is dynamically controlled by the recent activity in each neuron, as neurons represent the recent memory of their aggregated synaptic inputs in the form of electrical charges [2]. Experiments *in silico* show that this form of adaptive control of spiking ensures robust information transfer in the brain [2].

The information transferred to the receiving neurons could be excitatory or inhibitory, thus it might either activate or inhibit the neurons that receive the synaptic communication. New research shows that inhibitory synaptic communication might play unique computational roles in the auditory system [3]. Specifically, adaptive control of inhibition might perform gain control, ensuring high fidelity representation of the auditory signals, independent of how loud the stimulus is.

Correlated changes across inhibitory and excitatory neuronal populations contribute to the emergence of oscillations in neuronal activity. Recent research now provides novel insights into how sensory information modulates the timing of oscillatory synchronisation and its informative power in predicting the arrival of sensory information in the near future [4].

One of the ways cortical layers differ from each other is the rhythm of the local neuronal activity. New research provides novel insight into how the functional and electrical signatures of these oscillations vary across

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Prof. O. Jensen (p)
Prof. H.J. Kappen (p)
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Prof. B.E.R. de Ruyter (e)
Prof. P.H.E. Tiesinga (o)

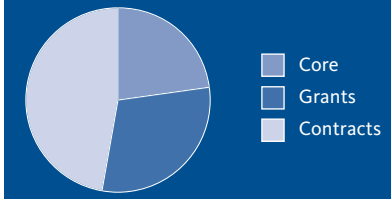
Tenured

Full professors	4.32 FTE
Associate professors	0.52 FTE
Assistant professors	4.50 FTE
Researchers	2.31 FTE

Non-tenured

Researchers	20.26 FTE
Doctoral candidates	46.65 FTE

Research staff funding



KEY PUBLICATIONS

1 de Leeuw, C. A., Neale, B. M., Heskes, T., & Posthuma, D. (2016). The statistical properties of gene-set analysis. *Nature Reviews Genetics*, 17(6), 353-364.
2 Huang, C., Resnik, A., Celikel, T., & Englitz, B. (2016). Adaptive spike threshold enables robust and temporally precise neuronal encoding. *PLoS Computational Biology*, 12(6), e1004984.
3 Keine, C., Rübsamen, R., & Englitz, B. (2016). Inhibition in the auditory brainstem enhances signal representation and regulates gain in complex acoustic environments. *Elife*, 5, e19295.
4 Meijer, D., Te Woerd, E., & Praamstra, P. (2016). Timing of beta oscillatory synchronization and temporal prediction of upcoming stimuli. *Neuroimage*, 138, 233-241.
5 Scheeringa, R., Koopmans, P. J., van Mourik, T., Jensen, O., & Norris, D. G. (2016). The relationship between oscillatory EEG activity and the laminar-specific BOLD signal. *Proceedings of the National Academy of Sciences*, 113(24), 6761-6766.

Dissertations	**9**
Academic publications	**217**
Professional publications	**7**

different cortical layers in the human brain [5]. This fundamental knowledge will help bridge animal and human experiments, ultimately extending the study of neural communication from local populations to whole brain networks.

Future research

The focus will continue to be on developing data acquisition techniques while combining methods. MRI combined with laminar resolution will be further improved and complemented by developing a statistical model to complement multi-unit recordings in freely behaving animals. Analysis approaches will be scaled to accommodate large, high-dimensional datasets, promoting strategic collaborations to enable vertical data integration.

The findings involving humans and animals will be integrated, with the aim of providing a system neuroscience perspective on neuronal communication and dynamics. Collaborations on clinical research will be extended to understanding neurological and psychiatric disorders at the network level. Brain-computer interfacing will be further developed, with the aim of improving communication – and device control – for disabled patients. ‹

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Radboud Institute for Health Sciences

The mission of the Radboud Institute for Health Sciences (RIHS) is to improve clinical practice and public health. It does so by providing evidence of the efficacy and efficiency of existing and new tests, treatments and policies as well as innovative modes of health care delivery, by training young researchers in methodologies for obtaining such evidence, and by developing new methodologies for improving research programmes in this field.

As evidence is typically obtained in probabilistic and qualitative rather than deterministic and mechanistic ways, research tends to be done among patients or the general population rather than through laboratory-based models. The Institute's focus is on developing methodologies that optimise personalised healthcare and on the application of these tools in disease-oriented research themes. In line with Radboudumc's mission of having *a significant impact on healthcare*, the Institute aims to bridge the gap between science and society. Societal impact is at the core of the Institute's ambitions.

Training of young researchers within the Institute is organised in a Royal Netherlands Academy of Arts and Sciences (KNAW)-accredited Graduate School.

Research at Radboudumc is organised in 18 themes. Five of these are embedded exclusively in the Donders Centre for Neuroscience and one is in the Radboud Institute for Molecular Life Sciences (RIMLS). The theme 'Healthcare improvement science' is exclusive to RIHS. Within the other 11 themes RIHS researchers work closely together with colleagues at RIMLS. We believe that optimal progress can be achieved when molecule, man and population-oriented researchers work together on the same disease-oriented 'playing field'.

Healthcare improvement science

Theme leader: Prof. Gert Westert

The main focus here is on the structure, process and outcomes of healthcare in daily practice, with the aim of improving performance and delivery from the perspective of the patient. Researchers study existing and new interventions at both the micro and the macro level. Their aim is to explore which interventions or structures work in what circumstances. Immediate value for patients is paramount.

Cancer development and immune defence

Theme leader: Prof. Joop Jansen

Researchers working on this theme investigate resistance to therapy, the tumour micro-environment, cancer-cell trafficking and the interaction between the immune system and cancer. This basic knowledge is translated into novel forms of therapy designed to target tumour cells. Strategies are also developed for expanding and manipulating immune cells for clinical use, exploiting and boosting the power of the immune system. For the translational part of this work, researchers carry out phase I, II and III clinical trials.

Rare cancers

Theme leader: Dr Carla van Herpen

Despite the rarity of each of the 'rare' cancers (*i.e.* an incidence <6/100,000 per year), they represent in total about 22% of all cases of cancer. Due to their low frequency, rare cancers pose particular challenges. The main aim is to improve diagnosis and prognosis and to perform personalised clinical studies and translational bench-to-bedside research in patients with rare cancers. This is performed in a national and international collaborative setting and in relationship with patient advocacy groups, where applicable.

Tumours of the digestive tract

Theme leader: Prof. Iris Nagtegaal

Research on this theme is designed to improve the prognosis and treatment of patients with tumours of the digestive tract, with a focus on sporadic and hereditary forms of colorectal and pancreatic cancer. The aim is to achieve better prevention of cancer in high-risk patients and to develop and implement new diagnostic tools for staging and therapy response. In addition, researchers are developing treatment innovations, ranging from improved surgical techniques to immunotherapy.

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Prof. W.J.H.M. van den Bosch (o)
Prof. D.D.M. Braat (o)
Prof. D.M. Burger (o)
Prof. N.H.J. Creugers (o)
Prof. R. van Crevel (o)
Prof. P.N.R. Dekhuijzen (o)
Prof. A.M. van Dulmen (e)
Prof. G. Elwyn (o)
Prof. A.W.M. Evers (o)
Prof. W.R. Gerritsen (o)
Prof. L.F. de Geus-Oei (o)
Prof. B. van Ginneken (o)
Prof. B.M. Goraj (o)
Prof. J. de Graaf (o)
Prof. W.T.A. van der Graaf (o)
Prof. P.G. de Groot (o)
Prof. J.A. Grotenhuis (o)
Prof. A.R.M.M. Hermus (o)
Prof. L.B. Hilbrands (o)
Prof. J.G. van der Hoeven (o)
Prof. J.J.M. van der Hoeven (o)
Prof. F.H.J. van den Hoogen (o)
Prof. M.T.E. Hopman (o)
Prof. M.E.J.L. Hulscher (o)
Prof. M.C.D.N.J.M. Huysmans (o)
Prof. P.P.T. Jeurissen (e)
Prof. C.A.J. de Jong (o)
Prof. E.M.G.J. de Jong (o)
Prof. J.H.A.M. Kaanders (o)
Prof. A. van Kampen (o)
Prof. E. Kampman (o)
Prof. N. Karssemeijer (o)
Prof. P.C.M. van de Kerkhof (o)
Prof. L.A.L.M. Kiemeney (o)
Prof. M. de Kleuver (o)
Prof. C.L. de Korte (o)
Prof. F.W. Kraaimaat (o)
Prof. J.A.M. Kremer (o)
Prof. A.M. Kuijpers-Jagtman (o)
Prof. B.J. Kullberg (o)
Prof. C.J.H.M. van Laarhoven (o)
Prof. A.L.M. Lagro-Janssen (o)
Prof. E. van Leeuwen (o)
Prof. M.S. Listl (o)
Prof. F.K. Lotgering (o)
Prof. A.H.E.M. Maas (o)
Prof. H.A.M. Marres (o)
Prof. G.J. Meijer (o)
Prof. W.J.H.J. Meijerink (o)
Prof. M.A.W. Merkx (o)
Prof. W.J. Morshuis (o)
Prof. J.W. Mouton (o)
Prof. M.W.G. Nijhuis-Van der Sanden (o)
Prof. P.M.P. Poortmans (o)
Prof. J.B. Prins (o)
Prof. W.M. Prokop (o)
Prof. P.L.C.M. van Riel (o)
Prof. M. Ritskes-Hoitinga (o)
Prof. G.A.P.J.M. Rongen (o)
Prof. C. Rosman (o)

Prof. M.M. Rovers (o)
Prof. H.M.J. van Schrojenstein Lantman (o)
Prof. L.J. Schultze Kool (o)
Prof. P.D. Siersema (o)
Prof. P.A.G.M. de Smet (o)
Prof. J.W.A. Smit (o)
Prof. P. Smits (o)
Prof. D. van Soolingen (e)
Prof. A.F.H. Stalenhoef (o)
Prof. H. Suryapranata (o)
Prof. C.G.J. Sweep (o)
Prof. D.J.O. Ulrich (o)
Prof. J. van der Velden (o)
Prof. A.J.A.M. van der Ven (o)
Prof. A.L.M. Verbeek (o)
Prof. N.J.J. Verdonschot (p)
Prof. F.W.A. Verheugt (o)
Prof. H. Vermeulen (o)
Prof. J.F. Verzijlbergen (o)
Prof. K.C.P. Vissers (o)
Prof. C.P.M. van der Vleuten (o)
Prof. A. Voss (o)
Prof. C. van Weel (o)
Prof. M.J.P. Wensing (o)
Prof. H.F.L. Wertheim (o)
Prof. G.P. Westert (o)
Prof. J.F.M. Wetzels (o)
Prof. S.N. de Wildt (o)
Prof. J.H.W. de Wilt (o)
Prof. J.R.L.M. Wolf (o)
Prof. G.A. Zielhuis (o)

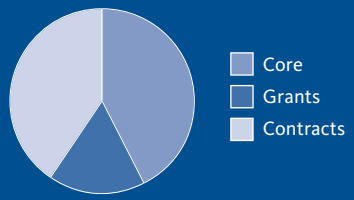
Tenured

Full Professors	24.2 FTE
Associate Professors	9.7 FTE
Assistant Professors	54.1 FTE
Researchers	80.3 FTE

Non-tenured

Researchers	151.0 FTE
Doctoral candidates	148.8 FTE

Research staff funding



Urological cancers

Theme leader: Prof. Jack Schalken

Research involves identifying and evaluating the usefulness of new biomarkers and imaging techniques for risk, diagnostic, prognostic and predictive assessment in prostate, bladder and kidney cancer. In addition, new and existing prevention and treatment modalities in these types of cancer are evaluated. Synergistic multidisciplinary research collaboration – from molecular life sciences to population sciences – ensures a focus on utility for patients and public health.

Women's cancers

Theme leader: Prof. Leon Massuger

The goal of this theme is to improve the patient-centred quality of care when treating women's cancers (breast, ovary, cervix, vulva, endometrium and pregnancy-related cancer). This is done in partnership with patients through prevention, early diagnosis and the implementation of new management strategies supported by a better understanding of carcinogenesis and tumour development, paying special attention to hereditary causes, preservation of fertility and individual post-treatment care.

Infectious diseases and global health

Theme leader: Prof. Mihai Netea

Researchers within this theme aim to have a significant and global impact on the control, treatment and elimination of infectious diseases. The theme combines cutting-edge research in immunology, microbiology, pharmacology and novel 'omics' methodology, with translational and implementation research in immunology and infectious diseases. There are two research lines: Infectious diseases & host defence, and Poverty-related infectious diseases.

Inflammatory diseases

Theme leader: Prof. Irma Joosten

Chronic inflammation is currently among the leading causes of morbidity and mortality in the Western world. Researchers working on this theme aim to translate results from the molecular and population level to the individual patient in order to improve diagnosis, disease management and the treatment of (chronic) inflammatory disorders.

Mitochondrial diseases

Theme leader: Prof. Jan Smeitink

The mission within this theme is to better understand the cellular bio-energetics in health and disease at all levels of complexity. Knowledge thus gained will enable the development of preventive measures and help to make substantial contributions to developing rational treatment strategies for mitochondrial diseases.

Reconstructive and regenerative medicine

Theme leader: Prof. Wout Feitz

The focus within this theme is on the development and clinical translation of innovative diagnosis and therapies, including regenerative medicine and nano-medicine, for personalised care and cure of patients needing reconstruction of lost or damaged tissues. This is achieved through transdisciplinary research by leading research groups in medicine, dentistry, biochemistry, chemistry, biology and materials science.

Renal disorders

Theme leader: Prof. Joost Hoenderop

Current and future care of patients with renal and renal-related disorders can be considerably improved. To achieve this, researchers working on this theme aim to increase knowledge of the molecular and immunological basis of rare glomerular and tubular disorders; they develop biomarkers for optimal prediction of disease prognosis; and apply strategies for preventing and improving renal replacement therapy.

Vascular damage

Theme leader: Prof. Gerard Rongen

In this theme the aim is to increase understanding of the causes and consequences of vascular injury and to translate this knowledge into improved personalised cardiovascular healthcare. Early detection of atherosclerosis, primary and secondary prevention of atherosclerosis, optimal treatment of atherosclerosis to preserve end- organ function, and the implementation of effective diagnostics and therapies in practice are key focus areas.

Research facilities

RIHS hosts some of the 19 formal Radboudumc Technology Centers (www.radboudumc.nl/en/research/technology-centers), which offer research facilities for both internal and external researchers:

- The *Biobank*, an infrastructure for collecting, storing and managing biomaterial and associated clinical data in a standardised manner. It contains large databases and biobanks of general population samples (*e.g.* the Nijmegen Biomedical Study) and of specific patient groups (*e.g.* those with congenital malformations, cancer, rheumatoid arthritis and inflammatory bowel disease).
- The *Clinical trials* centre, which offers logistics and data management for adult and paediatric human intervention studies.
- Consultation facilities for *statistics, health economics and transmural research*.
- The *Minimal Invasive Technology expert Center* (MITeC) field lab, which is used to evaluate surgical innovations.
- The Technology Center *Data stewardship* (started in 2016), which provides practical knowledge, services and solutions to ensure good research practice according to the FAIR criteria (Findable, Accessible, Interoperable, and Re-usable), in a way that suits each individual study and researcher. In order to support this, a newly developed Digital Research Environment (DRE) will be implemented in 2017.
- *Human performance*, which comprises the most important human in vivo measurement techniques.
- A *3D lab*, which offers 3D imaging and 3D printing for technological innovations in daily clinical practice.

In December 2016, State secretary Sander Dekker announced that the Radboudumc technology centres are listed on the NWO Roadmap for Large-Scale Scientific Infrastructure that will be given top priority in Dutch science in the next four years.

In addition to these technology centres, the RIHS has additional research facilities such as:

- Academic networks of GP practices (including the GP Continuous Morbidity Registration), nursing homes, institutions for people with an intellectual disability, municipality health services, care facilities for homeless people and dental care sites.
- The 'Koploper programme', a healthcare innovation in which professionals in primary care, public health, allied healthcare workers and the hospital jointly develop new approaches to prevention and care.
- A SYstematic Review Centre for Laboratory animal Experimentation (www.syrcle.nl).
- Consultation services designed to improve the quality of care (IQ healthcare).
- An online platform for Personal Health Communities (MijnZorgnet).

Collaboration

Although several research lines in the RIHS play a leading role worldwide, the Institute as a whole is best known in the Netherlands. To secure a transition to a more international level, RIHS is currently identifying attractive foreign research institutes and graduate schools in order to set up strategic alliances. Furthermore, RIHS annually offers at least two (three in 2016) junior researcher positions for projects proposed by a RIHS researcher, together with an international partner. PhD candidates, once appointed, carry out at least one year of the research abroad.

In 2016 Radboudumc started collaborating with Rijnstate Hospital in Arnhem, CWZ in Nijmegen and Sint Maartenskliniek in Nijmegen, making use of a regional PhD fund. A researcher from the regional hospital working with a Radboudumc (junior) Principal Investigator can submit an application to the fund.

Each year, a researcher or teacher from abroad is honoured with the 'Richard Grol Visiting Scientist Award'. In 2016 this award went to Trish Greenhalgh (Professor of Primary Care Health Sciences at the University of Oxford), an internationally recognised academic working in health services research/primary health care and a practising General Practitioner.

There are formal collaborations with the Universities of Twente, Eindhoven and Groningen for, *e.g.* MITeC. At the Institute level, there is a formal partnership in the KNAW-accredited research school CaRe (www.researchschoolcare.nl), together with CAPHRI (UM), NIVEL and APH (formerly EMGO+; VUmc).

The Institute has formal ties with the HAN University of Applied Sciences and with the Nederlands Paramedisch Instituut. The Institute is also a formal partner in 'Sterker op eigen benen' ('Stronger on your own two feet'), a consortium of five service providers for people with intellectual disabilities. Within the Academic Collaborative Centre AMPHI the Institute collaborates with 15 care organisations (including 60 nursing homes). with seven Dutch Community Health Services (GGDs) and within

UKON, the university network for long-term care in Nijmegen, RIHS collaborates with 15 care organisations (including 60 nursing homes). RIHS has collaborated with the Netherlands Comprehensive Cancer Organisation (IKNL), the National Expert and Training Centre for Breast Cancer Screening (LRCB), the RIVM, NIVEL, and the Dutch Ministry of Public Health, Welfare and Sport (VWS) for many years.

The RIHS collaborates in research and/or faculty exchanges with many universities around the world and with the European Union/ECDC, the WHO, UNESCO, the Centre on Birth Defects and Developmental Disabilities, various Centres for Disease Control and Prevention, INSERM (Paris), several Cochrane Centres, the MRC and the Institute for Cancer Research in London and deCODE Genetics in Reykjavik, Iceland. Within the scope of the EU 7th Framework and Horizon 2020 Programmes EuroTARGET, EURENOMICS, InSup-C, PACE, FAPIC, EYE-RISK, ENSAT-HT, MURAB, the Institute collaborates with numerous public and private organisations.

Research results

In 2016, two PhD theses received the predicate *cum laude*: Dr Niek Hugen ('Clinical and biological aspects of mucinous colorectal cancer') and Dr Ingrid Sturkenboom ('Occupational therapy for people with Parkinson's disease: towards evidence-informed care').

In November RIHS organised the international 'Radboud New Frontiers' conference 'Bridging the gap between biology and daily practice' for more than 250 scientists. Some other research highlights are listed below.

Healthcare improvement science

Professors Maroeska Rovers and Gert Westert, together with their colleagues, nicely summarised the evidence regarding the quality of patient-reported outcome measures (PROMs) validated in patients with obstructive sleep apnoea (Abma *et al. Sleep Medicine Reviews*, 2016).

