Recently, we published our new Strategic Plan (2015-2020). The motto of this plan is 'We invite you to change perspective'. This invitation is extended to students and employees alike. We encourage all those involved with the University to examine their own intellectual position critically and to adapt it where necessary.

This is one reason why our campus was designed to facilitate encounters. Each interaction opens up the possibility to become acquainted with another point of view, another perspective. Such an environment supports an open, intellectual climate, which is appropriate for a university like ours that is engaged with society.

Moreover, the combination of leading research institutes and state-of-the-art research facilities on a single campus motivates researchers to work in multi-disciplinary teams. Indeed, it is often at the interfaces between research areas that new insights arise, which in turn influence our way of looking at the world. An opportunity to change perspective reinforces the commitment of researchers, students, alumni and partners to our academic community.

A strong focus on world-class research allows us to serve society’s needs. Most of our research is inspired by important societal issues and – through it – we contribute to cultural, social and economic development worldwide.

In this report we present our most significant research achievements in 2014. We believe this is a transparent way to account for the resources that society has allocated to us and to demonstrate that we are in good shape to face future challenges.

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Introduction

Radboud University is a broad, internationally oriented, student-centred research university. We value quality, combining excellent education with leading-edge research. Our academic expertise is closely related to important societal issues, both in the public and in the private domain. We play an important role in transferring knowledge to society. In this respect, regional entrepreneurs in particular benefit from our activities.

Our ambition
In prioritizing the quality of our research we have achieved significant progress. According to International Peer Review Committees that have evaluated our research institutes, almost all research programmes at the university are assessed as ‘very good’ to ‘excellent’. What’s more, our researchers have acquired – against stiff competition – numerous national and international grants as well as personal awards. Many such awards were won by our talented younger generation of researchers. In the years ahead, we aim to consolidate and improve on these achievements. We aim not only to stay in the top echelons of universities in the Netherlands, but also to be among the very best of Europe’s academic institutions, while at the global level we expect greater recognition. As a consequence we will intensify internationalization of the University and the impact of our research. We will therefore strengthen our collaboration with strategic partners, both in the academic community and in the wider society. In 2014 we made good progress towards achieving these aims.

Our academic profile
Our research concentrates in particular on four of the five major academic domains: the Arts and Humanities, the Social Sciences, the Natural Sciences and the Life Sciences. For work in the fifth domain (Technical Sciences) – which is not one of our core competences – we cooperate closely with colleagues at the University of Twente, Eindhoven University of Technology and Wageningen University and Research Centre.

Research at the University takes place in 14 dedicated institutes. These are responsible for planning programmes as well as for training and supervising new generations of researchers. We do our best to ensure that all programmes within the institutes remain competitive internationally and that they make a major contribution to their respective research communities. Within the broad research context, ten sub-disciplines have been identified where the quality exceeds the high level achieved by researchers in the rest of the University. These ten areas are listed below.

Organic Chemistry
The focus within Chemistry is on Organic Chemistry, alongside Material Science, Life Science, Biomedical Science and Supra-
Molecular Chemistry. We concentrate in particular on Synthesis, Physical Organic Chemistry and the Life Sciences. The core 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. The numerous prestigious grants awarded over the years reflect the high quality of the research in Organic Chemistry. These include European Research Council (ERC) Advanced grants, Netherlands Organization for Scientific Research (NWO) Spinoza prize, Vici grants and – together with the Eindhoven University of Technology and the University of Groningen – one of the few highly prestigious ‘Gravitation’ programmes for work that will extend over the coming decade.

In 2014, Prof. Pruijn and his colleagues have studied the specificity of protein citrullination. This is involved in several physiological processes, such as regulation of gene expression, and it is associated with various diseases, such as cancer, multiple sclerosis, rheumatoid arthritis and Alzheimer’s. Prof. Van Hest’s group studied enzymatic cascade reactions in multi-compartment polymersomes. A simple cell mimic with sub-compartment was created based on polymer building blocks. It is hoped that these concepts will lead to a better understanding of the structure and functioning of the living cell. Prof. Huck and his group are exploiting reaction-diffusion systems in smart materials. Reaction-diffusion systems can exhibit extremely complex behaviour and the aim is to understand and harness this complexity. Prof. Nolte and his colleagues are developing a molecular Turing machine. This molecular Turing machine should be able to read and write data on a polymer chain. Prof. Rowan received the Soft Matter and Biophysical Chemistry Award 2014 from the Royal Society of Chemistry for his pioneering work on processive catalysis, functional self-assembly and developing biomimetic extracellular matrices (for more details, see pages 88 and 104).

Physics of Condensed Matter

At Radboud University research on the Physics of Condensed Matter is closely connected with research in Chemistry. Our researchers contribute to the Dutch national programmes Nanonext and Nanonext, as well as to EU programmes. International cooperation is excellent, for example through our unique infrastructure, including the High Field Magnet Laboratory (HFML) and three advanced Free-electron Laser Units (FELIX/FELICE/FLARE). Experimental Physics of Condensed Matter and Theoretical Physics of Condensed Matter are areas in which we lead worldwide. 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 former Associate Professor and current Extraordinary Professor André Geim and Professor Konstantin Novoselov, a PhD graduate from the University and currently also an Extraordinary Professor. The award of NWO Spinoza prizes and ERC Advanced grants also demonstrates the strong reputation of our research groups in this field. In 2013, the Netherlands’ Magnetic Resonance Research School was established, together with colleagues from the Universities of Utrecht, Wageningen,
Leiden, and Eindhoven and made possible by a subsidy from NWO. Another mark of recognition is the election (2014) of Prof. Katsnelson as member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

In 2014, Dr Zeitler and his colleagues found a temperature-driven transition from a classical semiconductor to a two-dimensional topological insulator. Topological insulators are a new state of quantum matter that is characterized by an insulating gap in the bulk and gapless edge states. The group led by Prof. Christianen demonstrated – together with members of the Bio-Organic Chemistry group – that high magnetic fields can be used to reversibly open and close nano-sized polymer capsules. This finding makes it possible to capture and release cargo particles, which is a crucial first step towards applications in magnet-assisted drug delivery. It is the first time that such a magneto-valve nanosystem has been produced (for more details, see page 104).

**Astrophysics**

Researchers in the Netherlands have played a leading role in astrophysical research for many decades. 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 very competitive internationally. The quality of the research is reflected in the successful acquisition of highly prestigious grants such as ERC Advanced grants, the NWO Spinoza prize and an ERC Synergy grant.

In 2014, work on the IMAPP-Astrophysics led projects BlackHoleCam, BlackGEM and MeerLICHT has progressed. The ERC Synergy project BlackHoleCam started in October 2014, while the Dutch radio telescope LOFAR embarked on its science production phase. New insights into the radio detection of cosmic rays with LOFAR – an innovative IMAPP-led effort which is unique in the world – were published in 2014. Prof. Falcke was elected in the Royal Netherlands Academy of Arts and Sciences (KNAW). Dr Buitink received an ERC Starting grant (for more details, see page 112).

**Microbiology**

The composition, functioning and evolution of ecosystems are key to our research on gene-environment interactions. This research covers all major biotic organisms, including micro-organisms, plants and animals, and their interactions. Adaptations – as well as stress responses – by these organisms are investigated in terms of how their molecular and physiological mechanisms are regulated. Our microbiologists specialize 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 twice received an ERC Advanced grant and Prof. Mike Jetten received the NWO Spinoza prize for discovering many new bacteria.

![Figure 1](image-url): Acquisition of ERC grants by host institution. Total number of ERC Advanced, Starting and Consolidator Grants until August 2014. Source: European Research Council.
and elucidating their unique properties. Together with NIOZ, Wageningen UR and TU Delft this team received an NWO ‘Gravitation’ grant and it participates in another such project led by the University of Utrecht in which VU Amsterdam and Wageningen UR are also involved.

In 2014, among a number of major studies, the microbiologists at the Institute for Water and Wetland Research (IWWR) investigated the role of the unique prokaryotic organelle in Anammox bacteria. They were able to isolate this organelle and analyse its protein and lipid content, as well as its role in hydrazine turnover. Prof. Mike Jetten was elected as a member of the European Molecular Biology Organization (EMBO). Dr Boran Kartal received an ERC Starting grant (for more details, see page 98).

**Cognitive Neurosciences**

Insights into brain and cognition have advanced considerably in recent years and, as a result, 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 as well as a multidisciplinary approach taken in Nijmegen ensure high-quality research. This is apparent from the many grants that have been received – against strong competition – by 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’ grant.

In 2014, a study carried out at the Behavioural Science Institute provided evidence for impaired cognitive functioning...
in clinical burnout patients. Researchers working on Language and Communication examined the brain mechanisms underlying multilingual speakers’ ability to switch between languages. Results from an fMRI study including Dutch/English/German trilinguals indicated that language switching recruits brain areas that are not language-specific. As a result, multilingual speakers use domain-general inhibition when switching between languages. Professors Bart Geurts and Marc Slors form the Research Institute for Philosophy, Theology and Religious studies have argued that philosophical and commonsense psychology should not be mistaken for pre-scientific cognitive psychology; this underscores the added value of philosophical analysis of commonsense psychology and helps to re-interpret results of cognitive psychological and neuroscientific research. Studies on Learning and Memory showed that sleep deprivation interferes with the normal nightly down-regulation of cerebrospinal fluid -amyloid 42, suggesting that chronic sleep deprivation might increase the risk of Alzheimer disease. Professor Guillén Fernández was elected as a member of the Academia Europaea and Prof. David Norris became an External Scientific Member of the Max Planck Society (for more details, see page 66).

**Infection and Immunology**

The interface between micro-organisms and man is where fundamental as well as clinical translational research in infection and immunology take place at the University. This research includes 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, the Spinoza prize and the NWO Vici grants, acknowledging the excellent performance of the teams working on infection and immunology.

In 2014, two ground-breaking publications in Science, by Prof. Henk Stunnenberg (Cancer development and immune defence) and Prof. Mihai Netea (Infectious diseases and host response) provided new information which enhances our understanding of 1) epigenetics and 2) energy metabolism in host defence and immunity. This information will help researchers to better understand and manipulate immune-mediated responses as well as develop novel therapies to fight human diseases. Both papers received extensive media coverage due to their important contribution to medical science. A novel malaria drug combination that kills both malaria parasites and mosquitoes was developed and tested. A study by Dr Teun Bousema and colleagues showed that a combination of a standard antimalarial with the mosquitocidal drug ivermectin was safe and efficacious in malaria patients. Professor Jolanda de Vries (Cancer development and immune defence) was awarded an NWO Vici grant for her proposal: “Theranostics for developing successful natural dendritic cell vaccines to combat and prevent cancer” (for more details, see pages 78 and 88).

**Cyber security**

Cyber security is about 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 authorization 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, or biometrics that can be used for this, and 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 absence 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 the formulating and formalizing of security policies and security rules, as well as methods for risk management and risk assessment.

ICIS is a leading international institute within its field of research. Its reputation is reflected in excellent assessments, and the award of an ERC Advanced grant, NWO Vici and Vidi grants, and several Veni grants.

In 2014, work within Prof. Bart Jacobs’s ERC Advanced grant gained momentum, with developing novel categorical axiomatizations for quantum computation and logic, based on the concept of effect algebra. Dr Lejla Batina – who received an NWO Vidi grant - has worked both on new attacks (e.g. on Elliptic Curve Crypto) and on countermeasures against attacks. What distinguishes her approach is a novel combination of evolutionary computation and cryptology. Associate Professor Jaap-Henk Hoepman was appointed as Director of the Privacy and Identity Lab. He also received an NWO Cyber Security research grant (for more details, see page 118).

### Human Genetics

We specialize 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. Our human genetics researchers have access to modern bio-informatics equipment and use the latest techniques. Translational research can explain some of the hyperactivity/impulsivity symptoms in ADHD.

Associate Professor Dirk Lefeber published – in the prestigious *New England Journal of Medicine* – the application of a novel high-resolution glycoprofiling method that can be used for early diagnosis and personalized treatment of Congenital Disorders of Glycosylation, a rare group of disorders comprising inborn errors of metabolism that lead to abnormal glycosylation of proteins. Also related to energy metabolism, Dr Richard Notebaart, described new computational tools that can be used to understand evolutionary biology. A central unresolved issue in this field is how metabolic innovations emerge. The *in silico* model he developed demonstrates that the genetic basis of evolutionary metabolic adaptations is predictable and could be used in many application areas, from bio-engineering to medical genetics, including understanding gain-of-function mutations in tumour development and the evolution of antibiotic resistance (for more details, see page 88).

### Linguistics

Our linguists carry out ground-breaking linguistics 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 there is close multidisciplinary cooperation with other institutes on the campus such as the Max Planck Institute for Linguistics and the Donders Institute for Brain, Cognition and Behaviour. They have received prestigious.
grants including ERC Advanced grants and the NWO Spinoza prize, and they are participating in the prestigious NWO ‘Gravitation’ programme ‘Language in Interaction’.

In 2014, the way babies acquire language was simulated by using computational models which ‘learned’ words from real speech without the need to transform continuous signals into single sounds or words. It turned out that these models can indeed ‘learn’ words and that they are able to successfully simulate babies’ behaviour in experiments.

Studies on similarities and dissimilarities between pointing signs in Sign Language of the Netherlands and pointing gestures in spoken Dutch revealed that by focusing on the location that is being pointed at (instead of on the pointing gesture itself), four different constructions can be distinguished. One of these – the most complicated one – turns out to appear only in sign language, suggesting that pointing signs in sign language evolve into grammatical parts of the language. The CLS Language and Speech Technology group played a pivotal role in developing the Common Lab Research Infrastructure for the Arts and Humanities (CLARIAH). CLARIAH, a consortium of humanity research institutions, has received an NWO grant worth 12 million for developing a digital infrastructure that can be used to combine software and large quantities of data from different disciplines in the humanities. Many researchers regard Digital Humanities as the most important development in their profession. Professor Paula Fikkert (Linguistics) has been elected as a member of the Royal Holland Society of Sciences and Humanities (KHMW) (for more details, see page 60).