Doctors Henk Eilander, Viona Wijnen and Jan Lavrijsen showed that a considerable number of patients with long lasting disorders of consciousness (even those who are still unconscious one to six months after injury) can recover and lead an independent or semi-independent life in the long term following specialised rehabilitation (Eilander *et al. Brain Injury*, 2016).

Cancer development and immune defence

A systematic review of animal studies by Dr Carlijn Hooijmans showed that there is no indication to suggest that locally administered anaesthetics are harmful during surgery in cancer patients. Volatile anaesthetics, however, might increase metastasis in animal models and clinical trials investigating this possibly harmful effect should receive priority (Hooijmans *et al. PLoS One*, 2016).

Rare cancers

The group led by Prof. Bram van Ginneken presented a novel Computer-Aided Detection (CAD) system for pulmonary nodule detection in CT scans. The promising results and the low computation time make the system highly suited for use as a decision aid in a lung cancer screening scenario (Setio *et al. IEEE Transactions on Medical Imaging*, 2016).

Tumours of the digestive tract

A case-control study by Prof. Hans de Wilt demonstrated that surgery of colorectal liver metastases leads to better survival than systemic therapy (de Ridder *et al. European Journal of Cancer*, 2016).

Urological cancers

An extensive meta-analysis by the group led by Prof. Maroeska Rovers, including all previous studies that evaluated magnetic resonance imaging (MRI) for detecting tumour growth outside the prostate, demonstrated that MRI is not sensitive enough to find all such tumours (de Rooij *et al. European Urology*, 2016).

Prof. Jelle Barentsz and his colleagues published a global standardised method designed to make and analyse MRI

Dr Geraline Leusink (Associate Professor and Medical Director at the Care Organisation Siza) is an expert in primary care, in particular long-term care. She explores how new technologies can be made applicable in the everyday lives of people with disabilities. She aims both to increase the independence of people with disabilities and to provide higher quality innovations in care. Since it is important that future physicians experience working in long-term care, her students are confronted with the challenges faced in such care.

prostate images (Weinreb *et al. European Urology*, 2016). Their paper was selected as the best clinical research paper published in the top journal European Urology in 2016.

Women's cancers

Dr Joanne de Hullu and her colleagues estimated BRCA1/2 mutation carriers' cumulative ovarian cancer risks after risk-reducing salpingectomy at various ages with delayed oophorectomy several years later, compared with risk-reducing salpingo-oophorectomy. They showed that the risk differences are small. This information can be used in counselling BRCA1/2 mutation carriers, thus facilitating a personalised, well-informed choice of strategy (Harmsen *et al. Obstetrics and Gynecology*, 2016).

Infectious diseases and global health

Dr Teun Bousema and colleagues published the first conclusive efficacy study on the use of low-dose primaquine to prevent malaria transmission (Dicko *et al. Lancet Infectious Diseases*, 2016).

Prof. Andre van der Ven and colleagues analysed the medical data of more than 350,000 African children and showed that vaccination of African babies directly after birth seems to be favourable for their growth and health, while vaccination later in life may have negative effects (Berendsen *et al. EBioMedicine*, 2016).

Inflammatory diseases

Dr Tjard Schermer showed that a diagnosis of Chronic Obstructive Pulmonary Disease (COPD) should not be based on a single spirometry test (Schermer *et al. NPJ Primary Care Respiratory Medicine*, 2016). This finding will have implications for current clinical guidelines.

Mitochondrial diseases

Dr Chris Verhaak showed that quality of life, fatigue and mental health problems in patients with mitochondrial disorders are only partly reflected by clinical assessments.

KEY PUBLICATIONS

- Abma, I.L., Wees, P.J. van der, Veer, V., Westert, G.P. & Rovers, M.M. (2016). Measurement properties of patient-reported outcome measures (PROMs) in adults with obstructive sleep apnea (OSA): A systematic review. *Sleep Medicine Reviews, 28*, 18-31.
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- Ridder, J.A.M. de, Stok, E.P. van der, Mekenkamp, L.J., Wiering, B., Koopman, M., Punt, C.J.A., Verhoef, C. & Wilt, J.H.W. de (2016). Management of liver metastases in colorectal cancer patients: A retrospective case-control study of systemic therapy versus liver resection. *European Journal of Cancer, 59*, 13-21.
- Rooij, M. de, Hamoen, E.H.J., Witjes, J.A., Barentsz, J.O. & Rovers, M.M. (2016). Accuracy of Magnetic Resonance Imaging for Local Staging of Prostate Cancer: A Diagnostic Meta-analysis. *European Urology, 70*(2), 233-45.
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Dissertations	**85**
Scientific publications	**2094**
Patents	**1**

In order to support patients more effectively, integration of patient-reported outcomes, alongside symptoms of their disease, is warranted in clinical practice (Verhaak *et al. Orphanet Journal of Rare Diseases*, 2016).

Reconstructive and regenerative medicine

The team led by Dr Thomas Maal presented and validated an innovative semi-automatic tool designed to quantify the displacement of jaw segments in orthognathic surgery. Their method provides clinicians with a powerful new tool that can be used to evaluate and optimise the accuracy of 3D planning in bimaxillary surgery. (Baan *et al. PLoS One*, 2016).

Renal disorders

Prof. Saskia de Wildt, Dr Carin Verlaat and their colleagues have shown that inflammation and organ failure significantly reduce drug metabolism (cytochrome P450 3A activity), which may importantly impact the efficacy and safety of drugs in critically ill patients (Vet *et al. American Journal of Respiratory and Critical Care Medicine*, 2016).

Vascular damage

Dr Dick Thijssen's group showed that exercise training tends to be more effective in reducing visceral adipose tissue compared with diet interventions in overweight and obese subjects. This suggests that changes in body weight represent a poor marker for adaptation in visceral adipose tissue, especially when performing exercise training, and indicates that in clinical practice caution should be taken when interpreting changes (or the lack of changes) in body weight after exercise training interventions (Verheggen *et al. Obesity Reviews*, 2016).

Awards and acknowledgements

- Prof. Bart Kiemeney was elected as new member of the Academia Europaea.
- Dr Teun Bousema received the Radboud Science Award. This award allows him to translate his malaria research into learning and teaching materials that are suitable for primary school pupils.
- Rebecca Verheggen won a Christine Mohrmann stipend for promising female PhD candidates. She will use the grant to work at Oxford University in the UK.
- Prof. Stefaan Bergé was elected Trainer of the Year 2016 by the association for residents 'De Jonge Specialist'.
- Dr Jakko van Ingen was presented with the European Respiratory Society (ERS) Research Award for his contribution both as a clinician and as a scientist to improving the diagnosis and treatment of diseases caused by non-tuberculous mycobacteria.
- Dr Jo Frencken was awarded China's prestigious International Scientific and Technological Cooperation Award for his decade-long efforts promoting more accessible cavity treatment of Chinese people.
- Dr Loes Derikx was awarded the best thesis award by the European Society of Biomechanics for her thesis, which was entitled 'Femoral fracture risk prediction in metastatic bone disease'.

Societal impact

Societal impact is at the heart of RIHS research. Much – if not most – RIHS research has direct societal impact and it is implemented in clinical care or public health. For this, RIHS encourages researchers to act in close collaboration with public organisations on topics with high societal relevance. RIHS research leads, *e.g.*, to more personalised treatment, to better cooperation between healthcare providers, to more efficient diagnostic protocols, and through all this to better and more efficient healthcare. Research results are shared with the professional and lay community through contributions to guidelines or protocols, professional and popular publications, newspaper and radio, board membership of national and international societal advisory groups and policy institutes, outreach activities and public-private collaborations.

Some highlights in 2016 were:

- RIHS organised a patient information meeting for bladder cancer patients and a public evening about the future of cancer research.
- RIHS organised a tour in Radboudumc for secondary school students.
- The RIHS PhD training in Epidemiology which leads to registration with the Foundation for training Medical-biological Scientific Researchers ('Stichting voor opleiding tot Medisch-Biologisch Wetenschappelijk Onderzoeker'; SMBWO) was re-accredited for a period of five years by the Netherlands Association of Epidemiology.
- Ten years after her appointment as a full professor, Prof. Merel Ritskes-Hoitinga held a public lecture on the status and future of animal research.
- During the Lowlands festival researchers from the Department of Anaesthesiology investigated whether you can tolerate more pain when listening to your favourite music instead of music you hate.
- FertilityConsult, an online fertility clinic, went 'live', an initiative of Radboudumc and Jeroen Bosch hospital.
- CMyLife, a platform for patients with chronic myeloid leukaemia – an initiative of Prof. Nicole Blijlevens – was launched.
- SCREENIVF, an instrument designed to screen psychosocial risks in IVF couples, which was developed by Dr Chris Verhaak and Radboudumc colleagues, was implemented in the European Guidelines for clinical practice of the European Society of Human Reproduction and Embryology and adopted by more than 1000 European fertility clinics (Gameiro *et al. Human Reproduction*, 2016).
- The team led by Prof. Ria Nijhuis-van der Sanden developed a practice guideline for anterior cruciate ligament rehabilitation for the Netherlands (Engelen-van Melick *et al*. British Journal of *Sports Medicine*, 2016).
- Prof. David Burger was a member of the Paediatric Antiretroviral Working Group (PAWG) that advised WHO on dosing recommendations for treating HIV-infected children under the age of five (Mulenga *et al. Lancet Infectious Diseases*, 2016).
- In collaboration with the Oxford University Clinical Research Unit in Vietnam, Prof. Heiman Wertheim showed that use of a rapid (five-minute) test can reduce antibiotic misuse when treating respiratory infections (Do *et al. Lancet Global Health*, 2016). Cutting the number of unnecessary antibiotic prescriptions is a key way to prevent the spread of antibiotic-resistant infections.
- Dr Tijn Kool showed that the Dutch healthcare inspectorate identifies the same hospitals as 'at risk' as those that patients rate as underperformers (Kool *et al. Journal of Medical Internet Research*, 2016).
- Dr Hein Janssens devised and developed a medical app for supporting diagnosis of gout without the need for microscopic investigation by a rheumatologist.
- Dr Jeroen Hasselaar edited a free book on integrated palliative care.
- The limited company 'Atro Medical' was established as a spin-off of Prof. Nico Verdonschot's laboratory. This company will prepare the first in-men study of the permanent meniscus prosthesis that is being co-developed by his laboratory.
- Prof. Henny van Schrojenstein Lantman-de Valk was honoured as an Officer in the Order of Orange-Nassau and Dr Sylvie Lo Fo Wong was honoured as a Knight in the Order of Orange-Nassau.
- Prof. Jan Kremer has been appointed as chairman of the Quality Council (Kwaliteitsraad) of the National Health Care Institute (Zorginstituut Nederland), and he is a

member of the Council for Health and Society (RVS) ('Raad voor Volksgezondheid en Samenleving'), which advises the Dutch government and parliament on health-related issues.

- Prof. Maria Hopman was appointed chairman of the Nijmegen Stedelijk Network, an organisation of CEOs and directors in all fields in Nijmegen, including the the Mayor and City Council Members.
- Dr Eddy Adang, Prof. Theo van Achterberg, Prof. Maria Hopman, Prof. Ellen Kampman, Prof. Bart Jan Kullberg and Prof. Gerhard Zielhuis are members of the Health Council of the Netherlands.
- Prof. Koos van der Hoeven, Prof. Bart Kiemeney, Prof. Judith Prins and Prof. Peter Siersema are members of the scientific council of the Dutch Cancer Society.
- Prof. Pim Assendelft, Prof. Judith Prins, Prof. Maroeska Rovers, Dr Tom Scheenen and Prof. Gerhard Zielhuis are board members of the Dutch Innovational Research Incentives Scheme (Veni-Vidi-Vici).
- Prof. Nicole Blijlevens is a member of the Horizonscan working group Oncology and Haematology of the Ministry of Health, Welfare and Sport.
- Prof. Gerard Rongen is a member of the Central Committee on Research Involving Human Subjects ('Centrale Commissie Mensgebonden Onderzoek'; CCMO).
- Dr Teun Bousema is a member of the Scientific Advisory Board of Médecins Sans Frontières.

Future research

The Institute will continue to invest in research facilities such as biobanks as well as in large national and international networks. The focus of research will increasingly be on personalised healthcare and patient-centred interventions. For example, Dr Erik Bischoff and Dr Tjard Schermer will further develop their smart app for personalised management of Chronic Obstructive Pulmonary Disease (COPD) exacerbations (EFRO grant). Prof. Maroeska and Dr Joanna in 't Hout will promote tailored health care by improving methods designed to investigate subgroup effects in treatment response when there are multiple individual participant datasets (ZonMw TOP subsidy). Together with two Radboudumc spin-off companies, ScreenPoint Medical and Thirona, Prof. Bram van Ginneken's group will focus on automatic interpretation of chest radiographs, mammograms, retinal images and chest CT scans (€4.6 million grant of the Dutch Technology Foundation STW for a consortium of five academic groups and seven companies).

Non-tuberculous mycobacteria are emerging causative agents of severe and treatment-refractory infections. With a prestigious NWO Veni grant Dr Jakko van Ingen will build a system to mimic human infections and assess the efficacy of smart combinations of antibiotics designed to combat these, and later, other bacteria. The best combinations can then proceed into clinical trials. Another NWO Veni grant was awarded to Dr Giesje Nefs. She will examine psychological predictors of nocturnal hypoglycaemia (low blood glucose), which is common in people with type 1 diabetes. Furthermore, she will investigate the consequences for daily life and the best approach to treating (and dealing with concerns about) very low blood glucose.

Dr Marit Tanke will use a prestigious Harkness Fellowship in Health Care Policy and Practice to investigate the way care of complex patients is organised. She will assess which cost components can be avoided by reducing lower-value care and inefficiencies in the system and how these factors can be influenced by regulatory systems and/or health insurers.

The ageing of the Dutch population will present enormous quality and efficiency challenges in healthcare. Cost-effectiveness will be central to healthcare policy for the next few decades. Three research groups will perform

Director Professor Bart Kiemeney

After a short career as a physiotherapist, Bart Kiemeney was trained as an epidemiologist at Radboud university medical center (Radboudumc). From 1992-1994 he received further training in clinical epidemiology at the University of Washington, Seattle WA and in genetic epidemiology at Johns Hopkins University, Baltimore MD. In 2003 he was appointed Professor of Cancer Epidemiology at Radboud University. His research focuses on the genetic causes and pharmacogenetics of urological cancers.

research on healthcare costs and effectiveness, with grants from the ZonMw programme 'DoelmatigheidsOnderzoek': Dr Mark van den Boogaard ('The impact of nUrsing DEliRium Preventive Interventions in the Intensive Care Unit (UNDERPIN-ICU)'), Prof. Ria Nijhuis-van der Sanden and Dr Thomas Hoogeboom ('Is Coach2Move cost-effective in day-to-day physiotherapy practice?') and Dr Bastiaan Klarenbeek ('Pelvic Floor rehabilitation to improve functional Outcome and quality of life after surgery for Rectal CancEr: a randomised controlled trial. FORCE trial').

The consortium 'Sterker op eigen benen', a collaboration between care organisations for people with intellectual disabilities (ID) and the Radboudumc, will develop a structural health monitoring system for people with ID using a grant of the Ministry of Health, Welfare and Sport. This project is led by Dr Geraline Leusink.

Dr Leon Bijlmakers and his partners will scale up the delivery of accessible, elective and emergency surgery at district hospitals to national level programmes in three African countries with a European Horizon 2020 grant. Other projects that will be performed with Horizon 2020 money are: 'HBM4EU: European Human Biomonitoring Initiative' (Dr Paul Scheepers), 'HYPERTRANS: Transport of hyperpolarised substrates for metabolic imaging' (ERC Proof of Concept grant, Dr Tom Scheenen), 'HOME_EU: Homelessness as unfairness' (Prof. Judith Wolf), 'PanACEA: a Pan-African Consortium for the Evaluation of antitubercolosis Antibiotics' (Dr Martin Boeree, Dr Rob Aarnoutse), 'PedCRIN: Paediatric Clinical Research Infrastructure Network' (Prof. Saskia de Wildt).

With a Bas Mulder Award from Alpe d'HuZes/KWF Dr Geert Litjens will try to improve treatment selection for prostate cancer patients, using digital pathology and 'deep learning'. Other projects that received awards from the Dutch Cancer Society are: 'Fluorescence image-guided surgery in patients with peritoneal carcinomatosis of colorectal origin' (Dr Mark Rijpkema),'Impaired Spermatogenesis and Testosterone Deficiency in Male Survivors of Childhood Cancer: a DCOG-LATER study' (Dr Jacqueline Loonen), 'Chemotherapy or not? Practice changing approach for the selection of patients for accurate chemotherapy treatment after colon cancer diagnosis' (Dr Jeroen van der Laak), 'Standardising training for endoscopic resection of large non-pedunculated colorectal polyps: It is prime-time to change practice' (Prof. Peter Siersema), 'Diagnostic accuracy of contrast-enhanced diffusion-weighted MRI for liver metastases of pancreatic cancer: towards adequate staging of pancreatic cancer'(Dr John Hermans), 'Favorable and unfavourable effects of risk-reducing salpingo-oophorectomy (RRSO) in women at high genetic risk of ovarian cancer' (Prof. Angela Maas).

In 2017, the Institute also plans to strengthen its expertise in, *e.g.* data engineering/big data in health sciences, in data integrity when establishing a digital research environment, and in healthcare research among refugees and low-income subgroups in the population. The policy of the Institute, along with that of the other two Radboudumc institutes, is in the recently published Research Agenda 2025 (www.rihs.nl/about-us/reports). <

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Radboud Institute for Molecular Life Sciences

Researchers at the Radboud Institute for Molecular Life Sciences (RIMLS) aim to increase insight into the molecular basis of disease, as expressed in the slogan *"Today's molecules for tomorrow's medicine."* This is achieved by integrating molecular and medical research to obtain multifaceted knowledge of normal and pathological processes. Findings are translated into clinical applications, into the development of diagnostics, and into the treatment of patients as part of personalised healthcare.

RIMLS – a leading research institute that focuses on the molecular mechanisms of disease – brings together research groups from the Radboud university medical center (Radboudumc) and the Faculty of Science (FNWI) at the university. Clinical and fundamental scientists who specialise in diverse areas of the life sciences work closely together in programmes designed to understand the underlying causes of disease. In line with Radboudumc's strategic vision to have a significant impact on healthcare, research is bundled into clinically-orientated research themes ranging from molecule to man. The RIMLS Graduate School integrates a dedicated two-year Research Honours MSc programme in Molecular Mechanisms of Disease (MMD) and a follow-up 3-4 year PhD programme, thus creating a challenging yet enriching international learning environment where researchers at all levels are exposed to societally relevant multidisciplinary research questions related to the molecular basis of disease.

Research themes

RIMLS research comprises 12 themes, which are described briefly below.

Cancer development and immune defence

Theme leader: Prof. Joop Jansen

The primary goal here is to gain insight into the molecular, genetic and epigenetic processes that lead to the transformation of normal (stem) cells into malignant cancer cells. Insights into tumour micro-environments and interactions between the immune system and cancer are translated into specific forms of therapy, targeting the affected molecular pathways, and using (modified) immune cells to target tumour cells.

Rare cancers

Theme leader: Dr Carla van Herpen

Despite the rarity of each of the 186 rare cancers, they represent in total about a quarter of all cancer cases. Examples include head and neck cancer, sarcoma, thyroid cancer, neuroendocrine cancer, brain tumours, lymphoma, and paediatric cancer. The mission of this group is to improve diagnosis and prognosis for this patient group in both a national and international collaborative setting.

Tumours of the digestive tract

Theme leader: Prof. Iris Nagtegaal

This research focuses on improving the prognosis and treatment of patients with tumours of the digestive tract, in particular colorectal and pancreatic cancer. Key objectives are to develop diagnostic tools for staging and therapy response, and to innovate in urgical techniques and immunotherapy. Improving knowledge of the aetiology, epidemiology and genetics of these tumours will improve cancer therapy in high-risk patients.

Urological cancers

Theme leader: Prof. Jack Schalken

This research is designed to identify and evaluate the effectiveness of new biomarkers and imaging techniques for risk, diagnostic, prognostic and predictive assessment in prostate, bladder and kidney cancer. In addition, the intention is to evaluate new and existing prevention and treatment modalities for these types of cancer. Synergistic multidisciplinary research collaboration – from molecular life sciences to population sciences – is the tool used to ensure that there is a strong focus on 'utility' for patients and public health.

Women's cancers

Theme leader: Prof. Leon Massuger

Central to this theme is improving the patient-centred quality of care in women's cancers (breast, ovarian, cervix, vulva, endometrium, and pregnancy-related) in partnership with patients. This includes prevention,

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Prof. W.B. van den Berg (o)
Prof. R.J.M. Bindels (o)
Prof. I. de Blaauw (o)
Prof. O.C. Boerman (o)
Prof. U. Brandt (o)
Prof. R.E. Brock (o)
Prof. P. Buma (p)
Prof. A. Cambi (o)
Prof. C.E.L. Carels (o)
Prof. P.M.T. Deen (o)
Prof. J.M.A. van Deursen (o)
Prof. C.A. Dinarello (o)
Prof. J.P.H. Drenth (o)
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Prof. W.J. de Grip (e)
Prof. R. de Groot (o)
Prof. I.C.J. Gyssens (o)
Prof. A. Heerschap (o)
Prof. L.P.W.J. van den Heuvel (o)
Prof. J.G.J. Hoenderop (o)
Prof. N. Hoogerbrugge-van der Linden (o)
Prof. M.A. Huijnen (o)
Prof. J.A. Jansen (o)
Prof. J.H. Jansen (o)
Prof. I. Joosten (p)
Prof. L.A.B. Joosten (o)
Prof. J.H.J.M. van Krieken (o)
Prof. R. Masereeuw (UU) (o)
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Prof. P.F.A. Mulders (o)
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Prof. W.J.G. Oyen (o)
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Prof. N.P. Riksen (o)
Prof. R. Roepman (o)
Prof. F.G.M. Russel (o)
Prof. R.W. Sauerwein (o)
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Prof. P.J. Slootweg (o)
Prof. J.A.M. Smeitink (o)
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Prof. I.J.M. de Vries (o)
Prof. P. Wesseling (o)
Prof. B. Wieringa (o)
Prof. J.A. Witjes (o)
Prof. T.J.M. de Witte (o)
Prof. E.J.J. van Zoelen (o)

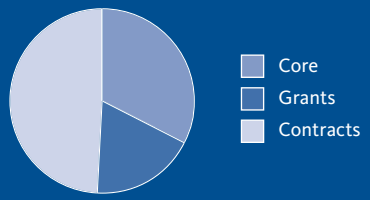
Tenured

Full Professors	31.1 FTE
Associate Professors	15.2 FTE
Assistant Professors	28.7 FTE
Researchers	31.8 FTE

Non-tenured

Researchers	162.6 FTE
Doctoral candidates	207.1 FTE

Research staff funding



early diagnosis and implementation of new management strategies, supported by a better understanding of carcinogenesis and development. Special attention is paid to hereditary causes, preservation of fertility and personalised care after treatment.

Infectious diseases and global health

Theme leader: Prof. Mihai Netea

The mission within this theme is to achieve national and international leadership in research and research training in infectious diseases, immunity and global health. The main aim is to improve the diagnosis, treatment and prognosis of patients with infections through fundamental, translational and epidemiological-based investigative approaches to studying disease pathogenesis.

Inflammatory diseases

Theme leader: Prof. Irma Joosten

In the Western world, chronic inflammation is among the leading causes of morbidity and mortality. Central to this theme is understanding and controlling inflammatory disease for the benefit of patients by i) unravelling the pathogenesis and immune pathogenesis of inflammatory disease processes; ii) elucidating the role of tissue-specific factors in regulating local immunity and inflammation; iii) identifying druggable targets and biomarkers; iv) developing clinical grading tools; and v) carrying out pharmacogenetic and epidemiological studies.

Mitochondrial diseases

Theme leader: Prof. Jan Smeitink

The mission of researchers working on this theme is to understand the cellular bioenergetics in health and disease at all levels of complexity. The knowledge thus gained will make it possible to develop preventive measures and contribute substantially to developing treatment strategies for mitochondrial diseases.

Reconstructive and regenerative medicine

Theme leader: Prof. Wout Feitz

The focus of this theme is on the development and clinical translation of innovative diagnoses and therapies – including regenerative medicine and nanomedicine – for personalised care and cure of patients needing reconstruction of lost or damaged tissues. This is achieved by transdisciplinary research involving leading research groups in medicine, dentistry, biochemistry, chemistry, biology and materials science.

Renal disorders

Theme leader: Prof. Joost Hoenderop

Current and future care of patients with renal and renal-related disorders can be improved considerably. To achieve this, the researchers aim to i) increase insight into the molecular and immunological basis of rare glomerular and tubular disorders; ii) develop biomarkers for optimal prediction of prognosis; iii) apply strategies that can be used to avoid the need for and, where necessary, improve renal replacement therapy.

Vascular damage

Theme leader: Prof. Gerard Rongen

Early detection as well as primary and secondary prevention of atherosclerosis, optimal treatment to preserve end-organ function, and implementation of effective diagnostics and therapies in practice are the key focus areas of this theme. The researchers probe the causes and consequences of vascular injury and translate this knowledge into improved personalised cardiovascular healthcare.

Nanomedicine

Theme leader: Prof. Jan van Hest

This mechanism-based theme focuses on the design, synthesis and characterisation of molecules and molecular assemblies in order to elucidate the structure and function of natural systems. The knowledge thus

gained is applied to developing nanostructured devices for diagnostics, targeted delivery and tissue repair. Examples include artificial cells, molecular probes and tissue-mimetic materials.

Research facilities

The nineteen Radboudumc Technology Centres (www.radboudumc.nl/research/technologycentres), which offer research facilities for internal and external researchers, are linked to the Radboud University Research Facilities. By joining forces, a wealth of expertise and facilities are available to address a wide variety of research questions. In December 2016, Dutch Secretary of State Sander Dekker announced that the Radboudumc technology centres are listed on the NWO Roadmap for large-scale scientific infrastructure that will be given priority on the Dutch science agenda in the coming years. RIMLS hosts the following centres:

- The *Centre for Molecular and Biomolecular Informatics* brings together experts from a range of disciplines *e.g.* sequence analysis, comparative genomics, *in-silico* drug design, systems biology, and protein structure analysis.
- The *Genomics* technology *centre* has four subunits: DNA isolation, DNA biobanking, high-throughput sequencing using targeted strategies and genome-wide sequencing strategies.
- The *Mass spectrometry technology centre* consists of strong analytical knowledge hubs that share hardware, protocols and reagents, and perform joined projects within proteomics, glycomics and metabolomics.
- The *Microscopy facility* forms a fully integrated multi-department centre with approximately 35 instruments hosted by several departments of the Radboudumc and the FNWI. Unique systems with national and international outreach include intravitral multiphoton microscopy, automated microscopy and3D electron microscopy.
- The *Central animal facility* offers expert advice and access to facilities for animal testing and several disease-related animal models.
- The *Imaging technology centre* provides cutting-edge technology and service for *in vivo* imaging-related preclinical and clinical research questions.
- The *Investigational Medicinal Products (IMP) technology platform* enables the development, validation and production of IMPs according to European Good Manufacturing Practice regulations in order to produce novel imaging tools for diagnostics or develop novel radiopharmaceuticals, nanoparticles or cellular therapies.

Collaboration

Science tackles the most complex problems. These can't be solved by single researchers or even single institutions. Forming sustainable, interactive networks of scientists across international borders is indispensable for conceptual breakthroughs and for translating fundamental findings into clinical practice. Building options for inter-institutional collaboration *e.g.* visiting professorships / lecturers, exchange possibilities for Masters students and PhD candidates, and arranging technology workshops, is a key ambition for the years ahead. The aim is to establish fully translational disease pipelines from 'molecule to man', and back again.

Locally, RIMLS is allied with the Institute for Molecules & Materials, the Radboud Institute for Health Sciences (RIHS) and the Donders Centre for Neuroscience (DCN), providing a solid platform for integrating chemical synthesis, nanomedicine and neuroscience with molecular life sciences and health sciences. In 2016, Radboudumc started collaborations with Rijnstate Hospital Arnhem, CWZ Nijmegen and Sint Maartenskliniek Nijmegen by means of a regional PhD fund. A duo consisting of a researcher from the regional hospital and Radboudumc (junior) Principal Investigator can submit an application to the fund. Nationally, RIMLS has contacts with other UMCs and universities as well as with public and private partnerships. Internationally, RIMLS collaborates with many prestigious institutes, such as Broad Institute (Massachusetts, USA), University of California (California, USA), Tel Aviv University in Israel, University College London (London, UK) and The Wellcome Trust Sanger Institute (Cambridge, UK). Within Europe, there is increasing collaboration with the University of Duisberg-Essen, specifically the Graduate School of Biomedical Science (BIOME) and with the Institute for Research in Biomedicine (IRB, www.irbbarcelona.org) in Barcelona. Previously, Paul Smits, Dean of Radboudumc, signed an agreement with Joan Guinovart, Director of IRB, paving the way for researchers to participate in each other's research and education programmes. Early in 2016, this initiative was given a €0.5 million boost with a Horizon2020 grant: European Academy for Biomedical Science (ENABLE, www.enablenetwork.eu) is a consortium that will connect aspiring European researchers of tomorrow with prominent scientists working today. Involved in the consortium are two other partner institutions: the Novo Nordisk Foundation Center for Protein Research (CPR) and the Italian-based European School of Molecular Medicine (SEMM).

Research results

Understanding the molecular mechanisms of disease is the common factor reflected in all of our research achievements, some of which are highlighted below.

Cancer development and immune defence

The group led by Prof. Henk Stunnenberg and collaborators showed that B-glucan exposure can re-instate a pro-inflammatory phenotype *ex vivo* – the first time that the tolerant state has been reversed. This discovery paves the way for future clinical trials in sepsis patients (Novakovic *et al. Cell, 2016*). A study by Lotte de

Winde under the supervision of Dr Annemiek van Spriel, which identified CD37 as a novel tumour suppressor in B cell lymphomagenesis, provides a strong rationale for blocking the IL-6 signalling pathway in patients with CD37-negative B cell lymphoma as a new therapeutic intervention (de Winde *et al. J Clin Invest, 2016*).

Rare cancers

Dr Theo Plantinga and Dr Romana Netea recognised – for the first time – autophagy activity as a biomarker of radioactive iodide (RAI) resistance, which potentially has mechanistic implications for elucidating the underlying processes driving non-medullary thyroid cancer (NMTC) dedifferentiation (Plantinga *et al. Autophagy, 2016*). To improve the assessment of the response in metastasised solid tumours the group led by Prof. Wim Oyen proposed adjusting the use of Positron emission tomography response criteria (PERSTST) for quantitative analysis of [18F]-FDG-PET/CT with integrated computed tomography (Willemsen *et al. Eur J Cancer, 2016*).

Tumours of the digestive tract

The results of a study by Dr Richarda de Voer and Dr Marjolijn Ligtenberg suggest a polygenic model of colorectal cancer (CRC) susceptibility in which patients with early-onset CRC carry a set of rare, pathogenic variants in their germline that put them at risk of develop CRCing (de Voer *et al. PLOS Genet, 2016*). The group led by Prof. Iris Nagtegaal demonstrated the limited role of lymph node metastases in colorectal cancer (Knijn *et al. Oncotarget, 2016*).

Urological cancers

Dr Toine van de Heijden and Prof. Fred Witjes found that progressive and non-progressive bladder tumours have different gene expression patterns and they identified a five-gene signature that can be used to predict progression in high-risk non-muscle invasive bladder cancer (van de Heijden *et al. Eur J Cancer, 2016*). The group led by Prof. Jack Schalken proposed a two-gene risk score to detect high-grade, clinically significant prostate cancer accurately. This risk score could therefore be used in decision making, reducing the number of unnecessary prostate biopsies and potential overtreatment (Van Neste *et al. European Urology, 2016*).

Prof. Jolanda de Vries (Professor of Translational Tumour Immunology) succeeded in establishing a clinical vaccination programme in which tumour-associated antigens were loaded on dendritic cells to treat melanoma patients. She demonstrated that natural dendritic cells circulating in the blood are also effective in antigen presentation and able to generate clinical responses when used as a vaccine in cancer patients. As a direct consequence of these promising results, a €19 million double-blind phase three study, which is uniquely sponsored by the Dutch government and the Dutch health insurance companies, will be carried out with stage III melanoma patients.

Women's cancers

Dr Hanny Pijnenborg and Prof. Leon Massuger showed in a collaboration study that L1CAM expression is a very valuable marker that can be used to identify non-endometrioid and aggressive endometrioid cases, which can lead to subsequent individualisation of the treatment (Pijnenborg *et al. Br J Cancer, 2016*). The group led by Prof. Willem Melchers showed the clinical value of HPV genotyping in triage of women with high-risk-HPV-positive self-samples, leading to personalised screening (Ebisch *et al. Int J Cancer, 2016*).

Infectious diseases and global health

Dr Taco Kooij provided growing support for a potential link between heavy metal homeostasis and host switching, revealing potential targets for the rational design of new intervention strategies to combat malaria, including a new lead for a genetically attenuated whole-parasite vaccine (Kenthirapalan *et al. Nature Communications, 2016*). Also in 2016, in order to understand the inter-individual variation of the human immune responses, Prof. Mihai Netea, Prof. Leo Joosten and their colleagues published a number of studies combining 'omics' technologies with in-depth functional phenotyping of the immune responses in healthy and diseased individuals (Li *et al. Nature Medicine, 2016*; Schirmer *et al. Cell, 2016*; Ter Horst *et al. Cell, 2016*; Li *et al. Cell, 2016*).

Inflammatory diseases

Prof. Irma Joosten and colleagues showed that platelet-derived microparticles (PMP) are actively involved in (pathogenic) immune responses and can prevent the deleterious switch of Treg from a suppressive towards a pro-inflammatory profile in a cell-contact dependent way (Dinkla *et al. Blood, 2016*). The data of a study published

by the group led by Dr Peter van Lent underline the potential of S100A8/A9 as a systemic local imaging biomarker tool in seronegative arthritis, for assessing not only inflammation but also the severity of inflammatory joint destruction (Geven *et al. Arthritis Res Ther, 2016*).

Mitochondrial diseases

The group led by Dr Werner Koopman showed that automated microscopy analysis of mitochondria in human metabolic disorders is suitable for application in fundamental research, mitochondrial drug development and mitochondrial toxicity analysis (Lanneti *et al. Nature Protocols, 2016*). Dr Leo Nijtmans and his colleagues found that mutations in TMEM126B gene cause a complex I deficiency with an unusual mild clinical phenotype. Their insights in complex I assembly made it possible to identify underlying defects and gain a better understanding of disease progression (Sanchez- Caballero *et al. Human Genetics, 2016*).

Reconstructive and regenerative medicine

Dr Luuk Versteegden and Dr Henk Hoogenkamp, under the supervision of Dr Toin van Kuppevelt, designed a straightforward technique that can be used to develop a unique elastic characteristic of scaffolds prepared from type I collagen alone. This may be useful for regenerating dynamic tissues such as blood vessels, ligaments and lung (Versteegden *et al. Acta Biomaterialia, 2016*). Dr Sander Leeuwenburg and his colleagues suggested that nanofibrous membranes containing silver particles as an implantable delivery vehicle have considerable potential to act as an active antibacterial dressing for local delivery of antibacterial agents to prevent percutaneous device associated infections (Song *et al. Nanomedicine, 2016*).

Renal disorders

A study by an international team of researchers (funded by EU FP7 Health project SYSCILIA) which

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Dissertations	**78**
Scientific publications	**1331**
Patents	**6**

was coordinated by Prof. Ronald Roepman gave detailed insights into the connectivity of over 1300 proteins as part of structural ciliary protein complexes or signalling pathways related to cilia function and dysfunction (Boldt *et al. Nature Communications, 2016*). Prof. Dorien Swinkels and her colleagues have shown that systemic hepcidin administration abolished haemoglobin-induced acute kidney injury in mice. At the same time, increased hepcidin synthesis was observed in the distal part of the nephron, suggesting that both systemic and renal synthesised hepcidin are essential for protection along the entire nephron (van Swelm *et al. J Am Soc Nephrol, 2016*).

Vascular damage

Prof. Niels Riksen's group analysed innate immune cell activation and epigenetic remodelling in symptomatic and asymptomatic atherosclerosis in humans *in vivo* (Bekkering *et al. Artherosclerosis, 2016*). Furthermore, their research on increased arterial wall inflammation through oxidised phospholipids on lipoprotein a(Lp(a)) provides a novel mechanism by which Lp(a) mediates cardiovascular disease and might lead to novel therapeutic targets (van der Valk *et al. Circulation, 2016*).

Nanomedicine

Prof. Alessandra Cambi and her colleagues analysed how dendritic cells probe their environment via podosomes. Unravelling the architecture and dynamics of protrusive structures may provide novel leads which can improve the specificity and efficacy of experimental anti-cancer therapies (Meddens *et al. Nature Communications, 2016*). The team led by Prof. Jan van Hest described an approach involving sensitive detection of human skin stem cell markers via immuno-PCR with 'home-made' antibody-DNA conjugates (van Buggenum *et al.* Sci Rep, 2016).

Societal impact

RIMLS' mission supports the strategic vision of Radboudumc to have a significant impact on healthcare and to advance personalised medicine. The impact of molecular life sciences-related research in society is emphasised in education and research at RIMLS. Training researchers in life sciences is of great importance for society, since those currently studying at RIMLS will form the new generation of scientists and biotechnology entrepreneurs who will develop novel treatments and diagnostics.

RIMLS researchers contribute actively to disseminating research results via conferences, teaching in schools and colleges as well as in the media. A prominent example is that of Prof. Jolanda de Vries (Cancer development and immune defence), who appeared on national television and radio to inform the public of a new experimental vaccine treatment that reduces the risk of the recurrence of skin cancer. This treatment will be covered by national basic health insurance for the next five years. Prof. Jolanda de Vries and Dr Mirjam Zegers (Woman's cancers) participated in a patient evening on the future of cancer treatment organised by the Radboud Institute for Health Sciences (RIHS) and Radboudumc Centre for Oncology (RUCO). Similarly, Prof. Jan Smeitink (Mitochondrial diseases) organised a public information day for patients with mitochondrial disorders. On World Kidney Day researchers working on renal disorders contributed to a large national public event to raise awareness about kidney disease. Furthermore, RIMLS researchers including Prof. Mihai Netea (Infectious diseases and global health) and Prof. Irma Joosten (Inflammatory diseases) took part in the InScience Dutch International Science Film Festival, a joint initiative of the Arthouse LUX and Radboud University. Prof. Mihai Netea also appeared regularly in the media to discuss his new discoveries on the workings of the immune system, scientific results that have led to the rewriting of the biology text books used in schools.

In the context of the theme Infectious diseases and global health, Dr Taco Kooij appeared in the news to talk about the potential role of heavy metals in the fight against malaria. Dr Ronald van Rij received media attention in connection with a potential new drug target that can be used to combat the Dengue virus and Dr Patrick Zeeuwen was in the spotlight regarding the bacteria that live in our skin. Also within this theme, Dr Monique van der Voet and Dr Ronald van Rij appeared on an episode of the children's education television show 'Klokhuis' to explain how the fruit fly (*Drosopila melanogaster*) can be used as an experimental model organism.