Business and Law
The Business and Law Research Centre has close ties with fourteen highly renowned law firms, financial institutions and companies, most of which operate internationally. Their people work together with ours on academic research in 1) company law, 2) financing, security rights and insolvency law, 3) business and patrimonial law, and 4) financial law. The Research Centre has produced numerous authoritative text books, monographs and serial volumes. The research groups are also very successful in raising funds.

In 2014, a comprehensive new volume was published in the prominent Asser series on patrimonial law from a private international law perspective. This book provides an extensive analysis of important company law and insolvency law topics and reviews various European, international and Dutch legal sources. It also provides an important reference resource for those working in future European projects in private international law (notably in property, contract and insolvency law). Another important research outcome includes the publication by Oxford University Press of a compre-
hensive volume on ‘Alternative Investment Funds in Europe’. This book provides a full review of the impact of the controversial European Directive on Alternative Investment Fund Managers. Professor Corjo Jansen was appointed as a member of the Scientific Advisory Board of the Max Planck Institute for Comparative and International Private Law in Hamburg (for more details, see page 34).

**Our academic reputation**

As in previous years, in 2014 many of our researchers were recognized for their achievements and their contributions to international academic publications. Also, the quality of our research is reflected in the impact factors of the journals in which it was published. Articles in peer-reviewed scientific journals published in 2014 mostly appeared in journals that have – across all academic domains – the highest impact factors (they are in the top 25%). And about half of these journals are in the top 10% (see Figure 3).

**Newly elected members at national and international academic societies**

- Profs Heino Falcke (Astrophysics and Radio Astronomy) and Mikhail Katsnelson (Theoretical Physics) were elected as members of the Royal Netherlands Academy of Arts and Sciences (KNAW).
- Profs Guillén Fernández (Cognitive Neuroscience), John Jansen (Biomaterials and Experimental Implantology), Antje Meyer (Psycholinguistics), Jeke Moerdijk (Algebra and Topology) and Han van Krieken (Pathology) were elected as members of the Academia Europaea.
- Prof. Mike Jetten was elected as a member of the European Molecular Biology Organization (EMBO).
- Prof. David Norris was elected as an External Scientific Member of the Max Planck Society.
- Profs. Peter Hagoort (Cognitive Neuroscience) and Paula Fikkert (Linguistics) were elected as members of the Royal Holland Society of Sciences and Humanities (KHMW).
- Drs Marieke van den Brink and Floris de Lange were elected to the Young Academy of the KNAW.

**Examples of recognition**

- Professors Christian Beckmann, Mikhail Katsnelson and Bart Kiemeney were listed in Thomson Reuters’ book The world’s most influential scientific minds 2014 (based on citations in the period 2002-2013).
- Prof. Richard Grol received the prestigious Donabedian International Award for Leadership in Quality of Care.
- Prof. Corjo Jansen was appointed as a member of the Scientific Advisory Board of the Max Planck Institute for Comparative and International Private Law in Hamburg.
- Prof. Vennix received an Outstanding Service Award “for excellence of service and accomplishment over a sustained period of time” at the International System Dynamics Conference 2014.
- Dr Christian Gilissen won the Young Investigator Award of the Netherlands Society for Human Genetics, the European Society of Human Genetics (ESHG) Isabelle Oberle award, and the European Journal of Human Genetics most cited paper award.
- Dr Simone van der Burg was awarded the Dutch L’Oréal UNESCO Fellowship for Women in Science.
- Prof. Jan van der Watt received an Alexander-von-Humboldt Stipendium.
- Prof. Rene ten Bos received an honorary professorship from the University of St. Andrews (Scotland).
- Dr Ioan M. rcu received the André Lichnerowicz Prize in Poisson Geometry.
- Prof. Gert-Jan van der Heiden was awarded an external FRIAS Fellowship (Freiburg, Germany).
Introduction

• Dr Willem Frankenhuis received the New Investigator Award from the European Human Behaviour and Evolution Association (EHBEA).

Internationalization

Scholarly research is inherently international and many research topics have global dimensions such as research on human health, education, literature, international law, cyber security and nature management. On the other hand, some research equipment is too large – and expensive – for one university to purchase alone (this is, for example, the case for research in Astronomy, Astrophysics, Particle Physics and High magnetic fields). This is why our researchers regularly join forces with colleagues at other institutes around the world. We put such strong emphasis on international cooperation in order to complement and create synergy (of expertise and/or facilities), to increase critical mass, to form international research consortia, to recruit talented students and to provide our PhD students with the best job opportunities. Many of our doctoral candidates, post-doctoral researchers and other staff were born outside the Netherlands: 24.5% of all researchers (in FTE). The illustration on the inside front cover of this report shows some of our international partner institutions around the globe.

Radboud Excellence Initiative

At Radboud University we feel strongly that the climate for research within the university should have an international dimension. International partnerships between researchers and leading academics around the world are a high priority. The Radboud Excellence Initiative promotes contacts and cooperation between outstanding academics. Under this initiative, very talented scientists based outside the Netherlands can work at the University for shorter or longer periods. The first call for Fellowships and Professorships was announced in 2013. The first full year of this valuable new initiative was 2014.

Radboud Excellence Fellowships

These are intended for exceptionally talented young researchers, who are selected on the basis of their academic record, as well as a promising original research plan. Twenty Fellowships will be offered every year. These are intended for researchers based outside the Netherlands who have obtained their doctorates between two and twelve years ago. Each Fellowship funds a research project lasting one to two years, to be conducted in one of our ‘top’ research groups.

In 2014 such fellowships were awarded to the following researchers: Dr Nixon Abraham (University of Geneva), Dr Andre Altman (Stanford University School of Medicine), Dr Claudia Civai (University of Minnesota), Dr William Duba (Swiss National Science Foundation at University of Fribourg), Dr Jan Engelman (University of Zürich), Dr Sara Fabbri (Western University, London, Canada), Dr Fabian Gieseke (University of Copenhagen), Dr Jens Kaad (International School for Advanced Studies, Trieste, Italy), Dr Sebastian Lücker (University of Vienna), Dr Samaya Nissanke (California Institute of Technology, Pasadena), Dr Alessandro Polini (Harvard Medical School, Cambridge, USA), Dr Valerio Ribeiro (University of Capetown), Dr James Ryan (Albert Einstein Institute, Golm, Germany), Dr Miriam Schmids (University College London), Dr Marine Vuillermet (University of California, Berkeley) and Dr Dayong Yang (Cornell University, Ithaca).

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.
The University awards between two and four Excellence Professorships every year. Each Professorship enables an eminent researcher to conduct research in Nijmegen for about six months.

For 2014 such professorships were awarded to the following researchers: Prof. Ian Holt (MRC National Institute for Medical Research, London), who is participating in research at the Radboud Institute for Molecular Life Sciences, Prof. Tania Kouteva (Heinrich Heine University, Düsseldorf), who does research at the Centre for Language Studies, Prof. Dexter Kozen (Cornell University, Ithaca), who joined the Institute for Computing and Information Sciences and Prof. Arthur Suits (Wayne State University, Detroit), who works at the Institute for Molecules and Materials.

Radboud Research Facilities
In March 2014 the province of Gelderland together with Radboud University financed a project called Radboud Research Facilities. Thanks to an investment of €12.4 million by Radboudumc and Radboud University – half of which was donated by the province – advanced research equipment for medical and scientific studies could be purchased. This state-of-the-art equipment is also accessible for companies in the region. The investment also provides an important stimulus for some of the top research areas at the University. The new facilities are dedicated to research on developing new drugs, new diagnostics, new surgery techniques, brain research, research on behaviour, mobility research, genetics, digital security in health care, and climate research.

Radboud Research Facilities is of particular interest to young start-up companies, for example those working in health care, chemistry and life sciences, as access to high-tech equipment is crucial for product development. These young companies often lack the resources to make the necessary investments.

The High Field Magnet Laboratory (HFML) at our University specializes in research on and constructing the strongest continuous magnetic fields for research in Physics, Chemistry and Life Sciences. In 2014 the HFML received from the Ministry of Education, Science and Culture (OCW) and NWO a Roadmap subsidy for large-scale infrastructure (worth €14.9 million) to build new high-power magnets and extend the cooling system.

Grants and awards for excellent young scientists
Many young scientists were awarded prestigious national or international grants in 2014, competing with some of the best researchers in the world.

Eighteen Radboud researchers received an NWO Veni grant in 2014. This will enable them to do research for three years after graduating with a PhD. The winners this year were Drs Marleen Ansems, Wenui Dong, Willem Frankenhuys, Saskia Haegens, Tessa van Leeuwen, Sebastian Lücke, Arne Nieuwenhuys, Gerardo Ortega, Floris Overduin, Simone Ritter, Esther Rozendaal, Lila San Roque, Joris Schapendonk, Arnt Schellekens, Guillaume Sescousse, Tineke Snijders, Francesca Vidotto and Monique van der Voet.

Six post-doctoral researchers received an NWO Vidi grant in 2014. This major achievement will enable them to develop their line of research for five years. These grants were awarded to Drs Lejla Batina, Jelle Goeman, Taco Kooij, Emmanuel Kuntsche, Sander Leeuwenburgh and Rogier Mars.

Two – more senior – researchers received NWO Vici grants in 2014. These substantial grants will enable them to further develop their line of research for five years. These grants were awarded to Prof. Jolanda de Vries and Dr Rob Baltussen.

Five prestigious Starting grants from the European Research Council (ERC) were awarded to Drs Boran Kartal, Stijn Buitink, Teun Bousema, Anouk de Koning and Mike Cohen. These grants allow budding top

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<tr>
<th>Year</th>
<th>Percentage of all grants acquired</th>
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<td>Veni</td>
<td>2008: 9.8% 2009: 10.2% 2010: 5.4% 2011: 12.8% 2012: 14.0% 2013: 12.8% 2014: 13.8%*</td>
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<td>Vidi</td>
<td>2008: 14.5% 2009: 9.9% 2010: 13.3% 2011: No 2012: 8.1% 2013: 12.5% 2014: 7.5%</td>
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<tr>
<td>Vici</td>
<td>2008: 3.8% 2009: No 2010: 10.0% 2011: 9.7% 2012: 14.3% 2013: 17.9% 2014: 7.1%</td>
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</table>

*In most cases the performance exceeds 7.3%, 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).

Table 1. Success rate in acquisition of personal grants for research (NWO)
One researcher – Dr Kees Albers – received a European Marie Curie Career Integration grant to extend his research group.

Three young researchers – Drs Marjoke Debets, Helen Buckler and Sasha Ondohaka – received an NWO Rubicon Scholarship to enable them to go abroad to conduct research immediately after receiving their doctorate.

Seven researchers received a European Marie Curie grant. This allows young researchers from our University to work for two years abroad or enables young researchers from abroad to do research for two years here. The five laureates in 2014 who went abroad were Drs Matteo Bolomino-Vittori, Matthias Sjers, Janny Stapel, Annelinde Vandenbroucke and Lennart Verhagen. The two laureates who came here from abroad were: Drs Ervin Poljac (KU Leuven) and Silvia Mihaila (Harvard-MIT, Boston).

**Societal impact**

One characteristic of our University is the involvement in important societal issues and much of the research agenda is inspired by societal need. For example, the Elder. He answers the question what the meaning of their work is by examining the cultural relationship between art and its audience. Both artists demonstrate social, economic and political resonances in their paintings. For Bosch the image was a morality play about the rarity of good in a world teeming with evil monsters. For Bruegel it was frequently a reference to political events. Far from producing puzzle pictures, they were assembling knowledge as part of a visual culture that was central to the life of society. It extends from the sexuality and spirituality of Bosch to secular satisfaction in Bruegel at a time of social upheaval and a great turning point of world history – the end of the Middle Ages and the beginning of the modern world.

**Language and communication**

- Dr Helmer Strik and Dr Catia Cucchiarini have acquired a patent for an ‘Automated system for training oral language proficiency’. As a result of increasing internationalization there is growing demand from education and business community for people who speak foreign languages well. Intelligible pronunciation is regarded as important for e.g. successful interaction and social acceptance. However, an important problem is that oral proficiency training requires so much time, feedback and practice, that very often it cannot be provided sufficiently in traditional language classes. So an automated system has been devised.

- A large group of CLS researchers took part in a workshop on linguistics for language teachers in Dutch secondary education. Considerable efforts are made in secondary education to teach students that some of their language forms are ‘ungrammatical’.

- Prof. Enny Das examines the origins of individuals’ reluctance to accept risk information as well as strategies to promote effective health communication. According to Prof. Das, people are more receptive to health promoting messages when they feel good about themselves.
A possible explanation is that a vulnerable ego is more likely to react defensively; so it’s important to first reassure the ego.

- Ankie Hoefnagels, MSc, Dr Migchels and co-authors received a Highly Commended Award from the Journal of Service Management for their article ‘Understanding generation Y and their use of social media: a review and research agenda’. Dr Joosten and Dr Van Birgelen obtained a similar award for their article ‘Value fusion: the blending of consumer and firm value in the distinct context of mobile technologies and social media’.