Prof. Anna Simon (Inflammatory diseases) published her book entitled 'Ebola – behind the mask', in which she describes her experiences while working in Sierra Leone during an Ebola outbreak, which killed a huge number of people. Clinical groups interact with patients and their relatives at Radboudumc on a daily basis, have close ties with patient organisations, and are involved in public and strategic policy. Finally, many RIMLS researchers' efforts have been acknowledged in high-level personal awards.

Future research

The following impressive grants from the Netherlands Organisation for Scientific Research (NWO) and European Research Council (ERC) subsidy were awarded to members of RIMLS, forming the basis for important future research:

- Four RIMLS researchers were awarded NWO Veni grants, each worth €250,000, to develop innovative lines of research. Dr Marije Doppenberg-Oosting (Infectious diseases and global health): *'Put the brake on Borrelia-induced joint inflammation'*, Dr Sandra Heskamp (Rare cancers): *'Towards better patient selection for immune checkpoint inhibitor therapy for cancer: imaging of the PD-L1 and PD-1 pathway'*, Dr Natalia Revelo Nuncira (Cancer development and immune defence): *'Turning on the alarms: how dendritic cells activate the immune attack'*, and Dr Nelleke Spruijt (Cancer development and immune defence): *'NuRD regulates development'*.
- Dr Michiel Schreuder (Renal disorders) was awarded a prestigious NWO Vidi grant worth €800,000 to develop his own innovative line of research: *'Why one kidney at birth is not enough ...'*
- Dr Miriam Schmidts (Renal disorders) received a €1.5 million ERC starting grant for her research proposal: *'Novel Therapeutic Avenues for dynein-related Ciliopathies'*.
- Dr Mangala Srinivas (Nanomedicine) was awarded an ERC Proof of Concept grant worth € 150,000 to explore the innovation potential of her research: *'CONQUEST: Enabling advanced medical imaging*.
- Dr Annemiek van Spriel (Cancer development and immune defence) was awarded a highly competitive ERC Consolidator Grant worth €2 million for her project: *'Secret surface'*. She aims to understand how cell surface receptors and membrane-proximal signalling proteins are organised by the tetraspanin web in tumour cells.
- KWF awarded two Young Investigators grants each worth each €600, 000 to Dr Sandra Heskamp (Rare cancers) for her project: *'Towards personalised use of immune checkpoint inhibitors by imaging of the PD-1/ PD-L1 pathway'* and to Dr Willemijn Hobo (Cancer development and Immune defence) for her project: *'Boosting graft-versus-leukemia immunity by combining hypomethylating agents and immunotherapy in patients with acute myeloid leukemia'*.

Furthermore, a number of large (consortium) grants were obtained:

- The international PERISCOPE project received a €28 million European subsidy from the Innovative Medicine Initiative, which collaborates with the Bill and Melinda Gates Foundation, to map the immune response to pertussis infection (whooping cough) and vaccination. Prof. Ronald de Groot (Infectious diseases and global health) is project coordinator.
- Prof. Jolanda de Vries (Cancer development and immune defence) will start a clinical trial with an experimental vaccine that reduces the risk of the recurrence of skin cancer. This study will last until 2021 and up to €20 million will be paid during that period by the Dutch government.
- The international research project, PERFORM, received a €18 million grant from the Horizon 2020 Health Programme to develop a rapid test to reduce the use of unnecessary antibiotics and quickly identify deadly cases of meningitis, sepsis and other life-threatening bacterial infections. Several groups at Radboudumc are involved, headed by Prof. Ronald de Groot and Dr Marien de Jonge (both working on Infectious diseases and global health). In total Radboudumc will receive €1.5 million.
- An international team coordinated by Prof. Aleksandra Trifunovic (University of Cologne) has been awarded a highly competitive €3.9 million Marie Skłodowska-Curie Innovation Training Network grant, REgulation of MItochondrial gene eXpression (REMIX), to train the next generation of scientists in mitochondrial gene expression regulation. Prof. Hans Spelbrink and Prof. Jan Smeitink (both working on Mitochondrial diseases) are involved on behalf of the Radboudumc.
- An STW perspective grant worth €3 million has been awarded to Dr Peter van der Kraan (Inflammatory diseases) and colleagues to develop a clinically suitable method for stimulating cartilage repair.
- This year, KWF gave awards to several projects led by RIMLS researchers:
  - Prof. Jack Schalken and Dr Gerald Verhaegh (Urological cancers) together with colleagues from Erasmus MC and VUmc received a €2 million Alpe D'HuZes/KWF grant to develop minimally invasive assays for the diagnosis and prognosis of prostate cancer.

- Prof. Iris Nagtegaal (Tumours of the digestive tract) together with colleagues from Academic Medical Centre Amsterdam received €1.1 million for the project *'Evaluation of optimal intervals for colonoscopy surveillance: a randomized trial'*.
- Dr Harry Dolstra (Cancer development and Immune defence) and Prof. Leon Massuger (Women's cancers) received €1 million for the project *'Intraperitoneal infusion of ex vivo-generated allogeneic natural killer cells in recurrent ovarian carcinoma patients: a phase I study'*.
- Prof. Otto Boerman (Nanomedicine) and Dr Sandra Heskamp (Rare cancers) received €600, 000 for the project *'Bimodal PSMA ligands for intra-operative tumour detection and photodynamic therapy of prostate cancer'*.
- Dr Paul Span (Women's Cancer), together with colleagues from Erasmus MC, received €600,000 for the project *'The role of APOBEC3B in breast cancer therapy resistance'*.
- Dr Frank van Leeuwen (Cancer development and Immune defence) received €500,000 for the project: *'Breaking therapy resistance in IKZF1 deleted Acute Lymphoblastic Leukemia'*.
- Prof. Iris Nagtegaal, Dr Marjolijn Ligtenberg, Prof. Nicoline Hoogerbrugge (all working on Tumours of the digestive tract) and Dr Jeroen van der Laak (Women's cancers) received €450,000 for the project *'Identify the patient and save the family - detecting hereditary pancreatic cancer'*.

- Dr Nicole van de Kar (Renal disorders) and her colleagues have been awarded €2.3 million by the Dutch Health Insurance Companies to optimise the duration and dose of the highly expensive drug, Eculizumab.
- A consortium consisting of CitiusBio BV, DKMS BV and Prof. Harry van Goor (Reconstructive and regenerative medicine) was awarded a European Fund for Regional Development (EFRO) grant worth €1.2 million to develop and validate the use of rapid measurement of hormones and biomarkers for heart disease as a compact point of care device.
- Dr Mangala Srinivas (Nanomedicine), together with academic and industrial collaborators, received a €750,000 Dutch Technology Foundation (STW) grant to develop non-invasive cardiovascular imaging tools for monitoring cardiac inflammation.
- A consortium consisting of Prof. Harry van Goor, Dr Sander Leeuwenburgh (both Reconstructive and regenerative medicine) and Prof. Jan van Hest (Nanomedicine, RU), as well as industrial partners was awarded a €750,000 Dutch Technology Foundation (STW) grant to develop bone-adhesive membranes for advanced surgical treatment of tissue defects.
- The EU's Horizon 2020 Programme awarded €500,000 to the project 'European Academy for Biomedical Science' (ENABLE), which aims to promote excellence in the biomedical sciences in Europe, strengthen scientific careers, and bring biomedicine closer to society. From the RIMLS, Dr Adrian Cohen (RIMLS) is leading the work package on scientific symposia.
- A consortium of seven EU partners, involving Prof. Toin van Kuppevelt (Reconstructive and regenerative medicine) has been awarded € 400,000 to study the diagnostic and therapeutic significance of specific alterations in heparan sulphate in Alzheimer's disease.
- Prof. Jan Smeitink, Prof. Frans Russel, Dr Tom Schirris and Dr Ria de Haas (Mitochondrial diseases) have been awarded a Prinses Beatrix Spierfonds €250,000 grant to evaluate potential pharmacological interventions that stimulate the cellular cholesterol efflux.
- Dr Jeroen van der Laak (Women's cancers), Dr Bart Smeets, Dr Eric Steenbergen and Prof. Luuk Hilbrands (Renal disorders), together with European partners, were successful in acquiring a €250,000 ZonMw Joint Transnational grant (Sys-MIFTA) to elucidate pathological processes leading to renal transplant rejection.

Scientific director
Professor René J.M. Bindels

René Bindels has been Professor – and has held the Chair – of Physiology since 2003. After a post-doc position at the University of Alabama in Birmingham, USA, his research focused on regulating ion transport processes in the kidney and intestine (in health and disease) and he currently specializes in renal TRP channels and salt transporters. Prof. Bindels is an elected member of the Academia Europaea and a recipient of the Robert Pitts Lectureship of the International Union of Physiological sciences, the Carl W. Gottschalk Lectureship of the American Physiological Society and the Homer Smith Award of the American Society of Nephrology.

In addition to these grants, numerous personal subsidies from a wide range of national and European agencies have been awarded, forming the basis of research for 2016 and beyond. Full details can be found on the RIMLS website (www.RIMLS.nl).

Academic integrity

Use of honest and transparent working ethics – as well as clear rules of accountability – plays a pivotal role in research at RIMLS and all researchers are expected to comply with the academic integrity policies laid down by the University. These regulations are published on various websites. Promoting awareness of academic integrity is equally important and RIMLS continues to raise awareness of this topic in Masters and PhD programmes. In our Masters course *'Science and Society'*, students are shown how to recognise ethical and social questions and how to address these issues through practical and theoretical analyses. Furthermore, students discuss academic misconduct and integrity, *e.g.* in issues arising in data management, data analysis and scientific authorship. Societal and ethical issues may arise at any stage in a scientific career, and therefore, PhD candidates in their second year follow a compulsory two-day follow-up course. The goal here is to further develop integrity as a professional competency. Real problems are shared by the students as 'cases' and matters relating to politics and media are analysed. Uniquely, senior researchers are also involved in the course, creating and maintaining awareness at all stages of participants' careers. The Radboud Postdoc Initiative also regularly organises workshops and informal gatherings on academic integrity.

Academic integrity policy was further expanded in 2016 with the campus-wide implementation of a digital lab-book licence to promote transparent, traceable data storage and analysis. This concept is being further explored in ongoing efforts to set up (in 2017) an extensive Digital Research Environment (DRE) that will allow researchers to import, merge, optimise, store, analyse, archive and share research data in a more secure and traceable fashion. ‹

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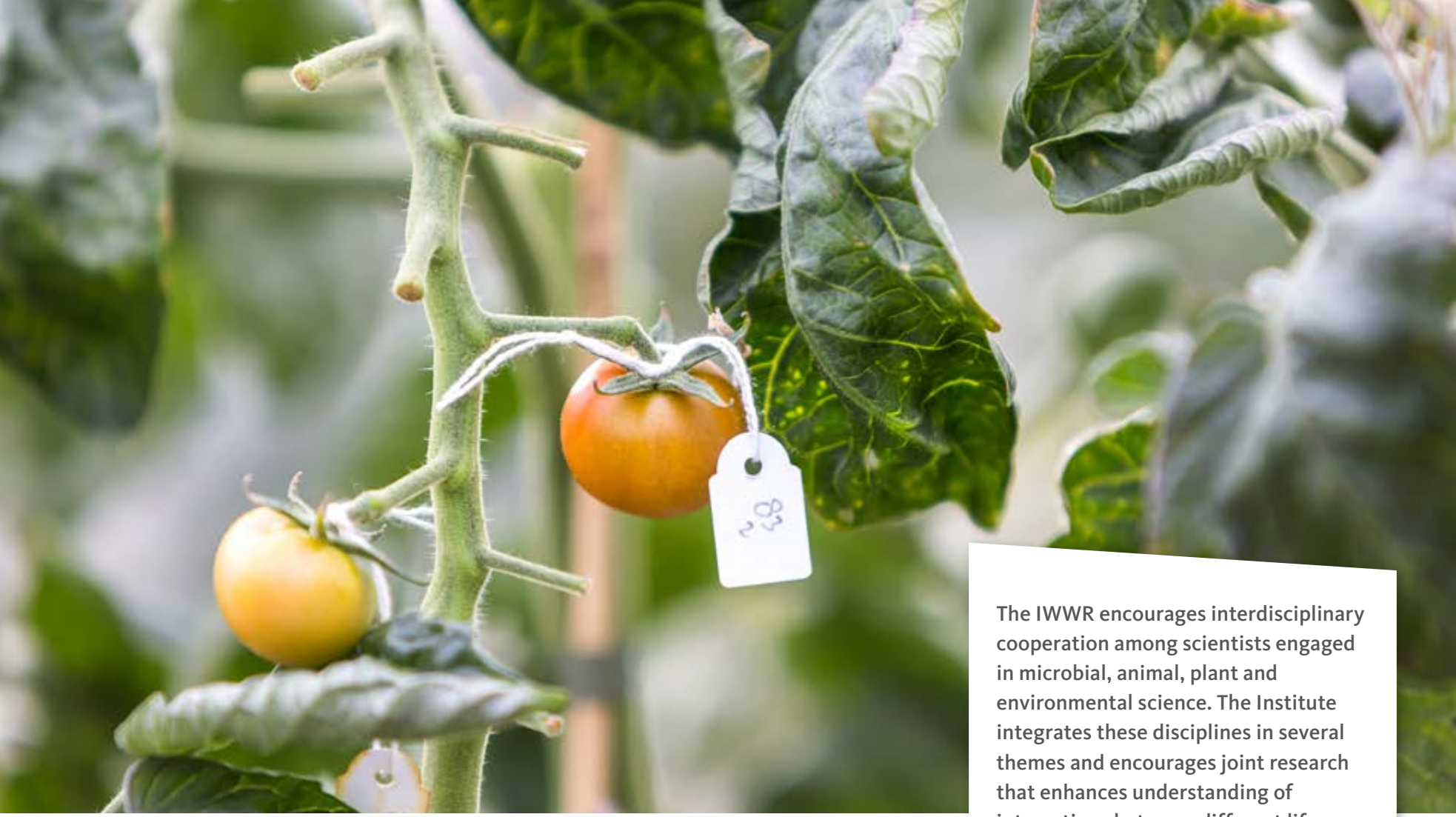


Institute for Water and Wetland Research

The IWWR encourages interdisciplinary cooperation among scientists engaged in microbial, animal, plant and environmental science. The Institute integrates these disciplines in several themes and encourages joint research that enhances understanding of interactions between different life forms as well as the way they interact with their habitats. Based on novel fundamental insights into these processes, the Institute makes a significant contribution to innovative solutions to urgent global water problems.

The main aim of IWWR is to become a world-class, multi-disciplinary institute for water and wetland research, with a strong emphasis on understanding the environmental stress responses and adaptations of wetland systems at various levels of organisation: from the cellular level via the organism to the ecosystem. Another important strand of research is explaining the ways in which plants, animals and micro-organisms adapt to changes in water quantity and quality from molecular mechanisms to changes on a global scale. In addition to discipline-specific research, there are five research themes, which focus on adaptations to stress and the conservation of wetland ecosystems. These themes highlight the multi-disciplinary nature of IWWR research and increase the visibility of the Institute, making it attractive for prospective Masters and PhD students, postdocs and tenure track scientists, as well as for collaborators and a range of other stakeholders.

These interdisciplinary themes are Microbial Biogeochemical Cycles, Plant Stress Responses, Animal Stress Responses, Conservation Biology and Human-Environment Interactions. Researchers working on each theme study mechanisms of adaptation to environmental stressors for particular sets of species or at particular levels of biological organisation. Researchers working within the Microbial Biogeochemical Cycles theme study the diversity and metabolism of aquatic micro-organisms, how they interact with plants and animals, and how they contribute to wetland biogeochemical cycles. In two themes (Plant Stress Responses and Animal Stress Responses) the focus is on mechanisms of stress adaptations at the organismal level in plants and animals, and how they scale up to encompass ecological responses by individuals and populations.

In Conservation Biology, the responses of animal and plant populations, species, communities and ecosystems to environmental change (*e.g.* hypoxia, warming and eutrophication) are examined, together with a variety of stakeholders, providing a scientific basis for conservation measures. In Human-Environment Interactions, the responses of numerous species – including humans – to multiple environmental stressors are investigated.

Intensive collaboration between people working on these themes has resulted in powerful interdisciplinary consortia that carry out top-level research. One of the centres of excellence at the University is Microbiology. They collaborate with experts covering a wide range of disciplines (Geology, Biochemistry, Structural Biology, Genetics and Metagenomics) including wetland bio-geochemists working on Microbial Biogeochemical Cycles. Researchers with a variety of disciplinary backgrounds collaborate in a similar way, creating opportunities for funding and novel research.

Research facilities

All research groups are housed in the Huygens Building, where they have access to state-of-the-art modern laboratory facilities and a central analytical service.
The equipment used includes:

- Radboud Experimental Garden, including a greenhouse, specifically designed for research together with climate room facilities, experimental fields, and the Phytotron, a unique national research facility for detailed ecological research on sub-surface processes of terrestrial and semi-aquatic vegetation.
- State-of-the-art light microscopy and electron microscopy facilities for ultrastructural analysis of micro-organisms, animals and plants.
- Extensive bioreactor and culture facilities for micro-organisms extended in 2014 with a brand new lab to accommodate the NWO Gravitation research of Microbiology wetland plants and animals, as well as for plant-soil interactions.

Staff

Prof. H.J.M. op den Camp (p)
Prof. N.M. van Dam (o)
Prof. G. Flik (o)
Prof. R.P.B. Foppen (o)
Prof. A.J. Hendriks (o)
Prof. P.M.J. Herman (e)
Prof. M.A.J. Huijbregts (p)
Prof. M.S.M. Jetten (o)
Prof. J.C.J.M. de Kroon (o)
Prof. L.P.M. Lamers (o)
Prof. C. Mariani (o)
Prof. L. Posthuma (e)
Prof. J.H.J. Schaminee (e)
Prof. H. Siepel (p)
Prof. A.J.P. Smolders (e)

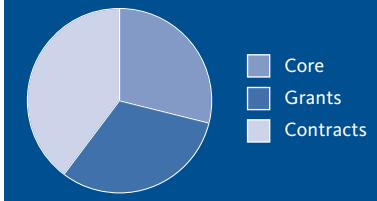
Tenured

Full Professors	4.3 FTE
Associate Professors	0.8 FTE
Assistant Professors	6.6 FTE
Researchers	1.6 FTE

Non-tenured

Researchers	23.4 FTE
Doctoral candidates	39.8 FTE

Research staff funding



- Gas Chromatography and Mass Spectrometry (equipped with a direct thermo-desorption unit).
- Large aquarium facilities for freshwater and seawater fish; for zebrafish research there is modern equipment, expertise and permits for producing transgenes.
- Extensive molecular biological facilities, used to perform quantitative RT PCR, RNA interference, Ion Torrent sequencing technology and *in-situ* hybridisation.
- Analytical equipment, including a High Pressure Liquid Chromatograph with photodiode array detection and Isotope Ratio Mass Spectrometry.

Collaboration

The following structural national collaborations include funding agencies:

- Radboudumc (NWO Gravitation grant SIAM)
- Delft University of Technology (NWO Gravitation grant SIAM, ERC)
- Wageningen University and Research, including Wageningen Environmental Research (Alterra) (NWO Gravitation grant SIAM, other NWO grants, STW GAP)
- Leiden University (STW GAP)
- University of Amsterdam (STW GAP)
- NIOZ Royal Netherlands Institute for Sea Research (NWO Gravitation grant NESSC, ERC, STW, NWO)
- University of Utrecht (NWO Gravitation grant NESSC, STW, NWO)
- University of Groningen (STW, NWO)
- Netherlands Institute of Ecology (NIOO) (NWO, Water Management authorities)
- B-Ware, spin-off company (provincial authorities, water management authorities, Ministry of Economic Affairs)
- Natuurplaza NGOs on campus (NWO)
- Institute for Public Health and the Environment (RIVM) (EU framework, H2020)
- Bayer Crop Science (Top sector H&S; NWO; STW)
- Bureau Waardenburg Ecology and Landscape (STW).

Internationally the Institute structurally collaborates with:

- Max Planck Institute for Marine Microbiology (Bremen)
- Max Planck Institute for Medical Research (Heidelberg)
- Max Planck Institute for Demography (Rostock)
- Duke University (Beaufort, NC, USA)
- University of Florida (Gainesville, FL, USA)
- University of Juiz de Fora, Brazil
- Uni Research AS (Bergen, Norway).
- Freie Universität Berlin (Germany)
- German Institute for integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

Dr Ivo Rieu (Assistant Professor) aims to elucidate the molecular basis of stress tolerance and to decipher the signalling pathways that regulate acclimation processes, in particular responses to heat stress. Exposure of plants to high ambient temperatures imposes constraints on growth and reproduction. Using a combination of phenotypic, cytological, physiological, genomic and genetic analyses, he determines which processes are most sensitive and which responses are adaptive. By studying the same processes in both model plants and crop species, he generates fundamental as well as applied knowledge. His results have been published in Plant Cell, Plant Physiology, Plant Journal and New Phytologist, among other journals.

Research results

IWWR microbiologists made several discoveries, most notably the use of iron as an electron acceptor by methanotrophic archaea (Ettwig *et al. PNAS*). These archaea appear to be very abundant in rice paddy fields (Vaksmaa *et al.* FEMS Ecology) and can also be used in more sustainable wastewater treatment. This finding received considerable media attention. The life cycle analysis of such a new type of waste water treatment plant was investigated together with IWWR environmental scientists (Hauck *et al.*). Further the complete metagenome of a full scale anammox waste water treatment plant was elucidated and published in *Nature communications* (Speth *et al.*).

IWWR aquatic ecologists further showed how keystone mutualisms can boost the resilience of coastal wetlands to drought, but also incur the risk of collapse (Angelini *et al., Nature Comm.*; De Fouw *et al., Curr. Biol.*). For freshwater systems, it was discovered that climate change could terminate unwanted algal blooms by stimulating fungal infection (Frenken *et al., Global Change Biol.*).

The animal physiologists of the institute are successfully using zebrafish as a model species for translational medicine, and in particular they applied studies on fish scales for bone formation and stress physiology (De Vrieze *et al., Bone*). The animal ecologists have shown for the first time that common bird populations are responding to climate change in a similar way in both Europe and the USA, as reported in Science this year

(Stephens *et al.*). Warm water speeds up the animals' metabolic need for oxygen to such an extent that it causes them to suffer from fatal respiratory distress (*Global Change Biology*).

Work by the plant geneticists and plant ecologists on the flooding tolerance of a wild Solanum species revealed habitat-induced genetic variation (Zhang *et al. J Ecol*) and signalling pathways regulating adaptive responses (Dawood *et al. Plant Physiol*; Nguyen *et al. Plant Cell Environm*). Studies on the effect of heat stress on pollen and fruit production, funded by the EU and NWO and in collaboration with seed companies, have generated insight into the genetics and physiology of this urgent problem in agriculture (*e.g.* Müller *et al. PLoS ONE*). In collaboration with colleagues at the Freie Universität Berlin, the plant scientists have discovered a hitherto unknown form of extra floral nectaries in *Solanum dulcamara* (Lorzing, Calf, *Nature Plants*), enhancing the fitness of the plants by increased ant activities.

The plant ecologists published a ground-breaking methodology (epiGBS) to map the genetic and epigenetic variation without prior knowledge of the genome, opening up new research on the genes that are affected by epigenetic modification of any organism (Van Gurp, Wagemaker *et al. Nature Methods*; together with researchers from NIOO). Together with the animal ecologists and international collaborators, a global comparison of plant life histories was published, showing how the fast-slow continuum in animals explains part of, but not all, the variation in plants (Salguero-Gomez *et al. PNAS*).

The environmental scientists concluded that human health is unlikely to be affected by the emission of pharmaceuticals which was investigated, but effects on the aquatic ecosystem cannot be ruled out (*cum laude* PhD thesis by Oldenkamp). Several papers listed

KEY PUBLICATIONS

- Angelini, C., Griffin, J.N., van de Koppel, J., Lamers, L.P.M., Smolders, A.J.P., Derksen-Hooijberg, M., Heide, T. van der & Silliman, B.R. (2016). A keystone mutualism underpins resilience of a coastal ecosystem to drought. *Nature Communications, 7*, 8-16.
- de Fouw, J., Govers, L.L., van de Koppel, J., van Belzen, J., Dorigo, W., Cheikh, M.A.S., Christianen, M.J.A, van der Reijden, K.J., van der Geest, M., Piersma, T., Smolders, A.J.P., Olff, H., Lamers, L.P.M., van Gils, J.A. & Heide, T. van der (2016). Drought, Mutualism Breakdown, and Landscape-Scale Degradation of Seagrass Beds. *Current Biology, 26*(8), 1051-1056.
- Ettwig, K.F., Zhu, B., Speth, D.R., Keltjens, J.T., Jetten, M.S. & Kartal, B. (2016). Archaea catalyze iron-dependent anaerobic oxidation of methane. *Proceedings of the National Academy of Science USA, 113*(45), 12792-12796.
- Kessel, M.A.H.J. van, Mesman, R., Arshad, A., Metz, J.R., Spanings, F.A.T., Dalen, S.C.M, Niftrik, L.A.M.P. van, Flik, G., Wendelaar Bonga, S.E., Jetten, M.S.M., Klaren, P.H.M. & Camp, H.J.M. op den (2016). Branchial nitrogen cycle symbionts can remove ammonia in fish gills. *Environmental Microbiology Reports, 8*(5), 590-594.
- Lenders, H.J.R., Chamuleau, T.P.M., Hendriks, A.J., Lauwerier, R., Leuven, R. & Verberk, W. (2016). Historical rise of waterpower initiated the collapse of salmon stocks. *Scientific Reports, 6*, 9-18.
- Lortzing, T., Calf, O.W., Bohlke, M., Schwachtje, J., Kopka, J., Geuss, D., Kosanke, S., Dam, N.M. van & Steppuhn, A. (2016). Extrafloral nectar secretion from wounds of Solanum dulcamara. *Nature Plants, 2*(5), 6-12.
- Nguyen, D., D'Agostino, N., Tytgat, T.O.G., Sun, P., Lortzing, T., Visser, E.J.W., Cristescu, S.M., Steppuhn, A., Mariani, C., Dam, N.M. van & Rieu, I. (2016). Drought and flooding have distinct effects on herbivore-induced responses and resistance in Solanum dulcamara. *Plant, Cell and Environment, 39*(7), 1485-1499.
- Salguero-Gomez, R., Jones, O.R., Jongejans, E., Blomberg, S.P., Hodgson, D.J., Mbeau-Ache, C., Zuidema, P.A., de Kroon, H. & Buckley, Y.M. (2016). Fast-slow continuum and reproductive strategies structure plant life-history variation worldwide. *Proceedings of the National Academy of Science USA, 113*(1), 230-235.
- Schipper, A.M., Belmaker, J., de Miranda, M.D., Navarro, L.M., Böhning-Gaese, K., Costello, M.J., Dornelas, M., Foppen, R.P.B., Hortal, J., Huijbregts, M.A.J., Martín-López, B., Pettorelli, N., Queiroz, C., Rossberg, A.G., Santini, L., Schiffers, K., Steinmann, Z.J.N., Visconti, P., Rondinini, C. & Pereira, H.M. (2016). Contrasting changes in the abundance and diversity of North American bird assemblages from 1971 to 2010. *Global Change Biology, 22*(12), 3948-3959.
- Speth, D.R., Zandt, M.H. in 't, Guerrero Cruz, S., Dutilh, B.E & Jetten, M.S.M. (2016). Genome-based microbial ecology of anammox granules in a full-scale wastewater treatment system. *Nature Communications, 7*, 11172-11181.

KEY PUBLICATIONS

- Stephens, P.A., Mason, L.R., Green, R.E., Gregory, R.D., Sauer, J.R., Alison, J., Aunins, A., Brotons, L., Butchart, S.H.M., Campedelli, T., Chodkiewicz, T., Chylarecki, P., Crowe, O., Elts, J., Escandell, V., Foppen, R.P.B., Heldbjerg, H., Herrando, S., Husby, M., Jiguet, F., Lehikoinen, A., Lindström, Å., Noble, D.G., Paquet, J.-Y., Reif, J., Sattler, T., Szép, T., Teufelbauer, N., Trautmann, S., van Strien, A.J., Turnhout, C.A.M. van, Vorisek, P. & Willis, S.G. (2016). Consistent response of bird populations to climate change on two continents. *Science, 352*(6281), 84-87.
- van Gurp, T.P., Wagemaker, N., Wouters, B., Vergeer, P, Ouborg, N.J. & Verhoeven, K.J.F. (2016). epiGBS: reference-free reduced representation bisulfite sequencing. *Nature Methods, 13*(4), 322-324.
- Verberk, W.C.E.P., Durance, I., Vaughan, I.P. & Ormerod, S.J. (2016). Field and laboratory studies reveal interacting effects of stream oxygenation and warming on aquatic ectotherms. *Global Change Biology, 10*.
- Welte, C.U. (2016). A microbial route from coal to gas. *Science, 354*(6309), 184-184.
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Dissertations	**14**
Scientific publications	**240**
Professional publications	**2**

bottlenecks for estuary restoration as well as ways to avoid invasive species in the field of river conservation. Historic salmon decline was attributed to water mill development, replacing pollution and overfishing as traditional explanations (Lenders *et al., Scientific Reports*). Likewise, DDT and PCBs turned out to be the main threat for polar bears rather than hunting and climate change.

Societal impact

The IWWR contributes to solutions for some of the most pressing water problems in the world. It does so by establishing close relationships based on novel insights between researchers at the Institute and external stakeholders. Such intensive interactions lead to solutions for urgent societal problems as well as new fundamental research. Novel insights into nature and water management are applied in collaborative studies with governmental and non-governmental organisations, water boards, as well as national, regional and local authorities.

The IWWR collaborates with a large number of companies and partners engaged in nature and water management. The microbiologists showed that anammox bacteria can remove nitrogen compounds from wastewater at low temperatures, using both ammonium and methane as an electron donor, thus considerably extending the application of these processes in municipal wastewater treatment systems. This work is boosted by an STW and an NWO Gravitation grant.

Collaboration within the Institute opens up avenues for novel interdisciplinary research as well as more opportunities for knowledge transfer and application. In the context of the Dutch 'Top' sectors that have been identified by the government as being of great economic significance, new collaborative research projects have started. Researchers working on plant stress responses are working with several companies on multiple plant stressors and they have obtained substantial grants from the Top sector Agrofood and Horticulture and the Dutch Foundation for Applied Research (STW). Research on the Animal Stress Responses theme continues to attract interest from fish aquaculture practices in the Netherlands and abroad, contributing significantly to discussions on fish welfare, including an advisory role in the Eurogroup for Animals in Brussels.

The Aquatic Ecology and Environmental Biology group and its spin-off company B-WARE Research Centre have a longstanding tradition in applied research on global environmental issues, which can be used directly in water and nature management. In 2016, recent applications of aquatic ecology include sustainable wetland agriculture (paludiculture), circular economy in water treatment, and the use of biodegradable structures for ecosystem restoration.

Applications in nature management exemplify the societal impact of the Conservation Biology theme at IWWR. After a ground-breaking *Nature* publication on the decline in bird species in relation to neonicotinoid insecticides which resulted, for example, in questions in the Dutch parliament, new work was started to explain the cause-and-effect relationships. This requires more work on insect abundance in relation to neonicotinoid pollution, as a decline in insects is a likely cause of the decline in bird numbers. Funded by grants from the Triodos Foundation and NWO, this new work is relevant for policy makers and the general public.

IWWR Environmental Science obtained an EU Marie Curie grant for five PhD projects, in cooperation with Unilever UK. The objective is to develop environmental footprints for consumer production, with a specific focus on energy, water, land and chemicals. Likewise, funding from the Dutch government was obtained to study and regulate invasive species.

Future research

The microbiologists at IWWR will continue to investigate the role of anaerobic methane and ammonium oxidising bacteria in marine and freshwater ecosystems, both in laboratory bioreactors and natural oxygen-limited ecosystems. The fate of methane in various wetland and volcanic ecosystems will be assessed using stable isotopes as well as molecular and environmental genomic methods, supported by an ERC Advanced Grant (Prof. Huub Op den Camp). From 2017 onwards, the new Radboud Excellence Initiative fellow Christian Jogler and his team will join the microbiologists to form a centre for planctomycetes research.

Aquatic Ecology and Environmental Biology will extend their applied research to include novel applications related to the restoration of disturbed wetlands (*e.g.* the Wadden Sea, Markermeer, peatlands and lakes), wet agriculture (paludiculture), the integration of water purification, phosphorus recycling and yield of high-grade products, and coastal protection.

The plant groups will study the responses of plants to a range of environmental stressors and link these to ecological or agricultural performance. A novel application explored by the plant ecologists is to translate their insights in root and community ecology into the management of dike grasslands. A new consortium with Dutch water boards and companies is being formed recommend new seed mixtures as well as measures for dike construction and maintenance.

The Organismal Animal Physiologists continue to work on topics related to fish aquaculture and welfare. Facilities to study fish behaviour (zebrafish phenotyping) are being explored in conjunction with companies and clinical groups at the Radboudumc. The group will intensify its research on energy and oxygen availability by increasing collaboration with the Animal Ecology group at IWWR.

The animal ecologists at IWWR will study the responses of aquatic ectotherms to changing water temperature and oxygen concentrations, using a combination of experiments and models. Eco-evolutionary population models will be used to reveal the relative importance of phenotypic plasticity and rapid evolution for stochastic population dynamics and resilience. Experiments will test whether oxygen dynamics mechanistically drive thermal performance responses in growth, maturation and reproduction.

The environmental scientists at IWWR intend to report global estimates of changes in land use (Life Cycle Analysis). They will continue to work on the fate, accumulation and toxicity of nanoparticles and pharmaceuticals, on arctic species, as well as on linking the extinction of species to historical data and understanding the impact of longitudinal dam constructions in rivers.

Director Professor
Hans de Kroon

Hans de Kroon has been Professor of Experimental Plant Ecology at Radboud University since 2000. He graduated from Utrecht University, has worked at several institutes in the USA and was an Associate Professor at Wageningen University. He specializes in below-ground traits of plants and has built the innovative experimental facility, the Nijmegen Phytotron. Another of his research interests is population modelling, which is increasingly being applied with partners from Natuurplaza on the campus. This collaboration resulted in a paper in *Nature* in 2014 on the relationship between neonicotinoid insecticides and the decline of birds. The paper, which had considerable impact around the world, led to Prof. de Kroon receiving the university's Hermesdorf Award in January 2015.

Awards

- Wilco Verberk was awarded a prestigious Vidi grant from the Netherlands Organisation for Scientific Research.
- Mike Jetten was elected as a member of the European Academy of Microbiology.
- Sebastian Luecker received the Antonie van Leeuwenhoek Prize for Best Microbial Postdoc.
- Muriel van Teeseling received the Westerdijk Award for Best Microbial PhD Thesis and an EMBO Fellowship.
- Daan Speth received a Rubicon Fellowship.
- Eric Hester received the Kiem Award for Best 1st Author Microbiology PhD Paper.
- Rob Schmitz received the Darwin Prize for Best Biology Masters Thesis. ‹

Institute for Water and Wetland Research

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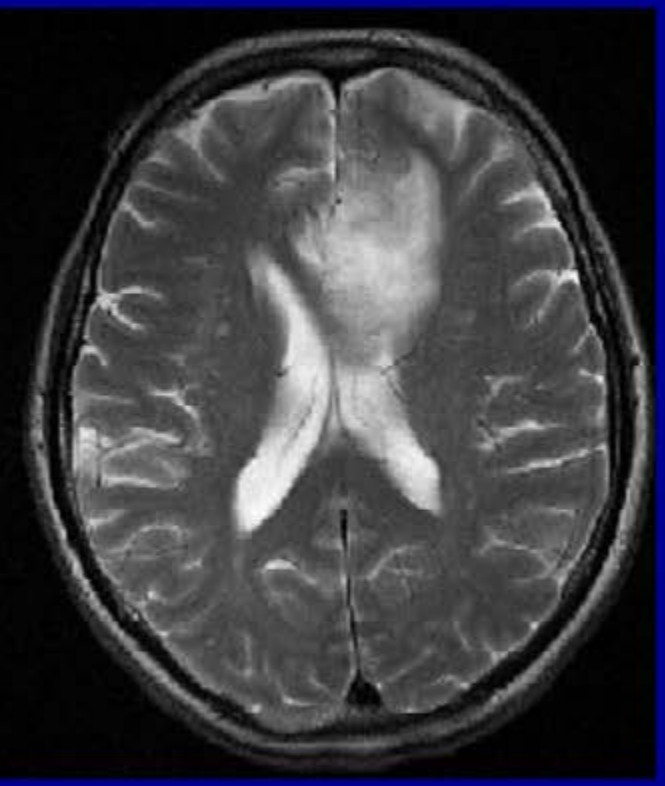
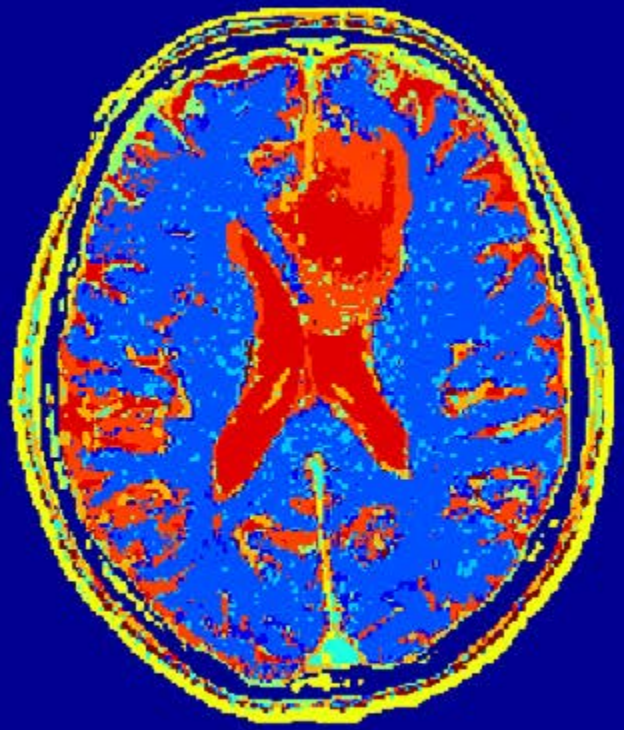
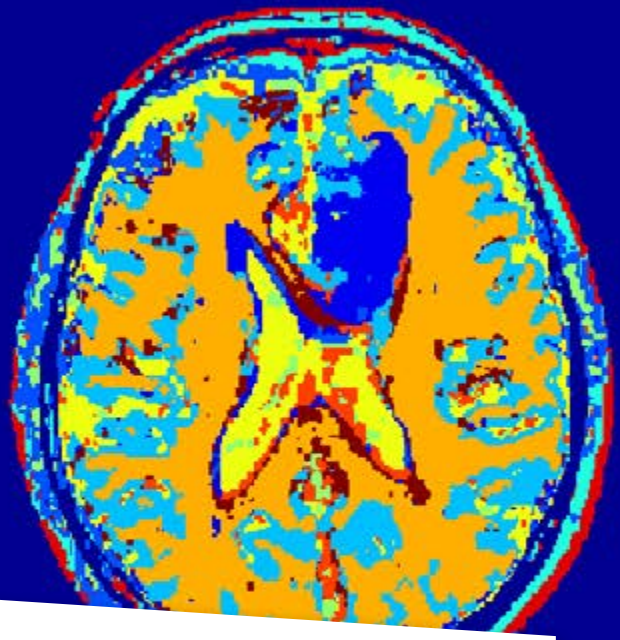






Institute for Molecules and Materials

The Institute for Molecules and Materials (IMM) is an interdisciplinary institute that is engaged in research in chemistry and physics at the university. Its mission is to perform fundamental research in order to better understand, design and control the functioning of molecules and materials. The institute is a centre of excellence that trains the next generation of leaders in science and entrepreneurship. Its staff actively explores and promotes interaction with industry and the application of its research results.