**Development of society and justice**

- Dr Jan-Rees Helderman, Dr Johan de Kruijf, Prof. Sandra van Thiell and Jesper Verheij, MSc, analysed the National Health Care Institute, an independent public body set up to improve Dutch health care. Commissioned by the board of directors of the Central Health Insurance board, they examine how the realization of this new governing institute can be understood against the backdrop of a changing health policy agenda and changing political-administrative and societal relations in their book ‘Dike-Reeve of the Health Care Polder’.
- Dr Sascha Füllbrunn and Prof. Catherine Eckel (Texas A&M) published ‘Thor ‘SHE’ Blows? Gender, Competition, and Bubbles in Experimental Asset Markets’ in the prestigious American Economic Review. Inspired by a New York Times article claiming that ‘with more women on the trading floor, risk-taking would be a saner business’, they used Smith, Suchaneck and Williams’ (1988) asset market design to experimentally test whether gender composition plays a role in price bubble formation. The results, supported by a meta-analysis of 35 markets, indicate that increasing higher proportions of women reduce price bubble formation and suggest that the statement in The New York Times is supported by evidence.
- Cohesion in societies is studied by examining ethnic diversity effects on social and economic capital. An article in the highly reputed Annual Review of Sociology summarizes the major insights on this issue. Several mechanisms that underlie the negative relationship between ethnic heterogeneity and social cohesion are scrutinized: the homophily principle, feelings of anomie, group threat, and social disorganization. The article shows that the hypothesized detrimental effects of ethnic diversity are spatially bounded to neighbourhoods, that support for the constrict claim is more common in the United States than in other countries, and that ethnic diversity is not related to inter-ethnic social cohesion.
- The Business and Law Research Centre plays an active role in consultations launched by Dutch and European legislators. An example includes the response prepared by the Centre to a consultation on the Financial Markets Act 2016. The Centre also produced a report on the topic ‘Shareholders’ rights in insolvency’ that was commissioned by the World Bank and the Central Bank of Italy.
- Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on cyber security issues and Dr Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting [‘Elektronisch stemmen in het stem-lokaal’] set up by the Dutch Ministry of the Interior.

**Behaviour and education**

- MindLight is a 3D video game developed by BSI researchers and game experts that uses the mind as the game controller. Through neurofeedback mechanics, the game incorporates evidence-based relaxation techniques and attention bias modification methods to produce an immersive game world through which children learn to face and overcome their anxiety and fears. One of the largest residential treatment centres in the Netherlands (Pluryn) is deciding now to implement the video game as regular treatment practice with their most impaired youth.
- BSI coordinated the NWO/NIHC programme ‘The learning child’, which is used to develop and evaluate new educational forms that do justice to the individual capacities of children in primary education. The programme makes use of the latest insights in brain and cognition research. In each of the projects within the programme, apps and other ICT tools have been developed to facilitate children’s learning. These innovative instruments will be disseminated in collaboration with the Expertisecentrum Nederlands.
- Together with major national publishers of school materials, (e.g. Malmberg) researchers at the Donders Institute actively participate in educational development. Recent insights into cognitive, social and emotional aspects of early human development are used to develop learning programmes for primary schools as well as those focusing on anxiety, habits and perception.
- Dr Emmanuel Kuntsche received an NWO Vidi grant for a project on the influence of parental alcohol consumption on attitudes to alcohol in their children.

**Molecules and materials**

- Grants for new chemical innovations (KIEM subsidies) were awarded to Prof. Pruijn, Prof. Rutjes, and Dr Feiters. Pruijn and NovioSmart plan to develop...
Introduction

a new blood test for detecting antibodies related to rheumatoid arthritis. Feiters and Okklo Life Sciences intend to make a medicine that avoids accumulation of damaging substances in the body caused for instance by a genetic disorder. Profs. Rutjes and Pansynt will focus on a new class of compounds that are very promising antibiotics. These compounds can only be produced under high pressure.

• Dr Sander Leeuwenburgh has developed novel materials for bone regeneration.

• Professor Rasing’s group has studied laser-induced spin precession in a granular film of FePt. This will be the recording medium used in next-generation hard disk drives as it has an exceptionally high magneto crystalline anisotropy, which facilitates much higher data storage densities than can be achieved with current recording media.

• Dr Schermer’s group worked on Ultra-thin, high-performance tunnel junctions for III-V multi-junction solar cells. Due to the lower absorption compared to a standard tunnel junction, the wavelength-dependent response of the underlying Gallium Arsenide cell improved, which led to more efficient double junction cells.

We play an important role in transferring knowledge to society.

medium to reach this level in environmental science. The authors – in particular Prof. Hans de Kroon – received several invitations to give public lectures about their results.

Personalized medicine

• Implementing new findings in clinical practice is part of the daily work of clinicians as is education of peers, patients and patient organizations through lectures and meetings (e.g. Parkinsonnet.nl). Researchers at the Donders Institute participate actively in current e-science developments (the digital Parkinson polyclinic and Parkinson TV), partly in collaboration with patient organizations, thus directly promoting the impact of research.

• A new device that measures pressure instead of force and may reduce the discomfort associated with mammography was awarded the MedTech Innovation Price 2014. Dr Mireille Broeders was one of the authors.

• Astrid Joosten (well-known Dutch TV presenter) presented at a public event addressing the important question: How far are we from a custom-made personalized kidney? In front of 200 members of the public, scientists, clinicians and other stakeholders discussed state-of-the-art research on developing a biological artificial kidney, ethical dilemmas, and expectations for the future.

• Maarten de Rooij and Prof. Jelle Barentsz were awarded the Lauterbur Award for the best scientific MRI-related work at a conference in New Orleans. The study shows the ability of multi-parametric MRI and MR-guided biopsy to improve prostate cancer diagnoses, and demonstrates that the MRI strategy appears to be cost-effective compared to standard care.

Transfer of knowledge and technology

Transfer of knowledge and technology is one of the core tasks – and a key ambition – of our University, and we stimulate innovation and create conditions for entrepreneurship. Academic knowledge is converted into practical results with societal value in various ways. At the same time societal problems are an important impulse for academic research at our institutes.

We encourage the use of academic knowledge in society by focusing on the following activities: post-academic education, joint research with private and public partners, public events, the formulation of guidelines, facilitating the establishment of new companies, supporting start-up companies and educating students in entrepreneurship. The University also participates in and initiates regional development programmes.

The proportion of researchers financed by research contracts in relation to the number of researchers financed by core funding (see key figures on page 7) shows that our University is successful in obtaining projects with societally relevant components. Radboud University has also been described by the KNAW-Rathenau Institute (2012) as a ‘very entrepreneurial university’.

Water and wetlands

• Our 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.

• The aquatic ecologists at IWWR work closely with the spin-off company B-Ware, which exploits biogeochemical and ecological knowledge related to water and wetlands.

• The aquatic ecologists at IWWR work closely with the spin-off company B-Ware, which exploits biogeochemical and ecological knowledge related to...
Some examples of knowledge and technology transfer in 2014:

Public-private cooperation
The University continued working on a project called ‘Knowledgealliance Rhine-Waal 2020’ with its partners the University of Duisburg-Essen, Wageningen University, the Eindhoven University of Technology, the HAN University of Applied Sciences, the Rhine-Waal University of Applied Sciences, Chamber of Commerce Province Gelderland and the Chamber of Commerce Duisburg-Wesel-Kleve. The University thus contributes – together with other research institutions and small and medium-sized companies (SMEs) – to an innovative region that extends across the nearby border with Germany. By financing grants to innovative, trans-boundary enterprises, this alliance delivered 15 new innovations in 2014 between research institutes and SMEs in the region.

The project ‘Gelderland valoriseert’ is designed to further develop the region as well as entrepreneurs by stimulating cooperation between knowledge institutions, companies and societal organizations. In 2014, this project organized 86 new contacts among Chemistry related enterprises. Also 15 boot camps were organized for SMEs and students, while 10 Innovation lab projects started and seven new innovative start-up companies received support.

The spin-off-support-organization ‘Mercator Incubator Nijmegen’ is closely related to Radboud University. It organizes activities and facilities for science-based spin-off-companies. Mercator Incubator cooperates with other organizations and participates in projects related to accommodation and facilities e.g. BV Campus Radboud University and iLab Nijmegen. In 2014, a second location of iLab Nijmegen was opened on the NovioTech Campus, nearby NXP Semiconductors. The first location of iLab Nijmegen is on the Radboud campus. There was remarkably rapid spin-off growth in 2014 in the ICT sector. To facilitate contacts between ICT companies and ICT scientists, Mercator Incubator set up ICT network Nijmegen and organized three meetings.

The ‘Science to Business Café’, organized by Radboud University, brings students, researchers, start-up and established companies together. Themes in 2014 were ‘International business’ and ‘Brilliant failures’.

Patents and licences
In 2014, Researchers at the University submitted a total of 14 patents in Chemistry, Health Sciences and Life Sciences. Furthermore, three spin-off companies started up on the basis of previously developed intellectual property.

Activities for the general public
Professor Jos Koldeweij is one of the founding fathers of the ‘Bosch Research and Conservation Project (BRCP)’. Five hundred years after the day the famous painter Jheronimus Bosch died – during the Bosch year 2016 – three of his triptychs will come back from Venice to his city of birth (Den Bosch) in the Netherlands.

Indicators for knowledge and technology transfer
In 2013, the universities in the Netherlands joined forces to formulate indicators for the conversion of academic results into societal results. From 2015 onwards, the activities at our University that are designed to maximize knowledge and technology transfer will be monitored according to these indicators.

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

Novolanguage, spin-off from the Centre for Language Studies, was elected as best Start Up of 2014 in the province of Gelderland. NovoLanguage and colleagues develop technologies for training speech.
Evaluation Protocol for Academic Research in the Netherlands, which includes evaluation of the training and education programme for PhD students. There are four criteria: 1) quality, 2) productivity, 3) relevance and 4) vitality and feasibility. The assessments, which range from excellent to unsatisfactory, are defined as follows:

- Excellent: leading, at the forefront worldwide
- Very good: internationally competitive, leading nationally
- Good: nationally competitive, visible internationally
- Satisfactory: visible nationally
- Unsatisfactory: not worth pursuing.

In 2014 the research at two institutes was evaluated and Assessment Reports on other institutes that were evaluated in 2013 were received.

**Institute for Management Research (IMR)**

The research and education of doctoral candidates at IMR was evaluated in 2013. The Assessment Report arrived early in 2014. The Committee praised the direction the Institute had chosen in the recent years and it “…approves of the way PhD students are introduced, trained, supervised and allowed their own organization. The committee found ample proof of the fact that the students are benefitting from the open, multi-disciplinary research environment the IMR offers them”. The five most important recommendations of the Review Committee were: 1) emphasize multidisciplinary research, 2) develop a strong publication strategy, 3) strengthen acquisition activities, 4) consider a new organization structure and 5) improve IMR’s visibility. The Institute addressed each of these recommendations in its response and meanwhile it is in the process of implementing its plans for further improvement.

**Nijmegen Institute for Social and Cultural Research (NISCO)**

Two programmes at NISCO – Cultural Anthropology and Sociology – were assessed in 2013 during national evaluations of these disciplines. The reports on these assessments were received in 2014.

Regarding anthropological research the Committee noticed that “The programme has many merits: its research topics are highly relevant…..the three foci, mobility, marketization and marginalization are well chosen and clearly interlinked”. The Committee had some doubts on the integration of anthropology and developmental studies, which might lead to “…losing the anthropologists’ capacity to make a distinctive contribution”. It recommended focusing PhD projects on a more limited number of topics.

The Committee that reviewed the Sociology research programme was impressed by the number of articles published in top journals. It concluded “The Nijmegen programme is small, coherent, integrated, and highly professional”. “…the research is of a very high standard, but just short of being world-leading or pioneering”. “Overall, the outlook appears to be promising … the strong focus… provides continuity”. Meanwhile, the NISCO and the Faculty of Social Sciences are currently working on a plan for further improvement.

**Institute for Water and Wetland Research (IWW)**

In November 2014 the IWWR was evaluated, and early 2015 the final Assessment Report was received. The Committee “was pleased to see the wide variety of world-class research within the IWWR” and “…there is no doubt that the IWWR has a very strong academic reputation”. It recommended defining the Institute’s research themes in a way that is more multidisciplinary, ‘big-question’ oriented and unifying. It considers the societal relevance of the research as one of the strongest points of the IWWR. Overall, the Committee judged the vitality and feasibility of work done at IWWR to be very high. The Institute and the Faculty of Science are currently working on a plan for further development and progress, based on the recommendations of the Review Committee.

**Business and Law Research Centre (Onderzoekcentrum Onderneming) and Recht (OO&R)**

In October 2014 the research of the OO&R was evaluated. In its Assessment Report the Review Committee concludes that the Centre has excellent leadership and that it is structured and purposeful in its organization, vision and strategies. The Committee regards the academic reputation and the research facilities of the Centre to be excellent. Furthermore, it is of the opinion that the research done at the Centre is world class. The committee is impressed with the PhD training provided by the OO&R. Supervision is excellent in all respects and the Research Masters programme is an ideal preparation for a PhD. The Committee suggests that attracting international junior and senior researchers should be a strategy in the years to come. Some other recommendations are: review the organizational structure, further enhance the policy on internationalization, reformulate the mission statement (including a statement on the independence of researchers), continue to apply for external research funding and improve the ‘time to completion’ of PhDs. In the meantime OO&R and the Faculty of Law have drawn up a plan to address these recommendations.

**Academic integrity**

The University Board actively promotes academic integrity and accountability by increasing awareness among researchers. 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, new policies related to data storage and management (data acquisition, data analysis and reporting), and critical assessments by colleagues.

Two examples: NISCO has institutionalized a system of archiving information related to all publications by its researchers. This makes it possible to perform several security checks with respect to fraud, plagiarism and data construction. Furthermore, there is a long-standing tradition, established by NISCO researchers, to provide the scientific community with well-documented open source data to improve scientific transparency and integrity. This tradition has been widely recognized as one of the best practices. The way both data and publications are archived together with source information has contributed to best practice at the University.

Use of honest and transparent working ethics as well as clear rules of accountability play a pivotal role in all research and RIMLS researchers comply with the academic integrity policies laid down by the University. Promoting awareness of academic integrity is equally important and RIMLS continues to raise awareness of this topic in Masters and PhD training programmes. Since the academic year 2012/13 (in the, MSc course on Science and Society) special attention has been paid to important aspects of good scientific conduct. Alongside bioethical issues and technology assessment, time is allocated to discussing integrity, scientific misconduct and the ethics of scientific authorship (under the supervision of Prof. Hub Zwart, Philosophy and Science Studies). Furthermore, data management has now been included in the MMD introduction course. Likewise in the compulsory introductory course of the PhD programme and in dedicated workshops, special attention is devoted to academic integrity and ethics. In 2014, a compulsory integrity workshop for 2nd year PhD students was set up.