The IMM, which is composed of twenty-two research groups, employs around 150 PhD students and every year some 30 of them graduate. There is a strong emphasis on interdisciplinary research involving theorists and experimentalists as well as physicists and chemists. Research is focused on three themes:

1 Structure and Dynamics of Molecules
2 Chemistry and Spectroscopy of Complex Molecular Systems
3 Quantum Matter

Structure and Dynamics of Molecules

Achieving a detailed understanding of interactions between individual molecules is of great importance to physics and chemistry. Within this research theme the aim is to unravel the interactions of molecules by building on a fundamental understanding of molecular structures. Processes that are studied include motions within molecules and biomolecules, as well as collisions and chemical reactions. Experiments are often based on advanced spectroscopic techniques such as Nuclear Magnetic Resonance and various laser techniques.

Chemistry and Spectroscopy of Complex Molecular Systems

Within this theme, the researchers are inspired by the chemistry in living cells. The next challenge in chemistry is to move away from studying isolated molecules and (diluted) reactions to mastering chemical processes in cells that contain mixtures of compounds with high overall concentrations. The aim is to design and synthesise chemical reaction networks, and study the complexity and functions that emerge in systems chemistry. Industrial and catalytic processes could benefit from this research, as they often take place under high concentrations and/or temperatures.

Quantum Matter

The goal within this research theme is to understand and develop new materials and concepts based on collective, emergent quantum effects. The main aim is to understand how properties of materials can be manipulated by changes at the atomic scale. More specifically, there is a focus on the new quantum phases that emerge in strongly non-equilibrium phases, at material interfaces, and in lower dimensional systems such as graphene. The research includes studying the robustness of superconductivity and modifications to magnetism, as well as modifications to electronic degrees of freedom.

Research facilities

The national and international position of the IMM is enhanced by the availability of a number of large-scale experimental research facilities, including:

- A High Field Magnet Laboratory (HFML) for continuous fields up to 37.5 Tesla. A hybrid magnet for achieving 45 Tesla is being constructed.
- The FELIX (Free Electron Lasers for Infrared eXperiments) Laboratory. The infrared lasers (FEL-1/FEL-2/FELICE) and the Terahertz laser (FLARE) are fully tunable between 3 and 1500 microns.
- The combination of FELIX and HFML offers scientists the opportunity to study matter and materials under conditions that cannot be found anywhere else in the world.
- The Solid-State NMR Facility for advanced material science, including a wide-bore 20 T (850 MHz) NMR instrument and high-field liquid-state NMR facilities up to 800 MHz.
- A Scanning Probe Microscopy laboratory capable of a wide range of Scanning Tunnelling Microscopy and Atomic Force Microscopy techniques.
- A Trace Gas Facility for applying laser diagnostics in biology and medicine.

Staff

Prof. A. Bax (e)
Prof. F.M. Bickelhaupt (e)
Prof. L.M.C. Buydens (o)
Prof. P.C.M. Christianen (o)
Prof. A. Fasolino (p)
Prof. A.K. Geim (e)
Prof. G.C. Groenenboom (o)
Prof. J.C.M. van Hest (o)
Prof. W.T.S. Huck (o)
Prof. N.E. Hussey (o)
Prof. M.I. Katsnelson (o)
Prof. A.P.M. Kentgens (o)
Prof. A.A. Khajetoorians (o)
Prof. A.I. Kirilyuk (p)
Prof. J.C. Maan (o)
Prof. S.Y.T. van de Meerakker (o)
Prof. G.J.M. Meijer (p)
Prof. R.J.M. Nolte (o)
Prof. K.S. Novoselov (e)
Prof. J. Oomens (p)
Prof. D.H. Parker (o)
Prof. G.J.M. Pruijn (o)
Prof. T.H.M. Rasing (o)
Prof. A.E. Rowan (o)
Prof. F.P.J.T. Rutjes (o)
Prof. H.W.M. Salemink (e)
Prof. E. Vlieg (o)

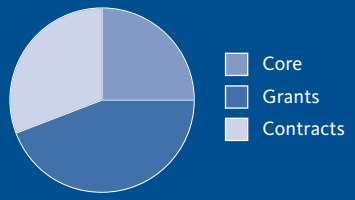
Tenured

Full Professors	10.0 FTE
Associate Professors	2.0 FTE
Assistant Professors	9.8 FTE
Researchers	3.2 FTE

Non-tenured

Researchers	57.8 FTE
Doctoral candidates	109.6 FTE

Research staff funding



Collaboration

The IMM groups collaborate extensively with other groups within IMM, the university and the Radboudumc and they collaborate within national and international programmes. A few examples:

- IMM coordinates the NWO Gravitation programme 'Research Center for Functional Molecular Systems' in which the organic chemistry groups at IMM collaborate with the Institute for Complex Molecular Systems at Eindhoven University of Technology and the Stratingh Institute for Chemistry at the University of Groningen to construct functional life-like molecular systems.
- The NMR facilities are a key component within the uNMR-NL cluster, which is part of the NWO National Roadmap for large-scale infrastructures. The solid-state NMR group is active in the Dutch Polymer Institute (DPI).
- Four research groups at IMM (Analytical Chemistry, Molecular and Laser Physics, NMR, Molecular Structure and Dynamics/FELIX) are involved in TA-COAST: the public-private partnership for innovating analytical science and technology in the Netherlands.
- Groups are involved in the Dutch Astrochemistry Network in order to study the origin and evolution of molecules in space.
- The large pan-European partnership focusing on innovation in 'raw materials' (RawMatTERS).
- IMM groups are involved in various EU-Horizon2020 consortia.
- The IMM is a partner in two formal collaborations with the Foundation for Fundamental Research on Matter (FOM), working on:
  - The exploitation of the free electron lasers 'FELIX and FELICE' in Nijmegen
  - The joint running of the HFML and promotion of materials research involving high magnetic fields.
- HFML coordinates the European Magnet Field Laboratory (EMFL), which develops and operates world-class high magnetic field facilities.
- The Engineering and Physical Sciences Research Council (UK) has an access contract for using the free electron lasers at FELIX and a distributed research grant for solid-state physics done at the University of Surrey.
- Within graphene research, the groups led by Profs. Katsnelson and Maan collaborate closely with their ex-colleagues Radboud Extraordinary Professors Geim and Novoselov (now professors at the University of Manchester).
- The SPM group led by Prof. Alex Khajetoorians is part of the VILLUM Centre of Excellence for Dirac Materials of Aarhus University.

Research results

Highlights are listed below under the Institute's three main research themes.

Structure and Dynamics of Molecules

Prof. Bas van de Meerakker and his colleagues (Spectroscopy of Cold Molecules) measured irregular diffraction patterns for inelastic collisions between NO radicals and rare gas atoms. These patterns revealed a new type of quantum stereodynamics that has no classical analogue or interpretation (*Nature Chemistry*).

Prof. David Parker and his Molecular and Laser Physics group have applied velocity map imaging for the first time to study UV desorption of molecular ices (submitted). Dr Frans Harren and his group have identified Pseudomonas aeruginosa and Aspergillus fumigatus mono- and co-cultures based on volatile biomarker combinations *(Journal of Breath Research)*.

The Molecular and Biophysics group (Dr Anouk Rijs) and her collaborators from the University of Gothenburg, have developed a new infrared spectroscopy technique, which significantly extends the scope of the molecules that can be studied in the gas phase. It is particularly suitable for neutral peptide molecules that lack an ultra-violet (UV) chromophore (*Phys. Rev. Lett.*).

The Molecular Structure and Dynamics (MSD) group led by Prof. Jos Oomens uses the radiation from FELIX to record IR spectra of a wide variety of ultra-low density samples in tandem mass spectrometers. The IR spectra provide detailed information on molecular structures that is not available from the mass spectra alone. The group is now able to routinely record IR spectra with the sensitivity and selectivity of mass spectrometry (*Nature Communications*).

The FELIX Users and Operators group, which is led by Dr Britta Redlich, has, in collaboration with groups from the UK, designed a modified pump-probe experiment to investigate coherent dynamics and demonstrated their capabilities with a measurement of the inhomogeneous dephasing time for phosphorous impurities in silicon (*Phys. Rev. B*).

Dr Lex van der Meer's FELIX FEL Technology group has constructed a bridge between the optical transport systems of FLARE and FELIX. This allows the light from FEL-1 and FEL-2 to be coupled to the part of the FLARE transport system that connects the FELIX with HFML. The first successful experiments in which THz radiation from FEL-1 was used in the 33-T magnet have been performed.

Within the Theoretical Chemistry group, Prof. Gerrit Groenenboom and his colleagues have developed a theoretical method for studying collisions of electronically excited molecules (*J. Chem. Phys.*). Dr Herma Cuppen and her colleagues have shown that solid-to-solid phase transition in molecular crystals can indeed proceed through cooperative motion (*Cryst. Eng. Comm.*).

The solid-state NMR group (Prof. Arno Kentgens) and the Theoretical Chemistry group (Dr Gilles de Wijs) have performed NMR, NQR and DFT studies in order to better understand the structure and dynamics of methylammonium lead halide perovskites (*J. Phys. Chem. Lett.*)

Chemistry and Spectroscopy of Complex Molecular Systems

In collaboration with the group led by Prof. Jan van Hest, Prof. Ger Pruijn and his colleagues at Biomolecular Chemistry have developed a molecular zipper-based approach to immobilising proteins at predefined positions on a solid surface. This approach is widely applicable for analysing biomolecular interactions (Analyst). Dr Kim Bonger and her colleagues explored a novel bio-orthogonal reaction for the chemical modification of biomolecules (*Angewandte Chemie Int. Ed.*).

Dr Daniela Wilson and her team (Bio-organic Chemistry) developed nanorockets with a molecularly built temperature-responsive braking system consisting of brushes made of polymers, enabling the rockets to start and stop at desired locations. The brushes swell or collapse in response to temperature, thus regulating access to hydrogen peroxide, which fuels the nanorockets (*Nature Chemistry*).

The Huck group (Physical Organic Chemistry) developed a new method for creating monodisperse liposomes using microfluidics. These liposomes are important building blocks for the creation of artificial cells. (*J. Am. Chem. Soc.*).

The Synthetic Organic Chemistry group led by Prof. Floris Rutjes has discovered a new method and mechanism for the stereo-selective synthesis of beta-mannose/mannuronic acid esters. This is a highly challenging linkage to synthesise, which can lead to biologically relevant sugar-based biomolecules (*Angewandte Chemie International Edition*).

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Dissertations	**29**
Scientific publications	**402**
Professional publications	**1**
Patents	**4**

The Biophysical Chemistry group (Dr Hans Heus) developed a new DNA-responsive hydrogel. By incorporating DNA aptamers that target cell receptors, the hydrogel can be used to control cellular behaviour from the outside in (Advanced Functional Materials).

Researchers in the Solid State Chemistry group led by Prof. Elias Vlieg designed a comprehensive classification system for multicomponent crystals. Classification may seem to be an old-fashioned topic in science, but it is highly relevant for the pharmaceutical industry because of patent issues (*Cryst. Growth. Des.*).

The group led by Prof. Lutgarde Buydens and Dr Jeroen Jansen (Analytical Chemistry) has developed a data analysis method for extending the technical potential of Multicolour Flow Cytometry, by pinpointing the specific cells in a blood sample that are related to an immune response. They have patented the method and developed a user-friendly interface so that it can be used by medical researchers (*Chemom. Intell. Lab. Syst.*).

The group led by Prof. Roeland Nolte (Molecular Nanotechnology), in collaboration with a group led by Prof He Tian at the East China University of Science and Technology in Shanghai, China, has developed a new supramolecular system which displays tunable multicolour photoluminescence, including the emission of pure white light (*J. Am. Chem. Soc.*).

Dr Paul Kouwer and the Molecular Materials team developed new approaches to hierarchically organising functional materials on substrates. They used liquid crystal templating, found ways to create complex structures from dilute aqueous solutions and were able to manipulate their organisation by external fields. (*Adv. Funct. Mater.* and a patent application).

Prof. Peter Christianen and his colleagues (Soft Condensed Matter & Nanomaterials, HFML) have discovered a new polymorph of coronene which is grown at high magnetic fields (*Nature Communications*). In collaboration with Biophysical Chemistry (Prof. Jan van Hest and Dr Daniela Wilson) they have developed a novel method for fabricating polymersomes of different shapes, which are promising for application as nanocontainers and in drug delivery (*Nature Communications*).

Prof. Lutgarde Buydens (Analytical Chemistry) does research on data analysis. This ranges from simple visualisation of data to prediction of, for instance, concentrations, and finding biologically interesting molecules in complex mixtures. She is one of the most influential analytical chemists in the world and is treasurer of TA-COAST, a public-private partnership which was established to strengthen analytical science in the Netherlands by bringing together R&D, human capital and infrastructure. In 2016, Prof. Buydens was elected to the Academia Europaea. Since September 2016, Prof. Buydens has been Dean of the Faculty of Science.

Quantum Matter

The group led by Prof. Nigel Hussey (Correlated Electron Systems, HFML) has explored members of the delafossite family PdCoO2 and PdCrO2, revealing the presence of an anomalous magnetothermopower (*Phys. Rev. Lett.)*, evidence for the chiral anomaly often associated with Weyl semi-metals (*Nature Communications*), and the loss of interlayer coherence at a magnetic transition (*Nature Communications, in press*).

New materials sometimes exhibit spectacular resistance phenomena. However, in a recent experiment in a well understood ultra-high mobility GaAs quantum well, the SCNS group led by Uli Zeitler demonstrated that a simple physical model is sufficient to explain the phenomenon of linear magnetoresistance. This showed that exotic explanations for spectacular phenomena do not always provide the right answer (*Physical Review Letters*).

The Spectroscopy of Surfaces and Interfaces group (Prof. Theo Rasing and Dr Alexey Kimel) discovered Femtosecond optical control of spin-polarised currents in magnetic nanostructures without the need for any applied voltage, which opens the way for future studies of THz spintronics (*Nature-Nano)*.

Prof. Andrei Kirilyuk and his Atomic Nanostructures group, in collaboration with the Theory of Condensed Matter group, discovered novel behaviour of magnetic exchange interactions at the sub-nanometre scale. This discovery relates the magnetic interactions with the electronic structure of nanomaterials, and paves the way for creating novel magnetic materials by design (*Scientific Reports*).

Members of the Theory of Condensed Matter group (Prof. Mischa Katsnelson) studied mechanisms that limit charge carrier mobility in a novel 2D material: phosphorene, single-layer black phosphorus. Using a combination of membrane theory and first-principles computations, they found that in-plane vibrations of phosphorus atoms are the main factor determining intrinsic mobility in phosphorene. These results are practically important as they establish a fundamental limit for the performance of phosphorene-based devices (*Physical Review Letters*).

In 2016, members of the SPM department (Prof. Alex Khajetoorians) completed construction of two new state-of-the-art cryogenic scanning tunnelling microscopes, which operate in UHV and in a magnetic field, with temperatures down to 30mK. In addition, they published two prominent *Nature Communication* papers on understanding the magnetism of individual atoms and the chiral interactions between them, and they published characterisations of various 2D materials, including MoS2 and TaS2, in collaboration with Aarhus University.

Prof. Peter Christianen and his colleagues (Soft Condensed Matter & Nanomaterials, HFML) published three linked papers on the magneto-optical properties of excitons in the single-layer transition-metal dichalcogenide WS2 (*Physical Review Letters, Nature Communications, Nano Letters*), a novel two-dimensional semiconductor that has promising properties for opto-electronic applications.

The Applied Materials Science group (led by Dr John Schermer) worked on a new deep-junction structure for high-efficiency III-V solar cells. Compared to the commonly used shallow-junction design, deep-junction

GaAs cells were shown to yield significantly reduced levels of non-radiative recombination. As a result the cell efficiency was raised from 25.8% to 26.5% (*Phys. Status Solidi A*).

Awards and grants

In 2016 Prof. Wilhelm Huck (Physical Organic Chemistry) was awarded the Spinoza Prize – the highest award in Dutch science for his research into the physical-organic, chemical and biological processes that take place in human cells.

Prof. Jan van Hest (Bio-Organic Chemistry) was awarded an ERC Advanced Grant to make artificial cells and cell components. Dr Jasmin Mecinovic (Synthetic Organic Chemistry) was awarded an ERC Starting Grant to improve understanding of genuinely important biomolecular processes in epigenetics that play essential roles in human health and disease. Dr Daniela Wilson (Bio-Organic chemistry) received an NWO Vidi award to develop nanomotors for disease detection and treatment. Dr Johan Mentink (Spectroscopy of Solids and Interfaces) received funding for a tenure track to carry out theoretical research on laser manipulation of magnets and thus increase the energy efficiency of data centres.

A FOM programme was awarded to Nigel Hussey (HFML) for research on 'strange metals'. FOM projectruimte grants were awarded to Bas van de Meerakker, Alexey Kimel, Alex Khajetoorians and Shengjun Yuan. Marie Skłodowska-Curie ITN were awarded to Elias Vlieg, Hugo Meekes (both Solid State Chemistry) and Floris Rutjes (Synthetic Organic Chemistry) and to Simona Cristescu (Trace Gas Facility). Dr Frans Harren (Trace Gas Facility) received an Interreg grant and an H2020 grant and Prof. Floris Rutjes received an EFRO grant. Jeroen Jansen was awarded an ISPT grant. Both Prof. Theo Rasing (Spectroscopy of Solids and Interfaces) and Prof. Peter Christianen (Soft Condensed Matter & Nanomaterials, HFML) were awarded a FET open grant. A KWF grant was given to Hans Heus (Biophysical Chemistry) and Alan Rowan (Molecular Materials). Dr Shengjun Yuan (Theory of Condensed Matter) received a Take-Off grant from the Dutch Technology Foundation STW.

Prof. Misha Katsnelson received the Hamburg prize for Theoretical Physics. Dr Anouk Rijs (Molecular and Biophysics/FELIX) was awarded the Minerva Prize for the best physics publication. Prof. Lutgarde Buydens (Analytical Chemistry) was elected member of the Academia Europaea. She also became dean of the Faculty of Science. Prof. Floris Rutjes (Synthetic Organic Chemistry) was elected as chairman of the KNCV, the Dutch chemistry association. Prof. Dave Parker (Molecular Laser Physics) was elected as a member of the American Physics Association. Tijs Karman, a PhD student in the department of Theoretical Chemistry, was offered a position as a visiting graduate student in the Harvard-Smithsonian Center for Astrophysics. Dr Daniela Wilson (Bio-Organic Chemistry) received the NML Researcher Award for research excellence in the field of nano- and micro-science. Prof. Bas van de Meerakker (Spectroscopy of Cold Molecules) received the Zdenek Herman MOLEC Young Scientist Prize. The Chemometric and Intelligent Laboratory Systems Award was given to Dr Jeroen Jansen (Analytical Chemistry). Dr Alix McCollam (HFML) was the recipient of the 2016 EMFL Prize. Peter Claus (Molecular & Laser Physics) was awarded the Prof. Jan Trooster-prize for his invention of the 'Nijmegen Pulsed Valve'. Anne Neerincx (Molecular and Laser Physics) won the grand finale of 'Radboud Talks' in Lux Theatre Nijmegen. Boy Lankhaar, Masters student in the Theoretical Chemistry group, received the Golden Master Award for the best Masters thesis in chemistry from the KNCV and the Unilever Research Prize was awarded to Masters student Elias Post (Synthetic Organic Chemistry).