Appointment of the Advice Council for Academic Integrity
On receiving the report and recommendations in it from the university task force on academic integrity in 2012, the Executive Board appointed an ‘Advice Council for Academic Integrity’ in 2013. This Council functions as a university think-tank, reflecting on diverse aspects related to academic integrity. An earlier report by the task force is used as starting point. The Council plays also an active role in implementing recommendations from this report. Members of the Advice Council are:

- Prof. J.W.A. Smit (Radboudumc, chair)
- Dr W. Haselager (Donders Institute, vice-chair)
- Dr M.J. Becker (Faculty of Philosophy, Theology and Religious Studies)
- Prof. A.P.J. van den Bosch (Faculty of Arts)
- Dr L. Consoli (Faculty of Science)
- Prof. S.C.J.J. Kortmann (Faculty of Law)
- Prof. T.M. Heskes (Faculty of Science)
- Prof. K. Roelofs (Faculty of Social Sciences)
- Prof. P. Leroy (Nijmegen School of Management)
- M. Spronken, MSc (Faculty of Social Sciences, doctoral candidate)
- P. Verleg (student).

Some achievements in 2014
A website on academic integrity was built in order to communicate best practices, plagiarism, rules, codes of conduct and other information for lecturers and researchers.

Since Autumn 2014 the course Academic Integrity has been available in the University’s curriculum for doctoral candidates. This course is taught by the Prof. Evert van der Zweerde and Dr Marcel Becker.

Following the University Policy on Storage and management of Research Data, the Executive Board has appointed the Steering Committee Research Data Management, chaired by Vice-president Wilma de Koning, MSc. The university-wide programme Research Data Management creates an infrastructure and supports research institutes with data storage and management.

In order to promote discussion on academic integrity, the Young Academy of KNAW initiated the theatre performance ‘Gewetenschap’ [ConScience] and the Advice Council supported performances on the campus. Two successful performances (and a discussion on 28 October) attracted 220 visitors.

Members of the Advice Council gave lectures both within and outside the university campus. A book on these lectures was published by Dr Luca Consoli and Ron Welters, MSc (eds.): ‘De Goede Wetenschapper’, essays over goede wetenschap en wetenschappelijke integriteit, [The good scientist, essays on good science and academic integrity].
The Research Institute for Philosophy, Theology and Religious Studies (PTR) enhances our understanding of humankind’s response to fundamental questions relating to society, human beings and their place in the natural world. Its research is organized in three interdisciplinary thematic programmes.

Programme 1: Competing Worldviews
Researchers working in this programme examine ‘Philosophy, Theology, and Science as Competitors and Complements.’ Throughout history, theology, philosophy and the sciences have emerged as large interpretative and explanatory frameworks. In some periods these frameworks complemented each other; in others, they were rivals. This programme focuses on this history and the current state of their interaction. Key topics are concepts e.g., ‘cause’, ‘soul’ and ‘justice’; institutions (e.g., universities, courts, monasteries and laboratories), methods (e.g., exegesis, experiment and analysis) and documents (e.g., encyclicals, inquisitional proceedings and university textbooks). This research programme, which is coordinated by Prof. Lüthy, encompasses the Center for the History of Philosophy and Science and the Center for Catholic Studies: Historical and Systematic Perspectives.

Philosophy of mind and language is one of the topics studied in the programme Cognitive Humanities.
Programme 2: Cognitive Humanities
Culture – which includes language and religion – and the human cognitive system are inextricably intertwined. On the one hand, language, religion and other cultural artefacts are products of the human mind. On the other hand, they provide a unique cognitive niche within which the human mind can function and flourish. Researchers working in the Cognitive Humanities programme investigate language and religion by using existing knowledge of the human cognitive system. Conversely, they investigate the human cognitive system through insights into language and religion. The programme, which is coordinated by Prof. Venbrux, consists of a thematic group working on Cognition, Culture and Language and a thematic group working on Religion and the Crisis of Meaning.

Programme 3: Modernity Contested
Modernization involves the discovery of subjectivity and the dominance of science in the domain of knowledge, societal differentiation, rationalization and secularization. The process of modernization is essentially contested. The critique of modernity and of its symptoms, whether inspired by religious, philosophical, or societal concerns, is pitted against equally passionate apologies. Contemporary culture is marked, for instance, by heated debates about Islam, and about religion in general. Researchers working in this programme investigate the status and legitimacy of various contestations of modernity. This programme, which is coordinated by Prof. Wils, combines a thematic group working on Islamic Studies with the Center for Contemporary European Philosophy.

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

Collaboration
Researchers at the Institute collaborate intensively with colleagues, locally, nationally and internationally. Locally, collaboration consists of joint research groups with other faculties. For example, the new book series, Radboud Studies in Humanities, which was launched in October 2014, is edited jointly by members of the Faculty PTR and of the Faculty of Arts. Scholars from the Center for the History of Philosophy and Science collaborate with researchers from Historical, Literary and Cultural Studies in the Radboud Medieval and Early Modern Studies group. And researchers from the Cognitive Humanities programme collaborate with the Center for Language Studies and with the Donders Institute for Brain, Cognition and Behaviour.

Nationally, members of PTR participate in various research schools. In 2014, for example, the annual conference of the National Research School of Philosophy took place in Nijmegen (260 participants; organizers: Prof. P. Bakker & Dr Ch. Bax). Other PTR researchers regularly participate in the Netherlands School for Advanced Studies in Theology and Religion, in the Netherlands Interuniversity School for Islamic Studies and in the Research School for Medieval Studies.

Internationally, PTR researchers collaborate extensively with international researchers and research groups, including those at high-ranking institutes such as the Massachusetts Institute of Technology, University College London, and Paris IV/Sorbonne in Paris. Programme 1 continues a series of joint-degree PhD projects, with the University of Bucharest, the Free University of Brussels, and the Technische Universität, Berlin. There has also been fruitful collaboration with the Excellence Cluster ‘Religion und Politik’ at the University of Münster, the international network ‘Justice,
Aristotle cannot have been ‘saved’ in the Christian sense, and studied a notorious fourteenth-century text according to which the emergence of Europe’s democratic structure. William Duba that is characteristic of Christianity and that has contributed to Daniela Müller presented heresy as part of a culture of dialogue.

Programme I

Research results
Programme 1

Daniela Müller presented heresy as part of a culture of dialogue that is characteristic of Christianity and that has contributed to the emergence of Europe’s democratic structure. William Duba studied a notorious fourteenth-century text according to which Aristotle cannot have been ‘saved’ in the Christian sense, and identified the author as the conservative Franciscan theologian Hugh of Novo Castro. Christoph Lüthy has proposed a new genealogy of Descartes’ metaphysics that connects the ontology of the ‘Triumph of Philosophy’ of Nicolaus Taurellus (1573) through Gorlaeus and Regius to Descartes’ dualism. Elena Nicoli discovered that the earliest Renaissance reception of Lucretius was by no means limited to philology, but that the first impact was, unexpectedly, in the domain of philosophy and in what we would nowadays call biology and physics. Frederik Bakker found that Lucretius’ zoogonical theory, which essentially reproduces Empedocles’ zoogony by means of natural selection, has been modified in response to Aristotle’s criticism of Empedocles. In his forthcoming book, Kuni Sakamoto explains the enigmatic Julius Caesar Scaliger, whose bizarre but highly successful Exoteric Exercises (1557) were applauded both by Aristotelians and by their opponents, as well as by Catholics and Protestants. Erik Döcker provided a trenchant analysis of the ethical dilemmas involving deep-sea biologists, who can only carry out their work with the funds of international companies, but at the same time have to protect the deep sea precisely from the mining plans of these companies.

Programme 2

Leon de Bruin has shown that the predictive coding approach to the brain solves classic problems in social cognition research. Bart Geurts and Marc Slors have both argued that philosophical and commonsense psychology should not be mistaken for pre-scientific cognitive psychology; this underscores the added value of philosophical analysis of commonsense psychology and helps to reinterpret results of cognitive psychological and neuroscientific research. Ellen van Wolde and Ruti Vardi have included methods from Construction Grammar, Collostructional Analysis, and Cognitive Grammar in the study of Biblical texts. Thus, they made significant steps towards a methodological approach by means of which moral information may be identified in texts where direct imperatives, virtue and vice lists, etc. are not present. Thomas Quartier initiated an international debate on monastic liturgy, combining methods and theories from ritual studies, liturgical studies and spirituality studies.

Carl Sterkens and colleagues found that silence of religious identification influences willingness to maintain social distance with out-groups. This finding highlights the role of out-group trust in ethno-religiously stratified societies with collectivist culture such as the Philippines. Chris Hermans and Carl Sterkens published an article on four major issues on methodology in cross-religious research. Hans Schilderman has shown that the definition and measurement of religion is highly problematic, since the assumption of a simple harmony between the scientific concept of religion, church doctrine and practiced belief can no longer be assumed.

Programme 3

Gert-Jan van der Heiden and Antonio Cimino have developed new perspectives on metaphysical categories such as ‘plurality’ and ‘contingency’. In the ongoing project on the Letters of Saint Paul, Ezra Delahaye demonstrated that the contemporary philosophical interest in these letters is well motivated by their severe political consequences. Philippe Van Haute has shown that the introduction of Freud’s Oedipuscomplex was much later than is often assumed. This underscores congeniality of early Freudian thinking to contemporary philosophers such as Deleuze and Guattari. Research on the foundations of democracy by Evert van der Zweerde and Marin Terpstra has shown their essential relationship to the philosophical and religious heritage of Europe. Thus, they show that the loss of trust in (European) democracy corresponds to growing doubts about the European identity and the future of modernity. Jean-Pierre Wils has argued that these doubts are also visible in the uncertainty about the philosophical and cultural relationship between religion and arts.

In research that has received ample media attention, Martijn de Koning investigated Islam activism and motivations for radicalization in Belgium, the Netherlands and Germany. De Koning shows how resistance of different networks to perceived humiliation, repression and submission by non-believers, leads to opting for an idealized view on Islam and society. This view, in turn, changes their perception of media and politics.

Societal impact

With diverse forms of knowledge utilization, the impact of PTR research on society is very substantial. Media attention for our research on Islam, Salafism and IS, for instance, is huge. Two practical resource brochures on peace building produced by PTR...
researchers are now widely used by NGOs in Indonesia. And an edited website with Biblical material made generally available received 1 million hits last year.

PTR researchers have a strong track record of public lectures, newspaper articles, interviews for various media and publications for wider audiences. With 73 public lectures, varying from the Amsterdam Brainwash festival to the Flemish Parliament, 38 interviews on national and international TV (Fox News, Nieuwsuur, Een Vandaag) and radio (NPO radio 1, 2 and 5), 44 newspaper interviews and 94 publications aimed at a broad audience, including some very well received books, this tradition was certainly kept alive in 2014.

But the societal impact of PTR research is not limited to these forms of dissemination. Manifestations, workshops, summer-schools, exhibitions, theatre productions and even the publication of a glossy magazine are also on the repertoire. Leon de Bruin, for instance, worked on an interactive theatre production on ‘The Collective Unconsciousness’. Brenda Matthijsen produced a ‘glossy’ on funeral cultures – Doodzaak – and organized a master class for undertakers. Inigo Bocken was co-organizer of an exhibition on Van Eyck and Rogier van der Weyden at the Rijksmuseum Twenthe, and contributed to the impressive catalogue. Christoph Lüthy developed a philosophy course for primary school, which culminated in a presentation by pupils at the Faculty. Christoph Hübenthal organized a conference on societal responsibility for the Thijmengootschap, William Duba gave a summer school on medieval manuscripts and Ria van den Brandt organized public events on the Holocaust, including an exhibition in Westerbork.

Future research
Researchers working in programme 1 will organize high-profile international conferences on Julius Caesar Scaliger and Girolamo Cardano (Sakamoto & Lüthy), on the History of Phaenomenology (Leijenhorst & Cimino), and on early-modern psychology (Colloquium: P. Bakker, Spruit & Lüthy). The first two volumes of John Buridan’s Commentary on Aristotle’s Physics will be published (P. Bakker, Thijssen, Streijger, Sylla). William Duba will co-organize a workshop at the Institut de Recherche et d’Histoire des Textes, Paris, on the medieval genre of principia-questions on the Sentences, which he has discovered to be the first ‘paper debates’ in history. Prof. Müller will focus on the role of women in religious debates as a possible point of departure for the emancipation of women in Europe. She will also work on self-sacrifice and suicide in the Christian tradition.

In programme 2, the ERC project on unravelling the language of perspective enters its second year (Dr Bary). Dr de Bruin intends to study the idea of ‘uncertainty management’, while a new NWO-funded programme on management of the self in psychiatry, supervised by Prof. Slors, will commence. Researchers working on death studies will extend their comparative research on how Catholicism and Protestantism have shaped relationships between the living and the dead in contemporary Europe. Biblical scholars will create an extended database (in the form of a source book) on Graeco-Roman and Hellenistic Jewish texts, guided by the Gospel of Luke, and will reconsider the Jewishness versus Graeco-Roman nature of the Gospel of John. Research collaboration with colleagues at the University of Groningen will result in a book on the Discursive Study of Religion.

In programme 3, a new edition of the ‘Drei Abhandlungen zur Sexualtheorie’ (Sigmund Freud) will be prepared by Philippe Van Haute and Herman Westerink. New lines of research on ‘Citizenship in the Arab World’ (Roel Meijer), on the ‘Sahaba Project on Companions of the Prophet’ (Nicole Boekhoff-van der Voort), on the ‘Social Dynamics of Public Goods’...
Key publications


Dissertations: 14
Scientific publications: 240
Professional publications: 133
Dr. Fleur Jongepier received a Frye Stipendium.

Prof. Paul Bakker, Dr Leen Spruit and Prof. Christoph Lüthy obtained funding for a Colloquium from the KNAW (Royal Netherlands Academy of Arts and Sciences).

Dr. Leen Spruit was appointed as a ‘KNAW Visiting Professor’.

Dr. William Duba was appointed as a ‘Radboud Excellence Fellow’.

Prof. Gert-Jan van der Heiden received an external senior Frias Fellowship.

Prof. Jean-Pierre Wils’ monograph ‘Kunst. Religion. Versuch über ein prekäres Verhältnis’ (Tübingen: Klöpfer & Meyer) was designated as ‘Book of the Month’ in September by the journal Publik-Forum.

Dr. Michael Scherer-Rath (RU) – in cooperation with Prof. M.A.G. Sprangers (principal investigator; AMC) – acquired an NWO grant for a research programme entitled ‘Improving the conceptualization and measurement of quality of life of patients with multiple chronic morbidities, exemplified by patients with cardiac disease undergoing cardiac intervention’ (2 PhD projects).

Prof. Slors acquired an NWO grant for a research programme on ‘Management of the Self: A Humanities approach to self-management in psychiatry and psychosomatic medicine’ (2 Postdocs and 2 PhD projects).

Prof. C.A.M. Hermans and Dr. T. van der Zee acquired funds for a research programme on ‘spirituality and school leadership’ (2 PhD projects). This research is financed by private funds.

Prof. Jan van der Watt received the Alexander-von-Humboldt-Stipendium 2014 (to be taken up in 2015) and a prestigious award for Christian publications (Christian Publishing Company, and Christian Art Company), 2014.

(Jean-Pierre Wils) on the ‘Changing Culture of Death and Dying’ (Jean-Pierre Wils), on ‘The Idea of Contestation in Modernity’ (Marin Terpstra), on ‘The Ethics of New Media and the Transformation of the Public Space’ (Marcel Becker) and on ‘Democracy in a New Key’ (Evert van der Zweerde).

Awards and Grants

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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 the fields of literature and literary theory, cultural studies, history, art history and archaeology. From 2014 onwards, HLCS research will be organized in two programmes based on a common focus and a specific period: ‘Europe and its Worlds before 1800’ and ‘Europe and its Worlds after 1800’.

‘Europe and its Worlds’ is a research theme in which questions whether and how ‘Europe’ consists of different worlds are addressed, how it differs from the rest of the world, and how it interacts with other worlds. Within these programmes, researchers collaborate in thematic groups to explore the spaces, cultural practices, beliefs, texts and ideas related to this central theme. The groups combine expertise from a variety of disciplines and function as platforms for discussing research plans and results, ensuring communication between researchers and supporting academic integrity. The results of HLCS research are mainly intended for a scholarly audience of peers, but often for a wider audience as well.

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, 1800-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).
- The Auxilia archaeological project bureau (Provincial Roman History; the analysis of excavations in the former territories of Germania Inferior (www.ru.nl/auxilia).
- Kunera: a database of over 15,000 medieval pilgrim badges and ampullae of religious and profane subjects (www.kunera.nl).
Collaboration

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

Prof. Olivier Hekster and Dr Gerda de Kleijn are members of the Executive Board of the International Network ‘Impact of Empire’, which studies the Roman Empire and the consequences of its actions for the regions it dominated. The network is directed by an international board of highly respected scholars drawn from the Classics, Archaeology, Ancient History, and History of Law from the Institute of Advances Studies (Princeton), CNRS (Paris), Leiden University, Università La Sapienza (Rome), Universität Wien, New York University, Universität Heidelberg and University of St Andrews.

Prof. Odin Dekkers and Dr Usha Wilbers are members of the core group of ESPRit, the European Society for Periodical Research, 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 organization is to unite the resources of individual scholars from various disciplines who work with periodicals.

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. It also seeks to help institutions becoming more visible beyond their national boundaries and facilitates cooperation between the participating institutions.

Prof. Alicia Montoya and Dr Marc Smeets 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 researchers at the centre aim to create interdisciplinary, fruitful collaborations within the academic community as well as visualization of the existing expertise in French-Dutch relations by means of an annual conference and the publication of its results. The centre can be consulted whenever specific expertise is needed related to current or historical developments in the relationship between France and the Netherlands.

Research results

In Art as History, History as Art, Jheronimus Bosch and Pieter Bruegel the Elder. Assembling knowledge not setting puzzles, Stephen Hitchins challenges many of the assumptions about Jheronimus Bosch and Pieter Bruegel the Elder. His answer to the question what their work means lies in the cultural relationship between the artwork and its audience. Both artists demonstrate social, economic and political resonances in their paintings that up to now have frequently been described in art historical terms alone. For Bosch the image was a morality play about the rarity of good in a world teeming with evil monsters. For Bruegel it was frequently a reference to political events. Far from producing puzzle pictures, they were assembling knowledge as part of a visual culture that was central to the life of society. This extends from the sexuality and spirituality of Bosch to secular satisfaction in Bruegel at a time of great social upheaval and an important turning point of world history – the end of the Middle Ages and the beginning of the modern world.

We live in a democracy, but what does that mean? The word democracy can relate to a political system, to a form of society, but also to a way of educating the next generation. It leads to a great deal of confusion. In Van wie is de burger? Omstreden democratie in Nederland 1945-1985 [Who does the citizen belong to? Contested
In our ever-changing and increasingly individualized society, it for future research.

What makes a novel a good novel, according to literary critics? For this research, Op de Beek and her colleague Yvette Linders (who did her PhD on the argumentational aspects of the reviews) have created a database of the collection of encoded reviews that is now available from 1999 onwards.


democracy in the Netherlands, 1945-1985], Wim de Jong argues that this confusion derives from the constant debate between conservatives and progressives, group thinkers and individualists, rulers and rebels about the interpretation of democracy. He shows how this debate carried on in the Netherlands after 1945 and how political elites and social movements repeatedly saw a ‘crisis of democracy’. An essential dilemma was the question as to whether citizens needed civic education and, if so, who should provide it. What was more important: creating law-abiding citizens or cultivating critical individuals?

What makes a novel a good novel, according to literary critics? Is it the style or structure, the sense of humour or the psychological depth? For her PhD research, Esther Op de Beek analyzed 743 reviews of novels that were published in five Dutch newspapers between 1955 and 2005. She examines some of the myths in Dutch literary history: how moralistic was the criticism of the fifties? Can you observe something like a ‘segregated’ (based on class and religion) or – in later decades – ‘desegregated’ way of reviewing? Is it true that reviewers increasingly write summaries and write less about the quality of the work? And how reliable or variable are such quality assessments? For this research, Op de Beek and her colleague Yvette Linders (who did her PhD on the argumentational aspects of the reviews within the Centre for Language Studies) have created a database of the collection of encoded reviews that is now available for future research.

In our ever-changing and increasingly individualized society, it has become more and more complicated to answer the simple question ‘Who am I?’ In her thesis More Than Meets the Eye: Dutch Fashion, Identity, and New Materialism, Daniëlle Bruggeman explores the complex notion of identity in relation to contemporary Dutch fashion brands such as Marlies Dekkers and Viktor&Rolf. Her analyses demonstrate that identity in contemporary fashion is quintessentially elusive and fluid. At the same time, fashion offers the opportunity to give identity a tangible form. Bruggeman advocates a view on fashion that will do more justice to the complex interaction between clothes, body and identity. In doing so, she argues for the importance of highlighting the embodied experience of wearing clothes as well as the emotional value of fashion. Fashion is often regarded as a superficial capitalist phenomenon in which idealized identities and outer appearances dominate. This research however emphasises that fashion is much more than meets the eye.

Societal impact

The sixteenth-century painter and printmaker Jacob Cornelisz van Oostsanen (ca. 1470-1533) is considered by art historians to be one of the greatest Dutch masters from this period. Yet, until recently, his meticulously executed paintings and numerous woodcuts were largely unknown to a wider audience. Dr Daantje Meuwissen was guest curator of the exhibition ‘Van Oostsanen: the first Dutch master’. She also wrote the exhibition catalogue, together with art history students. This unique exhibition, which was held at the Amsterdam Museum and the Stedelijk Museum Alkmaar from March until June, attracted more than 100,000 visitors. Art works from museums all over the world were brought to the Netherlands for this special occasion.

The city of Nijmegen played an important role in Operation Market Garden, one of the biggest military operations of World War II. With its two bridges across the Waal river (the main branch of the Rhine), control of the city was vital for the planned push towards Arnhem and Germany. After a failed attempt to cross the Rhine in Germany, in September 1944, the Allied advance was halted at Nijmegen. After several months of working on a new strategy, a British-Canadian army invaded Germany successfully from within the Nijmegen area. In his book The liberation in the picture [De bevrijding in beeld], Joost Rosendaal brings together different stories about the liberation of the Rhineland and the south-eastern Netherlands to create one coherent history. Photographs bring alive the consequences of this important phase in the war for local inhabitants.

How politically or socially engaged are writers nowadays and what are they committed to? And how do they use literary, religious and philosophical texts and traditions to achieve their goals? How powerful is the literary craft? In Op de hielen [Right behind you] edited by Dr Jos Muijres and Dr Esther Op de Beek – modern Dutch and Flemish literature is reviewed critically in nine essays. The book was composed on the occasion of the tenth anniversary of the post-academic course Recent Dutch and Flemish Literature, which attracts large numbers of participants every year.

‘Europe costs a lot of money.’ ‘The European Parliament has no power.’ ‘Voting for the European Parliament is a waste of time.’
Dr Floris Overduin – Assistant Professor of Greek and Latin Language and Literature – received an NWO Veni grant for his study on didactic poetry in ancient Greek. He will study these long poems – in which art and knowledge come together – from the perspective of the literary epic tradition rather than scholarly content.

Dr Floris Overduin received a Veni award for his project ‘The art of teaching: Greek didactic epic from the Hellenistic to the Imperial period’. Didactic poetry in ancient Greek from the first century AD is largely ignored by classicists. How should this scientific knowledge expressed in Homeric verses be assessed? This research will take long poems in which art and science are combined and, instead of considering them from an academic perspective, will consider them from the perspective of the literary epic tradition.

Dr Marguérite Corporaal acquired a grant in the Netherlands Organisation for Scientific Research (NWO) programme ‘Internationalisation in the Humanities’ in order to set up an International Network of Irish Famine Studies. In the past three years research on Ireland’s Great Famine (1845-1850) has greatly expanded and taken novel directions, mapping out hitherto underexplored sources from historical, political-economical, socio-geographical, literary and cultural perspectives. The new network will create a platform where Famine scholars can present their research and work on joint publications which will approach the Great Famine from interdisciplinary viewpoints and generate more generally applicable insights into the socio-cultural and economic contexts in which famines occur. In addition, the network will establish an internet forum where digitalized resources can be published, thus creating an archive through which public organizations with an interest in the Famine can get access to reliable information.

The aim of the Creative Industry programme Knowledge Innovation Mapping (KIEM) is to encourage and facilitate public-private partnerships in the creative industries. Senior researchers can apply for funding on behalf of consortia of companies and academic institutions.
**Key publications**


**Dissertations:** 14  
**Scientific publications:** 233  
**Professional publications:** 215
Dr Martijn Stevens (partner: Stichting COEN) was awarded funding for the project ‘The ability of knowledge’. Companies constantly need new knowledge to develop innovative products. Small businesses in the creative sector often find it difficult to adopt external knowledge. This project will make an inventory of the circumstances in which they need to make optimal use of external knowledge.

Prof. Anneke Smelik (partners: Vlisco Netherlands BV, Stichting Pieter Fentener van Vlissingen) acquired funding for ‘Vlisco: Made in Holland, adorned in West-Africa’. For more than 150 years, the Dutch company Vlisco has been producing colourful fabrics for the West and Central African market. To the African consumers these Dutch fabrics are inseparably connected with their culture and identity. The project team will investigate the historical and cultural developments behind this connection.
Research Centres of the Faculty of Law

Internationalization
The Faculty’s policy is to continue exploring options for international cooperation and the institutionalization of international contacts. Incorporating international and European law in legal research is essential in a world of interwoven legal systems. The Faculty board intends to form – or join – European consortiums in key areas, including Insolvency Law, Financial Law, European Private Law, Migration Law, Fundamental Rights and Security-related issues.

Societal relevance
Legal research almost always relates to legal practice and is therefore by its nature of societal relevance. The Faculty cooperates closely with – and also advises – external partners such as law firms and civil-law notary offices, financial organizations, international businesses, courts, government bodies, ministries, NGOs and European organizations.

Publications – academic papers in professional journals and case notes – are written with legal practice in mind. The Centre for Post-academic Legal Education (Centrum voor Postacademisch Juridisch Onderwijs, CPO) is the largest and leading provider of post-academic and professional legal education in the Netherlands. Academic publications also provide a solid foundation for legal practice. One aspect of the Faculty’s mission is to make academic research more practice-oriented, for example by preparing best practices, legislative proposals and EU directives.

The Business & Law Research Centre (Prof. Corjo Jansen)
The Business & Law Research Centre – Onderzoekcentrum Onderneming & Recht (OO&R) – involves cooperation between the Faculty and fifteen prominent, mostly international, law firms and Dutch multinationals. OO&R conducts fundamental research in ‘Business and Law’. It also offers a comprehensive Research
Master’s programme for gifted students and is actively involved in a wide range of postgraduate educational and professional training programmes.

The academic mission of the Centre is:
1. to conduct high-quality (national and international) academic research in Business and Law
2. to enhance the understanding of the theories which apply to Business and Law in the light of social, economic, political and financial developments
3. to encourage practicality in academic research, particularly by analysing the fundamental principles and foundations of (business-oriented) private law
4. to explore and initiate applications of academic research (e.g. in the area of national and international rules, regulations, principles and best practices)
5. to educate and supervise Master’s students and young researchers.

The four key research programmes of the Centre are:
1. Business and Patrimonial Law
2. Finance, Security Rights and Insolvency Law
3. Company Law
4. Financial Law

A major theme of the research in all programmes relates to European private law, comparative law and private international law.

The Centre, which was established in 1991, is recognized as a research school by the Royal Academy of Arts and Sciences (KNAW). In 2009, accreditation was renewed. In 2014 the Centre was evaluated according to the Standard Evaluation Protocol by an international Peer Review Committee. The preliminary findings of this committee are very promising and positive. The Centre’s educational programme for gifted students is certified by the Accreditation Organization NVAO.