Director Professor Theo Rasing

Theo Rasing is Professor of Experimental Physics and has a strong interest in light-matter interaction for efficient and fast data manipulation. He is a Spinoza laureate, an elected member of the KNAW and the Academia Europaea and recipient of an ERC Advanced Grant. To date, his research has yielded more than 450 publications with over 10,000 citations. He is also the initiator and coordinator of various large national and international partnerships and a member of the FOM Executive board. Prof. Rasing is keen on bridging the gap between research and society by participating in public debates and delivering popular lectures for general audiences.

The Radboud Education Prize went to Dr Steffen Wiedmann (HFML) and Dr Alix McCollam (HFML) has won the education award from the Faculty of Science at Radboud University.

Societal impact

IMM trains the next generation of leaders in science and entrepreneurship, thus contributing to society by providing industry, academia and other institutions with highly qualified personnel with the ability to work in interdisciplinary settings. IMM collaborates with leading companies, including AkzoNobel, ASML, Corbion, DSM, Friesland Campina, Huntsman, NXP, Philips, Shell, Solvay, Teijin, Hitachi and Unilever. In addition, IMM collaborates with (local) SMEs and the Institute has given birth to many spin-off companies. Research in the IMM focuses on societally relevant problems, such as faster and more energy-efficient ways of computing, transferring and storing data, more efficient chemical reactors and molecular quantum devices, as well as new methods for drug delivery. At IMM innovative products have been co-discovered and developed, including graphene, ultrafast switchable magnetic materials, solar cells and hydrogels for biomedical applications. High-quality equipment and state-of-the-art research facilities contribute substantially to technological and social innovation. IMM plays an important role in this respect. HFML, FELIX and the NMR facilities are part of the National Roadmap for Large-Scale Scientific Infrastructure.

In addition, IMM shares its fascination with groundbreaking research with others by co-organising open days, guided lab tours and giving dedicated lectures. When Scientific Advisory Board Member Prof. Ben Feringa (University of Groningen) received the Nobel Prize in Chemistry, IMM co-organised – in collaboration with Radboud Reflects – a public lecture on the scope of his research. IMM also organises summer schools and participates in pre-university college education. Finally, IMM seeks contact with the popular scientific (web-based) media, such as Kennislink, as well as newspapers.

Future research

The fact that HFML/FELIX and the NMR facilities are part of the National Roadmap for Large-Scale Scientific Infrastructure provides opportunities for future funding. The European Magnetic Field Laboratory (EMFL) – of which the Nijmegen High Field Magnet Laboratory (HFML) is part – was awarded the Landmark status by the European Strategy Forum on Research Infrastructures (ESFRI).

The NWO-BIG grant in 2006 for the Nijmegen Centre for Advanced Spectroscopy (NCAS) provided the resources IMM needs to construct both a 45 Tesla hybrid magnet for the HFML (this will be ready in 2018) and a Free Electron Laser for research using Terahertz radiation (FLARE). The coupling of the FELIX infrared and THz laser radiation to the 33 T HFML high-field magnet provides a unique experimental set up, which IMM will continue to exploit in 2017.

The NWO 'Gravitation' Research Centre for Functional Molecular Systems – in collaboration with partners in Eindhoven and Groningen – was positively evaluated §in 2016 and the remaining funding was made available. The Radboud Nanomedicine Alliance, a joint initiative of Radboudumc, NCMLS, and IMM, focuses on developing new, more effective medicines and materials for the treatment of diseases, tailored to the needs of individual patients.

The IMM will actively pursue R&D funds that are available in the region (EFRO and Euregio) and will apply for funding from the Dutch 'Top' sectors. Moreover, IMM aims to acquire funding for societal challenges within the European Framework Programme and researchers will be encouraged to apply for individual grants.

Integrity

IMM follows 'The Netherlands Code of Conduct for Scientific Practice'. Each new staff member is explicitly made aware of this document in the welcome letter they receive, and the code is listed on the IMM website. Implementation of this code is the task of senior researchers. Thematic afternoons on scientific integrity are organised and a course on this topic for all PhD students is being developed as part of their education programme. ‹

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This first *MeerLICHT* telescope (prototype) will couple one of the *BlackGEM* telescopes to the *MeerKAT* radio array, allowing simultaneous study of skies using optical and radio techniques.

Institute for Mathematics, Astrophysics and Particle Physics

The Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) carries out fundamental research in mathematics, high-energy physics and astrophysics, with a special focus on interdisciplinary topics.
The overarching research theme is the origin and evolution of the universe and its underlying mathematical structures.
The Institute is also actively engaged in outreach.

Mathematics

The main research areas of the Department of Mathematics are Mathematical Physics, Algebra and Topology, and Applied Stochastics. Connecting themes in the department are the study of Symmetry and of Geometry in various incarnations, including non-commutative geometry, symplectic and Poisson geometry, as well as algebraic and arithmetic geometry. The department distinguishes itself from similar groups elsewhere by its active engagement in cross-disciplinary research in interactions with researchers from other groups, most notably in Physics and Computer Science.

Astrophysics

Researchers at the Department of Astrophysics focus on five topics: compact objects (black holes, neutron stars and white dwarfs) in binary systems, super-massive black holes in the centres of galaxies, ultra-high-energy cosmic rays, gravitational wave astrophysics and stellar populations in a galactic setting. These are strongly connected: stellar-mass and super-massive black holes produce powerful relativistic jets, in which particles are accelerated to ultra-high energies. These particles we detect on Earth as ultra-high-energy cosmic rays. Compact stellar binary systems are the source population of periodic gravitational waves and, when black holes and/or neutron stars merge, of bursts of gravitational waves. We aim to understand how populations of stars, (super-massive) black holes and the interstellar medium are all connected in our Milky Way Galaxy, as an example for galaxies in general.

High-energy physics

Within the Department of High-Energy Physics researchers carry out and analyse experiments in elementary particle physics at the smallest distance and the highest mass scales attainable. This research includes accelerator-based and cosmic-ray experiments, as well as explorations of the theoretical foundations of elementary particle interactions, including gravity. There is a particular focus on electroweak symmetry breaking, the Higgs boson and physics beyond the Standard Model. The research on quantum gravity is focused on the construction of quantum observables that can be confronted with observation.

Research facilities

The experimental groups make use of the Large Hadron Collider (LHC), the world's largest and most powerful particle accelerator, and the following leading national and international astronomical and astroparticle observatories: ESO, La Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger. Under development are the IMAPP-led BlackHoleCam, BlackGEM and MeerLICHT facilities. The Institute houses two optical telescopes and a radio interferometer. It also makes use of the Faculty's mechanical and electronics workshops and the facilities of the Amsterdam-based National Institute for Nuclear and High-Energy Physics (Nikhef).

Collaboration

The research questions and themes studied at IMAPP are of international significance and these are explored in collaboration with scientists all over the world. The research facilities and collaborations are therefore also of an international nature. Moreover, researchers from 20 countries work at IMAPP.

Mathematicians at IMAPP are involved in the NWO mathematics clusters DIAMANT (Discrete, Interactive & Algorithmic Mathematics, and Algebra & Number Theory), GQT (Geometry and Quantum Theory) and STAR (Stochastics - Theoretical and Applied Research). They make a major contribution to GQT.

Staff

Prof. A. Achterberg (o)
Prof. C.C. Aerts (e)
Prof. J. Ambjorn (e)
Prof. E.A. Cator (o)
Prof. H.D.E. Falcke (p)
Prof. N. de Groot (o)
Prof. P.J. Groot (o)
Prof. G.J. Heckman (o)
Prof. W.H. Hundsdorfer (e)
Prof. O.B. Igonkina (e)
Prof. S.J. de Jong (o)
Prof. R.H.P. Kleiss (o)
Prof. H.T. Koelink (o)
Prof. N.P. Landsman (o)
Prof. R. Loll (o)
Prof. B.J.J. Moonen (o)
Prof. E.S. Phinney (o)
Prof. A.N.J.J. Schellekens (e)
Prof. P.J.C. Spreij (e)
Prof. F.W.M. Verbunt (o)

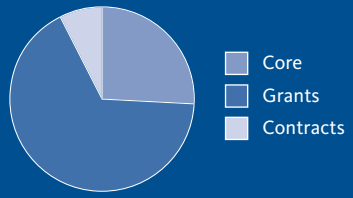
Tenured

Full Professors	6.2 FTE
Associate Professors	3.4 FTE
Assistant Professors	7.9 FTE

Non-tenured

Researchers	27.7 FTE
Doctoral candidates	45.3 FTE

Research staff funding



The elementary particle physics group – a partner in Nikhef – is associated with the European Laboratory for Particle Physics CERN in Switzerland. Astronomical research is carried out in association with ASTRON, SRON, ESO- and ESA-ESTEC. The Nijmegen group co-leads the EGAPS survey, leads the BlackHoleCam, BlackGEM and MeerLICHT projects, is the expertise centre for cosmic-ray detection with LOFAR, and is a member of the Virgo, LISA and CTA consortia. IMAPP particle physicists and astronomers are joint members of the Pierre Auger Observatory Collaboration in Argentina, and of Nikhef.

All researchers at the Institute are members of one of the following Dutch national research schools: Wonder (mathematics), OSAF (elementary particles), LOTN (theoretical physics) and NOVA (astronomy) – all accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW).

Awards and acknowledgements

- Prof. Sijbrand de Jong was re-elected president of the CERN council and elected member of the Academia Europaea.
- Prof. Gijs Nelemans obtained a Vici grant to support his work on gravitational waves with Prof. Paul Groot and Dr Samaya Nissanke. The three together received the Special Breakthrough Prize and the Gruber Cosmology Prize.
- Prof. Olga Igonkina received an NWO Vici grant.
- Prof. Klaas Landsman was appointed editor of the Springer journal Foundations of Physics and chaired the 2016 Program Committee of Foundations.
- Melissa van Beekveld, supervised by Dr Sascha Caron and Prof. Wim Beenakker won the Shell prize for best Masters thesis.

The research done by **Dr Samaya Nissanke** (Assistant Professor in Astrophysics) relates to gravitation wave astrophysics, black hole and neutron star physics. She intends to characterise the birth of black holes from pairs of compact stellar remnants by detecting gravitational waves with measurements of accompanying spectacular optical and radio flashes. In 2016, she received both NWO Vidi and Top-II grants.

Research results

- Prof. Eric Cator and Dr Henk Don, in collaboration with Prof. Piet Van Mieghem (TU Delft), have developed a new way of studying the contact process with arbitrary infection and healing rates that can accurately predict the meta-stable state of the 'infection' and estimate the speed of convergence.
- Prof. Gert Heckman and Dr Lei Zhao published – in Inventions Mathematicae – a paper on the moment map, which is a manifestation of the famous theorem of Emmy Noether.
- Prof. Erik Koelink and Dr Román made a major step in determining matrix-valued spherical functions on compact quantum groups with respect to right coideal subalgebras.
- Prof. Klaas Landsman finished his 895-page monograph on the foundations of quantum mechanics, to be published in Open Access by Springer in 2017.
- Prof. Ben Moonen established a nice connection between the Deligne-Mostow list of arithmetic ball quotients and families of algebraic surfaces in which the special fibres are dense. His PhD student Johan Commelin obtained a proof of the Mumford-Tate conjecture for some classes of product of surfaces.
- The ATLAS experiment (Prof. Nicolo de Groot, Dr Frank Filthaut, Dr Adriaan König, Dr Sascha Caron, Prof. Olga Igonkina) exceeded all expectations, as the LHC delivered a dataset more than ten times larger than in 2015. This was used to search for the production of the Higgs boson together with a pair of top quark.
- Dr Frank Filthaut assumed co-leadership of the ATLAS physics analysis subgroup studying Higgs boson decays to W boson pairs and co-initiated Dutch participation in ProtoDUNE, leading the data acquisition effort in this CERN experiment.
- The group led by Dr Sascha Caron continued to develop data recording algorithms and strategies for supersymmetry searches in ATLAS.

KEY PUBLICATIONS

- Aab, A., Aminaei, A., Buitink, S., Jong, S.J. de, De Mauro, G., Falcke, H., Horandel, J.R., Jansen, S., Nelles, A., Schulz, J., Timmermans, C., Aar, G. van, Velzen, S. van, Wykes, S. & *et al*. (2016). Measurement of the Radiation Energy in the Radio Signal of Extensive Air Showers as a Universal Estimator of Cosmic-Ray Energy. *Physical Review Letters, 116*(24), 1-9.
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- Abbott, B.P., Bloemen, S., Ghosh, S., Groot, P., Nelemans, G., Nissanke, S., Setyawati, Y., Shah, S. & *et al*. (2016). Observation of Gravitational Waves from a Binary Black Hole Merger. *Physical Review Letters, 116*(6), 061102.
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- Heckman, G.J. & Zhao, L. (2016). Angular momenta of relative equilibrium motions and real moment map geometry. *Inventiones Mathematicae, 205*(3), 671-691.
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- Landsman, K. & Wolde, E.J. van (Ed.). (2016). *The Challenge of Chance: A Multidisciplinary Approach From Science And The Humanities.* Berlin etc: Springer Verlag.
- Moonen, B.J.J. (2016). On the Chow motive of an abelian scheme with non-trivial endomorphisms. *Journal für die Reine und Angewandte Mathematik, 2016*(711), 75-109.
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Dissertations	**11**
Scientific publications	**505**
Professional publications	**1**

- Prof. Wim Beenakker and Dr Sascha Caron showed that supersymmetry still allows for natural dark matter candidates that survive all experimental constraints and can be discovered at the LHC. Prof. Beenakker used advanced resummation techniques at next-to-next-to-leading order accuracy for calculating the sizeable quantum corrections which dominate the production of strongly interacting supersymmetric particles.
- Prof. Ronald Kleiss has extended the application of QCD parton shower simulations to the development of electroweak showers in high-energy processes. The derivation of classical mechanics from QFT and the behaviour of the Abelian Higgs model, using only physical degrees of freedom, have been completed.
- Prof. Renate Loll has made significant progress in understanding the phase structure of Causal Dynamical Triangulations, in particular, the properties of the newly discovered bifurcation phase. There is good evidence that the associated new phase transition is also of a higher order, thus providing new candidates for continuum theories of nonperturbative quantum gravity. Intriguingly, the new transition can be interpreted in terms of breaking the homogeneity and isotropy of the space-time geometry of the ground state of the universe.
- Dr Frank Saueressig made fundamental progress in formulating an exact functional renormalisation group equation for quantum gravity, including a causal structure of space-time, and showed that the dynamic dimensional reduction of space-time leaves a distinct fingerprint in the corresponding thermal radiation spectrum.
- Sijbrand de Jong, Dr Jörg Hörandel and Dr Charles Timmermans led the radio detection of air showers with the Auger Engineering Radio Array, AERA. They established an absolute energy scale for cosmic rays based on radio measurements and measured the cosmic-ray arrival direction to better than a degree. The group contributed significantly to the design of Scintillator Surface Detector modules, the flagship part of the AugerPrime upgrade.
- Prof. Gijs Nelemans' team was deeply involved in the discovery of gravitational waves and he was one of the two editors of the astrophysical interpretation paper of the collaboration.
- Prof. Heino Falcke, Dr Jörg Hörandel and their group used LOFAR to determine the component masses of cosmic rays with energies of a few times 10 to the power 17 eV and found a surprisingly large contribution of hydrogen and helium.
- Prof. Frank Verbunt, Prof. Eric Cator – with graduate student Andrei Igoshev – developed a more accurate method for estimating the distances of radio pulsars from measurements.
- Prof. Paul Groot, Dr Elmar Körding – with graduate student Deanne Coppejans – doubled the number of dwarf novae detected in radio, and thus showed that dwarf novae as a class are significant radio emitters.
- Dr Onno Pols – with graduate student Thoms Wijnen – showed that pre-mainsequence disks do not sweep up enough mass to explain the enriched second population in globular clusters.
- Dr Søren Larsen and his collaborators showed that 'multiple populations' are present not only in old globular clusters, but also in star clusters in the Magellanic Clouds as young as six billion years. However, the phenomenon appears to be absent in even younger clusters.

Future research

The construction of BlackHoleCAM, MeerLICHT and BlackGEM will consolidate the strong research focus of the Astrophysics department on gravitational waves and black holes. The Radboud Radio Lab will coordinate the instrumentation efforts and the collaboration with industrial partners. Collaboration

Director Professor Frank Verbunt

Frank Verbunt studied Physics and Astronomy in Utrecht and obtained his PhD there in 1982. Following postdoctoral research in Cambridge (UK) and Munich, he became Professor of High-Energy Astrophysics in Utrecht in 1989, and moved to Nijmegen in 2012. His research focuses on mass transfer from an ordinary star to a compact star (neutron star or white dwarf) in close binaries, the importance of close encounters between stars for the formation and evolution of such binaries in star clusters, and the birth and evolution of single neutron stars.

of Astrophysics with Applied Stochastics and computer science in astrostatistics and with High-Energy Physics on gravitational waves, black holes and cosmology will be further developed.

In mathematics, IMAPP researchers will continue to work on some of the grand themes such as the Langlands programme and the theory of motives. Dr Van Essen and Dr Mueger are working on the Jacobi conjecture, via completely different approaches. Prof. Moonen has initiated the study of integral structures on Mumford-Tate groups in relation to moduli theory; this is directly relevant for several major open problems in arithmetic geometry. Dr Van Suijlekom intends to address the problem of formulating a mathematically rigorous, non-commutative geometric theory of quantum fields. Prof. Cator and Dr Don are starting a new promising project about disease spreading on networks.

Within the experimental high-energy physics group, momentum-imbalance reconstruction algorithms will be developed to be run on a new topological processor of the first ATLAS trigger level. In addition, the search potential for new physics at a high-luminosity LHC upgrade will be investigated. The theoretical research on supersymmetry and quantum gravity will be extended.

Societal impact

IMAPP is very active in outreach, giving courses for elderly people (HOVO) and non-science students, as well as many public lectures and discussion-talks to lay audiences, *e.g.* in Science Cafe's. Societal activities are largely integrated in the Radboud Pre-University College of Science, including teacher-training activities and masterclasses. Department members are very active in the (social) media, including many appearances in (national) newspapers and television shows. Astronomy news is spread on Twitter.

Six 'Public Nights' on astrophysics in winter each draw between 60 and 300 people per night. The Observatory gives more than 20 tours per year and is the home base of two public amateur astronomy groups.

Frank Verbunt is editor of the lay astronomy journal Zenit, writing a monthly column.

Several schools in/around Nijmegen installed cosmic-ray detectors built by IMAPP. Each year several secondary school classes come to our group for lab training in the NLT program.

An IMAPP team led by Wieb Bosma organised the 25th edition of the Mathematics tournament for secondary schools. This is the largest activity of its kind in the Netherlands, which each year attracts about 500 participants. The tournament also includes a special programme for high school teachers.

Prof. Eric Cator and Dr Ross Kang organised the Study Group Mathematics with Industry, which took place at the University in January 2016.

Prof. Klaas Landsman and Prof. Ellen van Wolde (FTR) organised the Week of Chance at the RU, a major outreach event including lectures, a theatre play and publishing of an interdisciplinary volume 'The Challenge of Chance' (Springer, 2016, also in Open Access).

Dr Bernd Souvignier contributed several chapters to the 6th edition of Volume A of the International Tables for Crystallography. This is the definitive resource and reference work for crystallography and structural science.

During the InScience film festival in November, Dr Wieb Bosma provided some mathematical background before the screening of the documentary 'The Origami Code'.