Research facilities
The Centre houses a collection of books, journals and electronic publications on international and domestic Business 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-fertilization between legal practice and academia. The Centre has regulations, which dictate that all parties involved guarantee academic independence. The following partners participate in OO&R: AEGON, AkzoNobel, Allen & Overy, APG Asset Management, De Brauw Blackstone Westbroek, Clifford Chance, Freshfields Bruckhaus Deringer, Houthoff Buruma, ING Bank, Loyens & Loeff, NautaDutilh, Pels Rijcken & Droogleever Fortuijn, Rabobank Netherlands, Stibbe and Stichting Eumedion.

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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 Max Planck Institute for Comparative and International Private Law (Hamburg, Germany), the Nottingham Trent University (UK) and the Network for Studies on Pensions, Aging and Retirement (Netspar, Tilburg, the Netherlands).

Within the framework of International Working Groups established by the Centre (e.g. in the fields of financial law, agency and insolvency 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 international GO/NGOs (e.g. the IMF, INSOL Europe and the World Bank).

**Societal impact**

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 relating to remuneration of corporate directors and employees, insolvency fraud, corporate rescue and regulation of financial institutions are important examples.

The Centre plays an active role in consultations launched by Dutch and European legislators, for example the response prepared by the Centre in relation to consultations on the Financial Markets Act 2016. Researchers were also involved in deliberations held under the auspices of the Dutch Ministry of Security and Justice on legislative proposals for the enactment of the Business Continuity Acts. The Centre produced a report on ‘Shareholders’ rights in insolvency’ commissioned by the World Bank and the Central Bank of Italy. About thirty researchers at the Centre regularly teach at the CPO.

**Research results**

Private international law is a main research theme at the Centre. Further to the publication of a new textbook on general principles of private international law in 2013, a comprehensive new volume was published this year (in the prominent Asser series on patrimonial law from a private international law perspective). The book also provides an extensive analysis of important company law and insolvency law topics and reviews various European, international and Dutch legal sources. The book, which was published by Prof. Rick Verhagen, Prof. Xandra Kramer (Erasmus University Rotterdam), Sanne van Dongen (LL.M.) and Dr Paul Vonken, provides an important reference source for future European projects in private international law (notably in property, contract and insolvency law).

The Centre has continued to invest in international comparative research across all of its research programmes. Of particular interest are structural research endeavours by International Working Groups in financial and insolvency law. Important research by these groups includes the publication with Oxford University Press of a comprehensive volume on ‘Alternative Investment Funds in Europe’ (edited by Prof. Danny Busch and Prof. Lodewijk van Setten). This book provides a full review of the impact of the controversial European Directive on Alternative Investment Fund Managers, which was adopted after much debate in October 2010 (‘AIFMD’). The AIFMD is intended to be a regulatory response to systemic risks that came to light in the financial crisis and will have a broad and material impact on the manner in which investment managers may operate in future. It will also affect non-retail funds (including hedge funds, private equity funds, real-estate funds and infrastructure funds), which were previously largely unregulated. The AIFMD will have an impact on all funds offered to professional investors based in the EU, potentially severely limiting the range of investments available to EU pension funds, insurance companies and other institutional investors.

**Future research**

A major international research theme in 2015 is related to secured transactions and insolvency law. Expected research will include the third volume of the Oxford International and Comparative Insolvency Law Series on ‘Ranking and priority of creditors’ and preparation of the manuscript of the fourth volume on ‘The treatment of security interests in insolvency’. Research on secured transactions law will also be carried out in a separate project on the origins, historical development and future evolution of secured transactions law in a comparative context. Prominent European scholars will be invited to provide contributions on main topics concerning various forms of proprietary security rights (including pledges, mortgages, enterprise charges and security ownership) and personal security rights (including guarantees and suretyship).

Research related to the global financial crisis will be continued. A major project will be started on the bankruptcy proceedings opened against entities belonging to the Lehman Brothers Group. The collapse of Lehman Brothers in September 2008 sent a shockwave through global financial markets and is often considered to be the defining moment of the crisis. Many issues encountered in the bankruptcy proceedings of Lehman Brothers entities were unprecedented in terms of scope and complexity. Substantial efforts were made to address these issues in the absence of pre-existing public knowledge. The aim of the project is to analyse the main lessons presented by key parties in the proceedings as well as independent third party experts. Another project – on European regulatory reform in the wake of the financial crisis – will address issues related to the European Banking Union with a team of international experts. A book will be published by Oxford University Press on various key aspects of the Union from a legal and economic perspective. The book will draw comparisons with the United States, particularly to assess whether Europe can learn from the US experience, especially as far as bank resolution is concerned.
In 2014, Prof. Carla Sieburgh (Private Law and, in particular, the influences of European Law on national private law) and Prof. Arthur Hartkamp (European Private Law) published two volumes on ‘The influence of EU law on national private law’. These books are part of the Kluwer series ‘Onderneming en Recht’ (81-I and 81-II).

Awards and acknowledgements

• Prof. Corjo Jansen was appointed to the Scientific Advisory Board of the Max Planck Institute for Comparative and International Private Law in Hamburg.
• Tim Elkerbout (LL.M.) was awarded the annual prize of the Dutch Financial Law Association (Vereniging voor Financieel Recht) for his Master’s thesis on ‘The European and Australian short selling regimes’.
• Irene Aronstein (LL.M.), Ingrid Ligteringen (LL.M.) and Sanne van Dongen (LL.M.) were invited for a research period of three months by the Max Planck Institute for Comparative and International Private Law in Hamburg.

Research Centre for State and Law (Prof. Thomas Mertens)

The Centre for State and Law – Onderzoekcentrum voor Staat en Recht (SteR) – focuses on key issues and basic principles of public law. Its researchers critically analyse national, European and international developments in constitutional, administrative and criminal law. SteR provides a stimulating environment in which high-quality, national and international multidisciplinary and comparative research flourishes. SteR consists of three research programmes:

1. Principles of Public Law
2. Migration Law (CMR)
3. Administration of Justice.

‘Principles of Public Law’ brings together researchers with a focus on the main principles of public law. They analyse the relationship between principles of the democratic constitutional state (the rule of law, fundamental human rights, the democratic order, and accountability) and national and international social developments. The principles are studied with a keen eye on European and global developments. The programme combines the expertise and know-how of constitutional, criminal, administrative, European and jurisprudential scholars.

‘Migration Law’ brings together researchers from various disciplines to provide a stimulating context for fundamental and applied research on international and national migration law and the protection of minorities. It is unique in Europe, thanks to its interdisciplinary approach and its international staff, who include lawyers, sociologists, anthropologists and political scientists.

Researchers working on the theme ‘Administration of Justice’ focus on law in action – the workings of courts, public prosecutors and the legal profession. New developments in procedural law are monitored closely against the background of the principles of effective legal protection and access to justice. Methods used to understand the impact of civil, criminal and administrative law at various court levels are also an important research topic.

Collaboration

The SteR participates in numerous international projects and networks, 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), the Glasgow Refugee, Asylum and Migration Network (GRAMNet) (UK), the Working Group on Policing of the European Society of Criminology, and the International Penal and Penitentiary Foundation (IPPF). It also has close ties with the Max Planck Institute for Foreign and International Criminal Law (Freiburg, Germany), National Taiwan University, and several universities participating in the International Research Universities Network (in particular with the University of Glasgow, the University of Münster and the University of Poitiers).
Key publications

Business & Law Research Centre


Research Centre for State and Law


Prof. Elspeth Guild and Dr Paul Minderhoud are experts in the new Network on Free Movement of Workers and Social Security Coordination, which is funded by the European Commission. CMR, which has a successful guest researcher scheme, hosted guest researchers from the Universities of Huelva and Cadiz (Spain), from the University of Giessen (Germany), the Université Libre de Bruxelles (Belgium), the University of Glasgow (UK) and a judge from the Constitutional Court of Latvia. Prof. Thomas Mertens hosted several guest researchers from the University of Santa Catarina (Brazil).

In the Netherlands, SteR collaborates with the Council for the Judiciary, the Ministry of Security and Justice, as well as several courts and municipalities.

Research results
SteR organised several seminars, including a reflection on “Heading to Europe” (on migration via the Mediterranean Sea, 16 May), on issues regarding the Single Permit Directive (8 December) and on Kant’s theory of law (3 July). The annual meeting of the Dutch Association for Migration Research on data collection and methodology was organised by CMR. Dr Tineke Strik contributed to a conference of the EU Fundamental Rights Agency on ‘Fundamental Rights and Migration to the EU’ (10-11 November, Rome), as well as to the annual ‘Global Dialogue’ of the UNHCR on the theme ‘Protection at Sea’ (10-11 December, Geneva). Prof. Janneke Gerards gave an invited lecture on ‘The ‘Alleingang’ of the European Court of Justice and the need to develop a methodology for EU fundamental rights protection?’ (9 May, Oxford). A keynote speech on ‘International Cooperation as a Means to Advance the Use of Non-Custodial Measures in Criminal Cases’ was held by Prof. Piet Hein van Kempen at the three-day ‘ASEAN +3 Conference on Probation and Non-custodial Measures’ of ASEAN (17-19 August, Cha-am, Thailand). Prof. van Kempen co-organised an international four-day conference on ‘Women in Prison. The Bangkok Rules and Beyond’ of the IPPF and the Thailand Institute of Justice (TIJ) (3-6 March, Bangkok, Thailand). Dr Eva Rieter spoke at the bi-annual Conference of the International Law Association’s Committee on International Human Rights Law (8 April, Washington, D.C.). Prof. Raymond Schlässels gave a speech at the conference ‘Effective legal protection in administrative law’, which was organised by the Hungarian Academy of Sciences and co-financed by the European Union (11-13 June, Budapest). Prof. Thomas Mertens spoke on Kant’s legal philosophy at conferences in the universities of Leuven, Keele (UK) and Bergen (Norway) (30 May, 3 & 28 November). Prof. Jan Terpstra and Dr Bas van Stokkom gave a speech on ‘Plural Policing in a comparative perspective: the issue of the public good’, at the European Society of Criminology Conference (10-13 September, Prague). Dr Ronald Tinnevelt was a visiting scholar at Stanford University (Autumn 2014).
Societal impact
SteR researchers regularly participate in national and international public advisory bodies. The results of this advisory work are generally made accessible for judges, lawyers, politicians, students and the general public. A commission consisting of Prof. Paul Bovend’Eert (chair), Prof. Carla van Baalen and Dr Alexander van Kessel (Centre for Parliamentary History, RU) publicly presented its report on ‘The Evaluation of the 2012 Cabinet Formation Process in the Netherlands’ and formulated some recommendations on new parliamentary procedures (9 December, Den Haag). During the symposium ‘The Dutch Constitution: Beacon or Ballast?’, organization: the Montesquieu Institute and the National Committee for 200 years Dutch Kingdom, Dr Joost Sillen gave a public lecture (28 March). Prof. Tonny Nijmeijer was nominated as a member of the Permanent Advisory Committee on Environmental and Infrastructure Law (Ministry of Infrastructure and the Environment). Prof. Piet Hein van Kempen attended a private audience with Pope Francis to discuss global developments and needs in terms of criminal justice and policy (23 October, Rome).

Future research
Within the University, SteR researchers collaborate with researchers from the Faculty of Management in the interdisciplinary network ‘EUROPAL’, which focuses on the Europeanization of Policy and Law. Within the programme ‘Principles of Public Law’ research on sources of constitutional law, form of state, form of government and political system, government powers and their limits, vertical division of powers, the judiciary and fundamental rights will continue. In 2015 research on judicial decision-making, lawyers’ ethics, the functioning of the European Court of Justice, and the (Europeanization of) migration law will be incorporated in this programme.

Grants and Awards
• The Dutch Ministry of Security and Justice awarded Prof. Tonny Nijmeijer a grant for the research project ‘Evaluation of the working of Article 6:22 General Administrative Act and the relativity requirement’ (in cooperation with Utrecht University).
• The Dutch Ministers of Economic Affairs; Health, Welfare and Sport; and Defence awarded Prof. Pieter Kuyppers various grants for research projects on ‘Evaluation of the Procurement Act 2012’, on ‘Various models of ambulance care’, and on ‘The ins & outs of Article 346 Treaty on the Functioning of the European Union’.
• The Dutch Ministry of Security and Justice awarded Prof. Jan Terpstra a grant for projects on ‘Models of coordination in local oversight and order’: ‘Redundant bureaucracy within the Dutch police force’ and ‘Summary proceedings and the consequences for police work’. Additional funding for a proposal on ‘Effects of the introduction of the national police for local authorities and the local police forces’ was provided by the ‘Foundation Society and Security’ (Stichting Maatschappij en Veiligheid).
• NWO provided an award for Prof. Janneke Gerards’ PhD Proposal ‘Improving supranational adjudication in fundamental rights cases. Towards a procedural approach for the European Court of Human Rights’.
• Dr Ricky van Oers received the Praemium Erasmianum prize for the best dissertation in 2014.
• Tamara Butter LL.M. was awarded the Frye-Stipend (Radboud University) for the most promising female PhD student of the Faculty of Law.

The Centre for Notarial Law (Prof. Freek Schols)
The Centre for Notarial Law – Centrum voor Notarieel Recht (CNR) – focuses on notarial law, in particular family property law (personal and family law and the relationship between property law, inheritance law and estate planning). The strength of the CNR’s research lies in combining tax and civil law. Particular attention is paid to the impact of these fields on general property law and to the combination of legal fields, for example, marital property law, real-estate law and company law. CNR researchers seek to provide a firm foundation for legal practice.

Collaboration
The CNR cooperates with ABN Amro Bank NV on estate planning and with the notarial organization Netwerk Notarissen.

Research results
Staff members regularly write articles for authoritative national and international academic and professional journals. Important research projects, such as the project on marriage contracts, are carried out in cooperation with external researchers. In 2014 two PhD theses were published in a series called ‘Publicaties vanwege het Centrum voor Notarieel Recht’.

Societal impact
The Centre has influenced public debate on a wide variety of topics, such as the debate on accepting the appointment as an heir and the position of the creditors of the deceased’s estate (Wetsvoorstel bescherming erfgenamen tegen onverwachte schulden). There are strong links between the CNR and legal practice. For instance, the CNR’s research creates an important academic basis for legal practice relating to family property law in the Netherlands.

CNR’s research has a clear effect on legislation. The Centre participates in shaping legislative proposals, such as the proposal for changing Dutch matrimonial property law (Het voorstel van wet tot beperking van de wettelijke gemeenschap van goederen).

CMR researchers regularly advise the Dutch government and members of the Dutch Parliament on several private law issues. Prof. Nuytinck joined the ‘National Commission on the Re-evaluation of Parenthood’ (Staatscommissie Herijking...
Director: Prof. Leonard Verburg

Leonard Verburg is Professor of Employment Law at Radboud University and, since 1 March 2013, he has been Vice Dean for Research at the Faculty of Law. He is a member of the Advisory Board of the Business and Law Research Centre (OO&R). He is also a member of the board of the foundation which supervises the education programmes of the Dutch Bar Association. Prof. Verburg is editor-in-chief of the journal *Arbeidsovereenkomst*, a member of the editorial board of the journal *Arbeidsrechtelijke Annotaties* and a member of the advisory board of Postacademische Leergang Arbeidsrecht, one of the oldest postgraduate programmes in the field of employment law. He is founder member of the curatorium of the annual Nationaal Arbeidsrecht Congres. In 2010, Prof. Verburg was appointed as a substitute judge at the Court of Appeal in the Hague.

ouderschap). Staff members work for the SBN (professional education for notaries), the Orde van Advocaten (professional education for barristers), the KNB (Royal Notarial Association), the estate planners of EPN (Association of Estate Planners in Notarial Practice), Novex (the Dutch Association for Executors) and VEAN (the Dutch Association for Inheritance Lawyers). CNR researchers are editors of several important journals for professionals such as the Weekblad voor Privaatrecht Notariaat en Registratie.

Future research
Continuing projects include the historical development – and the current legal position – of the surviving spouse in Dutch civil law, the legal exegesis of the provisions of last wills, delegation of last wills to third parties, wills for persons lacking will-making capacity, inheritance tax law, national and international aspects of estate planning and developments in legislation on marital property and ‘Inheritance law and the de facto spouse’. ‘Pension law, divorce and death’ is a new project.
The Institute for Management Research (IMR), the research institute of the Nijmegen School of Management (NSM), brings together researchers in business administration, economics, political science, public administration, human geography and environment studies. They combine their expertise to develop innovative theoretical and methodological approaches to investigating, designing, intervening in, and measuring the performance of public and private structures that regulate, govern and manage human interactions.

The IMR’s multidisciplinary composition makes it possible to investigate complex problems in innovative ways, by combining different theoretical perspectives and levels of analysis. The Institute’s major contributions are: 1) developing innovative concepts and methods that help understand complex international, societal and organizational challenges; 2) developing potential approaches to deal with these challenges; and 3) developing and evaluating intervention methodologies.

IMR Academy
A multidisciplinary approach is encouraged through the IMR Academy, which organizes academic workshops, lectures and conferences. The Academy is a powerful platform where science meets society, building a climate of dialogue, debate and exchange for researchers from various disciplines and backgrounds. Important themes such as sustainability, accountability, conflicts, governance and borders inspire the Academy.

Multidisciplinary Research Groups
Research in the IMR is concentrated in multidisciplinary research groups. In these collaborative efforts academic expertise is bundled that is most relevant when investigating specific problem areas in society.

Gender and Power in Politics and Management
This group focuses on the dynamics and interactions between power, gender and other dimensions of diversity, with the aim of reducing inequalities in society. The group participates actively in societal debates, develops strategies and measures for changing societal systems and has a long history of productively comparing and combining disciplinary paradigms and methods. Coordinators: Profs. Benschop and Verloo.
Europeanization of Policy and Law (EUROPAL)
This group focuses on the way national policies are adapted by member states under pressure from the EU, and vice versa, investigating how EU laws and policies affect national laws, policies, and policy making (‘downloading’), and how member states seek to influence laws and policies at the EU level (‘uploading’). Coordinator: Dr Mastenbroek.

Innovation and Entrepreneurship in Business Ecosystems
This group focuses on innovation and entrepreneurship as well as the related social, institutional, economic and geographical contexts. It combines expertise from several disciplinary backgrounds to study the design and governance of innovative ecosystems that simultaneously create value for those involved and society as a whole. Coordinator: Dr Hillebrand.

Governance and Innovation in Social Services (GAINS)
The needs of a variety of groups such as citizens, workers and customers for social support are at the core of the welfare state and social services. When these needs change and when they are no longer met by existing services new insights are needed. This group investigates how innovations in social services respond to (new) societal demands and new social risks that are traditionally not addressed by the market or existing institutions and how they are directed towards vulnerable groups in society. Coordinator: Dr Helderman.

Two groups are in the process of applying for formal recognition: 

Glocal: Global-Local Divides and Connections
This group structurally combines expertise in the fields of borders, inequality, conflict, growth, development and globalization, with the aim of advancing research in global-local divides and connections. It comprises the Nijmegen Centre for Border Research (NCBR), Centre for International Conflict Analysis and Management (CICAM), and Global Data lab (GDL). Coordinators: Dr Verkoren, Dr Van Houtum and Dr J. Smits.

Responsible Decision-making (RED)
This group focuses on decision-making in decentralized structures. Uncertainty about the consequences of decentralization requires a methodologically strong interdisciplinary research group that can support decision-makers in both the public and the private sector. Coordinator: Dr Rouwette.

Research facilities
The IMR operates two laboratories (Visa Skills Lab and Decision Lab), each of which are equipped with specialized software. These labs facilitate top-level research that is designed to support the development and improvement of methods.

In the Visa Skills Lab, group-based decision-making (e.g. brainstorming sessions, scenario development, priority-setting, voting procedures and collective writing of documents) is investigated. This allows researchers to involve a range of stakeholders in exploring problems, developing strategies for intervention and investigating the effectiveness of interventions.

The Decision Lab supports research on individual and group decision-making and makes it possible to test theories and build models (e.g. in behavioural economics). Issues such as behavioural modelling of attitudes to uncertainty, financial decision-making, institution and market design processes, strategic interactions in game-theoretical settings, cooperation and negotiation in land and property development, and strategies for conflict resolution are addressed.

Staff

**Prof. P.M. Ache (o)**
**Prof. Y.W.M. Benschop (o)**
**Prof. J.M.M. Bloemer (o)**
**Prof. F.W.M. Boekema (o)**
**Prof. R. ten Bos (o)**
**Prof. T. Brandsen (p)**
**Prof. A.M.A. van Deemen (p)**
**Prof. S. Dühr (p)**
**Prof. H. Ernste (o)**
**Prof. B.I.J.M. van der Heijden (o)**
**Prof. R.E.C.M. van der Heijden (o)**
**Prof. I. Helsloot (e)**
**Prof. P.H. Hendriks (p)**
**Prof. M. Herweijer (e)**
**Prof. G-J. Hospers (e)**
**Prof. E. de Jong (o)**
**Prof. J. Jonker (p)**
**Prof. E. van der Kranenburg (o)**
**Prof. V.A.W.J. Marchau (p)**
**Prof. J.M. Mastop (p)**
**Prof. H.J. Meurs (o)**
**Prof. A.C.R. van Riel (o)**
**Prof. E.-M. Sent (o)**
**Prof. S. van Thiel (o)**
**Prof. J.A.M. Vennix (o)**
**Prof. J.A. Verbeek (o)**
**Prof. M.M.T. Verloo (p)**
**Prof. P.A.M. Vermeulen (o)**
**Prof. D.E.M. Verweij (e)**
**Prof. E.G.J. Vosselman (o)**
**Prof. R.H. Lieshout (o)**
**Prof. V.A.W.J. Marchau (p)**
**Prof. J.M. Mastop (p)**
**Prof. H.J. Meurs (o)**
**Prof. A.C.R. van Riel (o)**
**Prof. E.-M. Sent (o)**
**Prof. S. van Thiel (o)**
**Prof. J.A.M. Vennix (o)**
**Prof. J.A. Verbeek (o)**
**Prof. M.M.T. Verloo (p)**

Tenured

Full Professors 11.9 FTE
Associate Professors 11.3 FTE
Assistant Professors 22.4 FTE
Researchers 0.7 FTE
Lecturers 0.4 FTE

Non-tenured

Researchers 11.8 FTE
Lecturers 0.7 FTE
Doctoral candidates 46.9 FTE

Research funding

- Core
- Grants
- Contracts
The IMR hosts several large databases. The Global Data Lab (GDL) contains data on over 20 million people in 110 low and middle-income countries and thus makes it possible to compare countries and regions – especially in the Global South – in terms of health, education and labour. Another database focuses on industrial real estate (e.g. property, economic value, maintenance levels). The IMR also coordinates the Global eXperimental Panel (GXP), an innovative collaborative platform for conducting online experiments in various domains of decision-making.

Collaboration
Several new institutional collaborations started in 2014:

The IMR participates in the FP7-funded project 'Third Sector Impact' with Prof. Brandsen leading the Dutch team. The consortium consists of research institutes and networks from eleven European countries, led by the Norwegian Institute for Social Research.

Dr Mastenbroek and Prof. Van Thiel obtained an NWO (Netherlands Organisation for Scientific Research) Research Talent grant for a project in collaboration with Tilburg University: ‘Closing the regulatory cycle? Ex-post legislative evaluation in the European Union’.

Leading an international consortium, Dr M. Van Leeuwen and Dr L. De Vries received NWO/WOTRO funding for the project ‘Enhancing justice through land governance reform in DRC & South Sudan’. Consortium partners are The Hague Academy for Local Governance, Norwegian People’s Aid (Norway), the United Nations Human Settlements Programme (DRC) and Wageningen University.

Dr Hillebrand and Dr Driessen received an NWO grant from the Sustainable Business Models programme for their project ‘Sustainable innovations and their societal impact’, which will be conducted together with TIAS, Tendris, and thinktank ‘Het Groene Brein’.

Prof. Ruwaard (Maastricht University), Dr Helderman and Dr Bekker obtained a two-year ZonMw grant for their project ‘Health by governance, consolidation and accountability in the NPP-EiH’ to evaluate the National Prevention Programme ‘Everything is Health’.

In the project ‘Simcity ValueCap’, Profs. Van der Krabben and Weitzel make policy makers with various nationalities play serious games, providing insight into the value of negotiation tools used in spatial planning. Participants include policy makers from municipalities, project developers and consultancy firms. NWO and Belgian, British, and Norwegian equivalents fund the project as part of the European Joint Programme Initiative (JPI) Urban Europe.

Prof. Hospers collaborates with Linköping University (Sweden) in the project ‘Strategies for shrinking municipalities?’ studying shrinkage regions in Sweden and the Netherlands. FORMAS, the Swedish Research Council, funds the study.

Dr Größler and colleagues obtained a Horizon 2020 grant for their project ‘Global systems Rapid Assessment tools through Constraint FUnctional Languages’ (GRACeFUL) to design a formal computer language for policy makers. IMR researchers combine their Group Model Building expertise with that of computer science experts from other European institutions.

Dr Wiering received an NWO grant for the European Joint Programming Initiative on Climate project ‘Mobilizing grassroots capacities for sustainable energy transitions: path improvement or path change? (MobGIs)’. Transformation of energy systems is difficult to achieve since it has technical, but also social and economic dimensions. Partners: Aalborg University, Denmark and Linköping University, Sweden.

Prof. Benschop and Dr Van den Brink obtained two European grants to investigate barriers and success factors in the careers of young academics. Dr Bleijenbergh received a grant for research on gender equality training for managers in academia.

Research results
Prof. Sabel (Professor of Law and Social Science at Columbia Law School) received an honorary Excellence Professorship from Radboud University, on behalf of the NSM, to conduct his outstanding research in Nijmegen.

Various types of output were produced:

Dr Van den Brink and Prof. Benschop published ‘Gender in academic networking: the role of gatekeepers in professorial recruitment’ in the prestigious *Journal of Management Studies*, proposing an innovative theoretical framework for understanding how gendered networking practices produce or counter gender inequalities.

Dr Van der Vleuten, Dr Van Eerdewijk and Dr Roggeband published ‘Gender Equality Norms in Regional Governance. Transnational Dynamics in Europe, South America and Southern Africa’. This book investigates the diffusion of gender-equality norms in and between the EU, South America and Southern Africa.

Dr Van Houtum published a front-page article in the *Washington Times*: ‘Desperate trips to Europe turn deadly for immigrants’. As conflicts worsen in the Middle East and North Africa, immigrants from these regions increasingly embark for Europe in search of a better life. The article argues that the flow of migrants impacts the relationships between struggling countries in the South.
where migrants live, and prosperous countries in the North, where migrants are heading.

Dr Helderman, Dr De Kruijf, Prof. Van Thiel and J. Verheij analysed the National Health Care Institute, an independent public body in Dutch health care. The resulting book, which was presented during the inaugural conference of the National Health Care Institute, provides unique insights into the development of a core institute of Dutch health care, and sheds light on the historical institutional evolution and political-administrative logics of Dutch health care.

Dr Groß featured in a documentary on German TV channel Das Erste, ‘Die Story im Ersten’, using the Tupperware system to demonstrate how direct sales and franchise companies work. She argues that companies like Tupperware recruit franchisees by making big and unrealistic promises.

Dr Knoben published ‘Built to last or meant to end: Inter-temporal choice in strategic alliance portfolios’ with Rene Bakker (Queensland University of Technology) in the prestigious journal Organization Science. The authors discuss how inter-firm relationships can be established for finite periods of time. By analysing longitudinal data on the inter-temporal alliance choices made by SMEs, they show the importance of separating planned terminations from duration-based performance measures.