Dr Francesca Arici made it to the finals of Radboud Talks, in Arthouse Lux.

Dr Maarten Solleveld, in collaboration with PUC, organised a second round of the Dutch Mathematics Olympiad at the University.

The BlackGEM project collaborates with Airborne Composites in the Netherlands and the Fornax, Sybilla, Cilium and STA companies globally. MeerLICHT and DOME collaborate with IBM on green and exascale computing. Within the NOVA context IMAPP collaborates with a dozen additional Dutch companies.

IMAPP contributes to the Regionaal Steunpunt Arnhem-Nijmegen on Natuur, Leven and Technologie and to Stichting natuurkunde.nl (editorial board). <

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Institute for Computing and Information Sciences

The long-term aim of the Institute for Computing and Information Sciences (iCIS) is to contribute both to science and to society. The Institute works from the perspective that computer scientists are not just the architects of the digital world, but have become the architects of the social world as well.

At iCIS researchers aim to contribute at the highest levels of science and the institute educates Masters students and PhD graduates to become leading independent researchers. The societal focus is on diligence. Now that computing technology is shaping all aspects of modern societies, we need to be careful about how we employ these technologies. This translates into 1) addressing the increasing tension between those who wish to get access to more and more data for various forms of advanced analysis and those who wish to shield data for various security and privacy reasons; and 2) delivering techniques and tools for producing reliable software in order to reduce the risks of failure or compromised systems.

The Institute was established to improve the fundamentals of software development via formal, mathematically founded theories, methods and tools that support the specification, design, analysis and evaluation of computer-based systems. Research aims include improving the quality of software, with an emphasis on enhancing reliability, security, architectures and system alignment. The quality of the research remains very high, resulting in an excellent score in the latest Research Assessment. iCIS has again been evaluated as the top Computing Science institute in the Netherlands.

Members of the institute advocate open source software as well as digital security through design and openness (in contrast with security through obscurity). In the same spirit, iCIS promotes a culture of openness when dealing with academic integrity. Work in progress (papers, research proposals and research methodology) is discussed regularly in small meetings within the institute, which are open to all members of iCIS. Software and data are made freely available whenever possible. Security weaknesses are first reported to the companies or authorities involved before they are made public.

Research within iCIS is organised within three themes, which in 2016 were aligned with the specialisations in the Masters programme in Computing Science.

Digital security involves developing theories and formal methods for analysing and improving the security and privacy of the digital world. The scope of the research includes cryptographic software and hardware (in particular smart-cards and RFID), identity management, (privacy-preserving) security protocols, applied cryptography, quantum computation and legal aspects.

Researchers working on *Software science* explore and develop theories, formal methods and tools for model construction, implementation, testing, validation and verification of software, and for developing new programming principles. An explicit aim is also to bridge the gap between theory and practice through collaboration with stakeholders from industry and other application areas and to understand in what way the developed methods can contribute to solving real-world problems: the iCIS 'Practice as Laboratory Approach'.

Data science involves developing theories and methods for learning from data and reasoning with it. The long-term research goal is to work towards 'bounded rational' data science methods that properly take into account all information available and then provide an optimal answer, given finite resources and computation time. The aim is to show that such algorithms improve the state of the art, both in theory and practice.

Collaboration

The network of iCIS consists of a well-balanced mixture of national and international partners who guarantee the academic success of the research themes Digital Security, Data Science and Software Science, and the basic research on their mathematical foundations. Furthermore, the

Staff

Prof. E. Barendsen (p)
Prof. J.J.C. Daemen (o)
Prof. J.H. Geuvers (o)
Prof. T.M. Heskes (o)
Prof. M. Hildebrandt (p)
Prof. R.T.W. Hinze (o)
Prof. J.J.M. Hooman (o)
Prof. B.P.F. Jacobs (o)
Prof. N. Karssemeijer (e)
Prof. W. Kraaij (e)
Prof. E. Marchiori (p)
Prof. M.J. Plasmeijer (o)
Prof. H.A. Proper (e)
Prof. J.J.M.M. Rutten (e)
Prof. F.W. Vaandrager (o)
Prof. E.R. Verheul (e)
Prof. J.M.W. Visser (e)
Prof. A.P. de Vries (o)
Prof. Th.P. van der Weide (o)
Prof. H. Zantema (e)

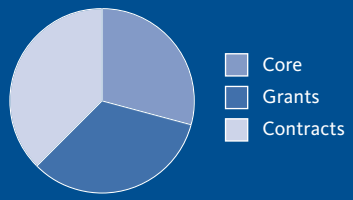
Tenured

Full Professors	5.1 FTE
Associate Professors	1.2 FTE
Assistant Professors	3.6 FTE

Non-tenured

Researchers	13.5 FTE
Doctoral candidates	40.1 FTE

Research staff funding



network of iCIS offers ample opportunity for valorising research. Partners include the Dutch Ministry of Internal Affairs for a project on business process reengineering, the University of Grenoble Joseph Fourier, France (Tarot), KU Leuven (EU project FutureID, ESF Cost network TRUDEVICE), IBM Research Zurich (EU project FutureID), TNO Delft, the Netherlands, Aalburg University, Denmark (Artist2), the Dutch Foundation for Internet Domain Registration (SIDN), the Dutch Banking Association (NVB, Amsterdam), Radboudumc & the Province of Gelderland (ParkinsonNext project), Thales and TNO-ESI, Eindhoven (Metis) and TILT (University of Tilburg), Netherlands Defence Academy and the Dutch Tax Office.

Research results

Researchers working on the *Digital Security* theme develop theories and formal methods, which they use to analyse and improve the security of the digital world. The PEP project led by Prof. Bart Jacobs started in 2016. The project is focused on privacy generated exchange of medical data for specific medical research purposes and it builds on the Polymorphic Encryption and Pseudonymisation technique developed by Prof. Jacobs and Prof. Eric Verheul. It is a collaboration with Prof. Bas Bloem at Radboudumc. The legal section also contributed to the PEP framework, having developed a Data Licensing Agreement, which is particularly relevant for in the domain of healthcare and education. Prof. Mireille Hildebrandt wrote the Preadvies 2016 for the Netherlands Lawyers Association on Data Driven Intelligence in Criminal Law, including position statements on the role of software verification and legal protection by design, which were voted positively by a large majority. The USEMP project, which involved data scientists, living lab research and the iCIS lawyers has been brought to a successful end with the DataBait profile transparency tool (which won the ICT2015 Exhibition prize), and for which Radboud University holds a trademark. Hildebrandt was invited to deliver a keynote at the Learning Analytics and Knowledge Annual Conference 2016. Prof. Joan Daemen's scientific highlight was the discovery of an efficient solution for achieving uniformity in threshold schemes against side-channel attacks that he presented at the Theory of Implementation workshop, held together with Conference on Computer and Communication Security (CCS) in Vienna. Dr Peter Schwabe presented the "Newhope" post-quantum key exchange protocol (joint work with Erdem Alkim MSc, Dr Léo Ducas, and Dr Ing.Thomas Pöppelmann) at USENIX Security 2016. The software was used in a post-quantum TLS experiment by Google. Dr Lejla Batina and her group focused on efficient and side-channel secure implementations of curve-based cryptography with a publication at Eurocrypt as the main highlight. The COST project TRUDEVICE successfully finished with a final conference held in Barcelona. Research into privacy improvements for GSM has led to discussions with the GSM Association about the possibility of incorporating the results into the international standards.

In the *Software Science* theme Prof. Rinus Plasmeijer continued work on Functional Programming (Clean) and Task Oriented Programming (iTasks), together with the NLDA (Netherlands Defence Academy), the Royal Dutch Navy, the Netherlands Coastguard, the Dutch Tax Office and TNO. Prof. Frits Vaandrager continued to work on algorithms for constructing state machine models of black box implementations. iCIS algorithms were used, for instance, to support the rejuvenation of a legacy software component in a development project at Philips Healthcare. Issues were found in both the refactored and the legacy implementation at an early stage, before the component was integrated. Our approach to learning models of Linux, Windows and FreeBSD implementations of TCP – one of the main protocols of the Internet protocol suite – was also applied. iCIS analysis revealed several instances in which TCP implementations do not conform to their RFC specifications. A new project, COPD+, which started in 2016, focuses on technology transfer from *Software Science* to society of techniques that support self-management of chronic diseases by patients using smartphone apps.

Researchers working on the theme *Data Science* are involved in three ongoing EU projects designed to unravel the causal mechanisms behind complex diseases. The role of iCIS within these projects is to develop new techniques for data fusion and causal analysis in order to obtain a better understanding of the aetiology of the disease and

Louiza Papachristodoulou MSc (doctoral candidate) received a Christine Mohrmann stipend. She investigates side-channel attacks (SCAs) in order to develop cryptographic algorithms. An SCA is an attack based on information from the physical implementation of a cryptosystem. New powerful SCA techniques allow security protocols to be applied, for instance in RFID tags, chips and electronic wallets. She will use the stipend to visit the University of Edinburgh where she will examine the security and resistance to SCAs of the popular currency Bitcoin.

KEY PUBLICATIONS

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- Traub, M.C., Samar, T., Ossenbruggen, J. van, He, J., Vries, A.P. de & Hardman, L. (2016). Querylog-based Assessment of Retrievability Bias in a Large Newspaper Corpus. In N.R. Adam (Eds.), JCDL '16 : *Proceedings of the 16th ACM/IEEE-CS on Joint Conference on Digital Libraries: Big Libraries, Big Data, Big Innovation, Rutgers University, Newark, NJ, USA, June 19-23, 2016*. (pp. 7-16). New York: ACM.
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Dissertations	**10**
Scientific publications	**237**
Professional publications	**6**

to derive putative biomarkers. The group has been involved in developing several open source machine learning packages, most notably BCM, a software package for Bayesian analysis of computational models written by former Masters student Bram Thijssen, and stablespec, an R package for stable specification search in structural equation models developed by PhD student Ridho Rahmadi.

MAGMA, a tool for gene analysis and generalised gene-set analysis of GWAS data, developed by PhD student Christiaan de Leeuw, has quickly become the standard in computationally efficient gene-set analysis. A paper on the general characteristics of gene-set analysis was published in *Nature Review Genetics*. Within the NWO-TOP Compartment 1 project 'Combining Machine Learning and Game-theoretic Approaches for Cluster Analysis' new efficient and effective algorithms were developed for local community detection in very large networks. These algorithms have been applied to real-life networks from diverse domains including social science, information science and biology. In collaboration with the Diagnostic Image Analysis group at the Radboudumc deep neural networks were used to detect brain white matter lesions from image data. These are important markers for diseases such as multiple sclerosis and Alzheimer's disease. Within a joint project with the Chemometric group we developed and implemented an effective methodology based on neural networks for the design and interpretation of classification models with vibrational spectroscopic data. This is a challenging task that is relevant in diverse application domains such as pharmaceutical, forensic, environmental and food sciences, as well as in medicine.

Societal impact

The institute's impact is evident in various projects that were designed to improve the quality of software. Examples include those in the medical field (developing new tools and techniques for analysing and describing clinical and pathological data which can be used to understand and improve the prognosis, diagnosis and treatment of several diseases, including neuro-degenerative diseases) and model checking, together with Océ and ASML. Work on offering home support to patients with COPD and pregnancy-related disorders by means of intelligent smartphone apps is one of the first examples where part of hospital treatment management has been moved to the home environment using off-the-shelf equipment.

Cyber Security and privacy remain societally important. Public interest in these topics continues to grow, making headlines in the news almost on a daily basis. Researchers working on the Digital Security theme not only address these concerns through their research, but also play an active role in public debates on these issues. The group's expertise is in demand both from the public and from the private sector, on topics such as the smart grid (especially smart electricity metres and smart charging of electric vehicles), the security of web applications, electronic payment systems, electronic voting and identity cards.

Research continued on the privacy and security of medical data in collaboration with Radboudumc (the PEP project). The *Cyber Security* Council granted an assignment on the role of the 'duty of care' to the Law Faculty of the university, with Prof. Mireille Hildebrandt involved in supervision. Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on Cyber Security issues and Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting that was set up by the Dutch Ministry of the Interior. Profs. Mireille Hildebrandt and Bart Jacobs are members of the advisory group for the Dutch watchdog for the Intelligence Services (CTIVD) and Prof. Hildebrandt is a member of the board of appeal with SIDN, and was part of the Advisory Board of the Netherlands Bar Association

Director Professor Herman Geuvers

Herman Geuvers has been Professor of Computer-Assisted Reasoning since 2006 at the Institute for Computing and Information Sciences and since 2007 also at Eindhoven University of Technology. Since 2011, he has also been a professor of Theoretical Computer Science. He studied in Nijmegen, where he obtained his PhD. He specializes in logic in computer science, lambda calculus and type theory, and computer-assisted proving.

(NOvA) until October 2016. Prof. Hildebrandt was invited to give a lecture at Utrecht University on privacy issues related to big data applications in education, and received a special invitation to speak for an hour to the closed session of the ICDPPC (global conference of privacy commissioners) on data protection and Artificial Intelligence. She was also consulted by various organs within the EU on the interrelationship between big data, machine learning and data protection. Further evidence of societal impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) funds a part-time chair in Information Security (Prof. Eric Verheul).
Bayesian techniques developed at iCIS are being used to combine data with background knowledge, for instance to localise sources of activity in the brain and to improve the performance of brain-computer interfaces. The TACTICS project was established to identify the neural, genetic and molecular factors involved in the pathogenesis of compulsive behaviour. Using novel methods for causal discovery, statistical evidence was found that the inattentive component in Attention Deficit Hyperactivity Disorder (ADHD) drives the hyperactive component. This finding suggests that the chance of reducing hyperactivity by reducing inattention may be more successful than trying to do it the other way around. iCIS research was covered in the national and international press, in particular on the website nu.nl and on Belgian radio.

Awards and acknowledgements

Facebook awarded the 2016 Internet Defense Prize to Peter Schwabe and his international collaborators for their work on post-quantum cryptography. Tom Claassen received the Outstanding Reviewer Award at this year's Conference on Neural Information Processing Systems (NIPS 2016). Former Masters student Harm Berntsen presented his framework for resisting adversarials in deep learning at the workshop New Challenges in Neural Computation and Machine Learning (NC^2). He received the second prize for best presentation. Tom Claassen, together with an interdisciplinary team of researchers led by Joris Mooij of the Informatics Institute (UvA), won the first prize in the 2016 CRM Causal Inference Challenge. Prof. Joan Daemen was among the finalists for the European Inventor of the Year awards, which are organised by the European Patent Office.

Future research

In the context of iDark, the intelligent dark matter survey funded by the Netherlands eScience Center, Prof. Tom Heskes' group will collaborate with colleagues working on Particle Physics, Astrophysics and eScience to determine the nature of dark matter by combining available data worldwide within the most general models of dark matter. Furthermore, the group will continue developing and analysing novel algorithms for causal discovery from 'big data'. The methods thus developed will be applied to ecological data (in collaboration with Prof. Mark Huijbregts, IWWR), cognomics data (in collaboration with Prof. Barbara Franke and Prof. Jan Buitelaar at Radboudumc) and Big functional genomics data. Within the EU projects TACTICS (obsessive compulsive disorders), OPTIMISTIC (myotonic dystrophy), and MATRICS (conduct disorder), the development and application of data mining and machine learning algorithms will continue in order to gain insight into disease progression and the causes of brain diseases. Research on side-channel analysis and on fast and safe implementations of cryptography will continue. The *Digital Security* group will continue working on the project 'Privacy and security for purposes of big data in health' (in collaboration with Prof. Bas Bloem at Radboudumc). Further e-Health research, including work on the self-management of chronic diseases, will move towards implementation in clinical practice. In collaboration with commercial companies, modelling workflows and active learning of software components will be taken to the next level, both in theory and in practice. The legal section of iCIS has started collaborating with the Department of Private Law at the university's Law Faculty, co-hosting three PhD students on the subject of 'duty of care' in relation to damage or harm caused by the development, sale and/or usage of ICT.

The COST network EUTYPES, with iCIS as coordinator, will further develop type theoretic methods for software verification. At the national level, research on software verification will be carried out with various industrial partners in the 'Sovereign' project, which is funded by STW. In cooperation with the Nuclear Research and consultancy Group (NRG), the Dutch Department of Public Works (Rijkswaterstaat, RWS) and other industrial partners, Prof. Herman Geuvers aims to develop a framework for modular formal verification of safety-critical software. ‹

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Glossary

(e)	Extraordinary chair
(o)	Ordinary chair
(p)	Personal chair
BSI	Behavioural Science Institute
CLS	Centre for Language Studies
CMBI	Centre for Molecular and Biomolecular Informatics
CMR	Centrum voor Migratierecht – Centre for Migration Law
CNR	Centrum voor Notarieel Recht – Centre for Notarial Law
DCC	Donders Centre for Cognition
DCCN	Donders Centre for Cognitive Neuroimaging
DCMN	Donders Centre for Medical Neuroscience
DFG	Deutsche Forschungsgemeinschaft – German Research Foundation
DFN	Diabetes Fonds Nederland – Dutch Diabetes Research Foundation
DI	Donders Institute for Brain, Cognition and Behaviour
ERC	European Research Council
FELICE	Free Electron Laser for IntraCavity Experiments
FELIX	Free Electron Laser Infrared eXperiments
FLARE	Free-electron Laser for Advanced spectroscopy and high Resolution Experiments
FOM	Stichting voor Fundamenteel Onderzoek der Materie – Foundation for Fundamental Research on Matter (Netherlands)
FTE	Full-time equivalent
FTE 1st	Full-time equivalent for research directly funded by government (core funding)
FTE 2nd	Full-time equivalent for research funded by KNAW or NWO (research grants)
FTE 3rd	Full-time equivalent for research funded by other public and/or private organizations (contract research)
HFML	High Field Magnet Laboratory
HLCS	Institute for Historical, Literary and Cultural Studies
ICIS	Institute for Computing and Information Sciences
IMAPP	Institute for Mathematics, Astrophysics and Particle Physics
IMM	Institute for Molecules and Materials
IMR	Institute for Management Research
IWWR	Institute for Water and Wetland Research
KNAW	Koninklijke Nederlandse Academie van Wetenschappen – Royal Netherlands Academy of Arts and Sciences
KWF	Koningin Wilhelmina Fonds – Dutch Cancer Foundation
MPI	Max Planck Institute for Psycholinguistics, Nijmegen
NHS	Nederlandse Hartstichting – Netherlands Heart Foundation
NIAS	Netherlands Institute for Advanced Study
NIH	National Institutes of Health
NSM	Nijmegen School of Management (*i.e.* Faculty of Management Studies)
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek – Netherlands Organisation for Scientific Research
OO&R	Onderzoekscentrum voor Onderneming & Recht – Business and Law Research Centre
PTR	Research Institute for Philosophy, Theology and Religious Studies
Spinoza Prize	The most prestigious prize for scientists in the Netherlands who are the highest-achieving researchers, awarded by NWO
REI	Radboud Excellence Initiative
RIHS	Radboud Institute for Health Sciences
RIMLS	Radboud Institute for Molecular Life Sciences
RSCR	Radboud Social Cultural Research
SteR	Onderzoekscentrum voor Staat en Recht – Centre for State and Law
STW	Technologiestichting STW – Technology Foundation STW (Netherlands)
Radboudumc	Radboud university medical center
Veni grant	Personal grant from NWO awarded over a period of three years to researchers who have recently obtained their PhD, to allow them to continue to develop their work
Vidi grant	Personal grant from NWO awarded over a period of five years to researchers who wish to develop an innovative line of research in which they appoint one or more co-researchers
Vici grant	Personal grant from NWO awarded over a period of five years to senior researchers who wish to establish their own research group
ZonMw	ZorgOnderzoek Nederland NWO Medische Wetenschappen – Netherlands Organisation for Health Research and Development

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