Dr Füllbrunn and Catherine Eckel (Texas A&M) published ‘Thar ‘SHE’ Blows? Gender, Competition, and Bubbles in Experimental Asset Markets’ in the prestigious American Economic Review. Inspired by a New York Times article claiming that ‘with more women on the trading floor, risk-taking would be a saner business’, they used Smith, Suchaneck, and Williams’ (1988) asset market design to experimentally test whether gender composition plays a role in price bubble formation. The results, which were supported by a meta-analysis of 35 markets, indicate that increasing the proportion of women does indeed reduce price bubble formation.

Aafke Raaijmakers, MSc and Prof. Vermeulen published ‘I need time! Exploring pathways to compliance under institutional complexity’, co-authored by Prof. Meeus (Tilburg University) and Dr Zietsma (York University) in the prestigious Academy of Management Journal. They examined when and how organizations respond to coercive institutional demands from a powerful constituent when other important constituents do not accept the demand as legitimate, using a novel experimental design.

Prof. Verloo, Dr Van der Haar and Van Huis MSc conducted two studies for the European Commission’s Organization of Exchange of Good Practices on Gender Equality Programme. One study investigated the role of men in gender equality in the Netherlands, the second gender impact assessment.

Various academic conferences, workshops and lecture series were partly or mainly organized by IMR researchers. These included a symposium on the Practices of Intersectionality, a Corporate Responsibility Conference and several Alexander von Humboldt lectures on Spatial Justice.

Below are details of two grants that were awarded in 2014.

Dr Akkerman and Dr P. Peters received an NWO grant for the project ‘Labour conflict goes underground? Effects of work flexibilisation on the diffusion and articulation of labor conflict’, studying how flexible workers voice their discontent about working conditions.

Dr Carton’s project ‘Smart Emission’ obtained funding from Technology Foundation STW to collect data on air pollution in and around Nijmegen. It determines geo-infrastructures for processing and analysing data in multiple scenarios, resulting in long-term planning and short-term traffic management.
Key publications


Dissertations: 10
Scientific publications: 239
Professional publications: 119

Awards and acknowledgements

Prof. Vennix received an Outstanding Service Award “for excellence of service and accomplishment over a sustained period of time” at the International System Dynamics Conference 2014, for his activities for the System Dynamics Society since 2000.

Dr Minnaar and Prof. Vosselman received a Highly Commended Paper Award for ‘Shared service centres and management control structure change: Exploring the scope and limitations of a trans-action cost economics approach’, which was published in the *Journal of Accounting & Organizational Change*.

Dr Belei’s dissertation ‘The best of both worlds? Studies on healthy indulgences and their effects on food intake control’ was ‘highly commended’ in the EFMD Outstanding Doctoral Research Awards.

Ankie Hoefnagels MSc, Dr Migchels and co-authors received a Highly Commended Award from the *Journal of Service Management*.
Director: Prof. Allard van Riel

Since 1 July 2009 Allard van Riel has been Professor of Business Studies at Radboud University, with a special focus on Marketing. Prof. Van Riel studied Philosophy at the University of Amsterdam and received his PhD in Marketing from the University of Maastricht in 2003. Before he moved to Nijmegen he worked at the University of Maastricht and as a professor at the University of Liege. Prof. Van Riel has published articles on marketing strategy and management, innovation in services, innovation management, project management, brand extensions and private labels in the retail sector.

for their article ‘Understanding generation Y and their use of social media: a review and research agenda’.

Dr Joosten and Dr Van Birgelen obtained a similar award for their article ‘Value fusion: the blending of consumer and firm value in the distinct context of mobile technologies and social media’.

Dr Van den Brink was appointed as a member of KNAW’s Young Academy, a Dutch innovation platform for young, successful academics who recognize the importance of debating scholarship-related issues and academic policy.

The Dutch House of Representatives asked Radboud University to evaluate the Treaty of Lisbon and examine the functioning and effectiveness of the Early Warning System and other instruments implemented by national parliaments following the Treaty (to monitor and control the European legislative process). The Lower House will use these results to reflect on how to influence EU decision-making. IMR researchers involved are Dr Mastenbroek, Dr Zwaan and Nora Dörrenbächer, MSc.

Prof. Jonker was appointed ‘Chaire d’Excellence Pierre de Fermat’ at Toulouse Business School for two years.

Prof. Ten Bos was appointed Honorary Professor at the University of St Andrews in Scotland.

Dr Mastenbroek was appointed Visiting Professor at the Department of Political Sciences of Copenhagen University.

Societal impact
The IMR seeks to actively collaborate with partners wishing to work with excellent researchers. For example, we collaborate with energy network company Alliander in the international project ‘Jaromir’ on Energy transition in European historical city centres.

The best of our researchers went to Nijmegen City Hall to give a series of lectures on topical issues related to local government, thus contributing to effective and more efficient local governance.

Prof. Van Kranenburg carried out a study on innovation in the media sector, which was commissioned by the Dutch Incentive Fund for Journalism and the Dutch House of Representatives.

Future research
NWO awarded a Veni grant to Dr Schapendonk for his project ‘Fortress Europe as a mobile space? Intra-EU mobility of African migrants’. Using an innovative study design that focuses on tracking migrants, he provides insight into how, how many and why African migrants travel across internal EU borders. Using mobility instead of domicile as a basic premise, the project will result in a better understanding of the integration of migrants.

The exclusive European Consortium for Political Research (ECPR) Research Sessions will be organized at Nijmegen School of Management for the next two years.
Scholars at the Nijmegen Institute for Social and Cultural Research (NISCO: Nijmeegs Instituut voor Sociaal en Cultureel Onderzoek) focus on multidisciplinary and comparative research topics. They describe and explain developments in inequality, cohesion and modernization in both Western and non-Western societies. Various complementary theoretical approaches, research designs, data collections and analytical strategies are used within this research framework.

NISCO – a research institute of the Faculty of Social Sciences – consists of two research groups: 1) Cultural Anthropology and Development Studies (CAOS) and 2) Sociology. To advance understanding of the dynamics of societal phenomena and processes, they examine themes from a historical perspective within single societies, in a comparative perspective across different societies as well as from a historical perspective in different societies. The associated Research Master’s programme in Social and Cultural Sciences provides high-level training in theories and methods for conducting empirical comparative research on societies. Scholars at NISCO work on three research themes: inequality, cohesion, and modernization.

Inequality
The focus of this theme is on differences in access to and control over resources that affect peoples’ opportunities, such as in education, success on the labour market, identity formation and health. 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, the cultural climate and national policies. Aspects of individual, family and contextual resources are thought to affect outcomes. Social inequality in intra-generational and inter-generational mobility is also studied.

### Cohesion
Within this research theme researchers describe and explain differences in social participation in formal organizations, as well as in informal social networks, including families and ethnic and friendship groups. First, developments in the relationships between an individual’s social and economic resources and pro-social attitudes and anti-social behaviour are explored, focusing on variations among societies with different welfare-state regimes and state of development. Second, comparisons are made to show which social groups have exclusionist attitudes towards ethnic out-groups, taking differences in economic, cultural and demographic contexts into account.

### Modernization
Researchers at NISCO study economic and technological developments, and particularly those that are associated with secularization in Dutch and other European societies. Much attention is paid to belief systems, identity construction and to meaning derived from religion, to conceptions of justice and altruism, and the implications of these for participation in society. NISCO researchers also focus on modernization processes in developing countries and their effects on inequality and poverty, as well as on social and political cohesion. Dimensions of gender and ethnicity are studied from an anthropological perspective. Furthermore, various reactions to modernization processes are the subject of research on the role of governments, civil society organizations and individual citizens.

### Research facilities
One way researchers at NISCO contribute to the academic community is by collecting large-scale data. Data facilities include both longitudinal collections – on Dutch individuals and their life courses and networks (Family Survey Dutch Population (FSDP), Netherlands Longitudinal Lifecourse Survey (NELLS), Social and Cultural Developments in the Netherlands (SOCON)) – as well as cross-national collections that contain a wide range of topics (e.g. the European Social Survey (ESS) and the New Immigrant Survey Netherlands (NIS2NL)). These data are highly valued for comparative research, as they provide excellent opportunities for multidisciplinary cooperation. All of the above-mentioned data were collected with additional funding from the Netherlands Organisation for Scientific Research (NWO) and transparently documented and deposited at the Royal Netherlands Academy of Arts and Sciences’ Data Archiving and Networked Service (DANS). The Dutch data have been downloaded by more than 2000 colleagues worldwide since 2007.

### Academic integrity
Recently, NISCO has institutionalized a system of archiving information related to all publications by its researchers. This makes it possible to carry out a number of security checks with respect to fraud, plagiarism and data construction. A long-standing tradition has been built up by NISCO researchers to provide the academic community with well-documented open source data with the goal of improving academic transparency and integrity. This tradition has been widely recognized as best practice and both data and publications are carefully archived with source information at the University.

### Collaboration
Members of NISCO cooperate with colleagues in other Dutch research schools in order to advance national and international collaboration and provide education to PhD candidates, including the Research School for Resource Studies for Development (CERES) and the Interuniversity Centre for Social Science Theory and Methodology (ICS). Scholars at NISCO have cooperated with

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<th>Staff</th>
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<td>Prof. K. Breedveld (e)</td>
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Nijmegen Institute for Social and Cultural Research (NISCO)

top international institutes, such as the Social Science Research Center (WZB), Berlin; Pacific Studies Research Group University of Bergen, Norway; Ohio State University, Columbus, USA; Centre de Recherche et de Documentation sur l’Océanie, Aix-Marseille Université, France; Collaborative Research Centre on Human-Environment Interaction as well as with several departments at German universities of Cologne, Bamberg, Göttingen and Konstanz, and British universities of London, St. Andrews, Essex and Oxford. Within the Netherlands, collaboration is facilitated through the Institute for Migration and Ethnic Studies (IMES), the Nederlands Studiecentrum Criminaliteit en Rechtshandhaving (NSCR), the Netherlands Institute for Social Research (SCP) and Statistics Netherlands (CBS). NISCO has also established international partnerships through the South Africa-Netherlands Research Programme on Alternatives in Development (SANPAD).

NISCO staff also participate in a variety of academic networks, such as the European Association of Social Anthropologists (EASA); the European Association of Development Research and Training Institutes (EADI); the European Network for Research Expertise on Economic change, Quality of Life and Social Cohesion (EQUALSOC); European Research Centre on Migration and Ethnic Relations (ERCOMER); ISA Research Committee on Social Stratification and Mobility (RC28), the European Consortium for Sociological Research (ECSR); the European Consortium for Pacific Studies (ECOPAS), the European Society for Oceanists (ESO), the Network of Excellence ‘Enhancing the Interest in Science in a Developing Europe’ (EISDE); the Development Policy Review Network, and the International Civil Society Forum on Conflicts (INFOCON).

Research results

In the field of inequality, NISCO researchers explored whether a country’s macro-economic circumstances and level of social protection affect individual economic deprivation. It has been shown that in countries that perform worse economically, deprivation is more prevalent, while high levels of social protection seem to safeguard people from experiencing economic deprivation. Other research focused on how an individual’s social background is associated with occupational success. Results confirm inter-generational transmission of occupational status, but it seems that a father’s occupation is less relevant for his offspring’s first job nowadays. Similarly, the effects of an individual’s educational attainment also decreased over time. As a result, no trend from ascription to achievement could be established. Anthropological research focused on global food exports, which appear to offer a promising way to lift Africans out of poverty by creating new work opportunities. By interviewing fishermen and traders, ethnographic researchers have uncovered a tendency to perceive business in purely individualistic terms and this often compromises local careers. This contribution thus raises critical questions about conventional interpretations of Africa’s global food exports.

Cohesion in societies is studied, looking at the effects of ethnic diversity on social capital. An article in the highly respected journal Annual Review of Sociology summarizes major insights on this issue. In it several mechanisms that underlie the negative relationship between ethnic heterogeneity and social cohesion are scrutinized: the homophily principle, feelings of anomie, group threat and social disorganization. Research showed that the hypothesized detrimental effects of ethnic diversity are spatially bounded to neighbourhoods, that support for the ‘constrict claim’ is more common in the United States than in other countries, and that ethnic diversity is not related to inter-ethnic social cohesion. A second article examined support for radical left ideologies in 32 European countries. Results have shown that the unemployed and those with a lower income are more likely to support a radical left ideology, also in the 21st-century. Furthermore, cross-national differences in the likelihood of supporting the radical left are strongly associated with whether a country has a legacy of an authoritarian regime. CAOS researchers investigated gender mainstreaming. A special issue of the Journal of International Development focused on policy making as a social practice that is embedded in discursive politics.

Modernization processes are also examined in CAOS research, especially the adaptation of managerial working styles by non-governmental organizations (NGOs) working on international development. Findings show that modern managerial ideas and practices seem to clash with traditional values, views and goals in private aid. Anthropological research focused on movement, place-making and cultural identification as intersectional and highly related processes. Ethnographic case-studies are employed to illustrate such intersections in Oceania. Research done in the Sociology group confirms the expectation that informal caregivers report lower levels of well-being than non-caregivers. This relationship, however, varies between countries, as generous availability of formal care arrangements reduce the gap in well-being between caregivers and non-caregivers. Surprisingly, services that are specifically designed to support informal caregivers do not alleviate the negative well-being they experience as a consequence of providing care.

Awards and acknowledgments

Principal Investigator Dr Lubbers was awarded a highly selective NORFACE grant for his project on migrants’ attitudes to the welfare state. Also, a Stepping Up, Stepping Out (SUSO) project on sex workers across the globe received funding. Dr te Grotenhuis and Drs Visscher were invited by SAGE to publish a methodological introduction to SPSS entitled ‘How to Use SPSS Syntax. An Overview of Common Commands’.

Societal impact

Scholars at NISCO believe that knowledge should be made available to societal and academic stakeholders to help improve policy construction. To do this, researchers participated in public
Dr Marcel Lubbers – Associate Professor of Sociology – was awarded a European ERA-NET NORFACE grant. As Principal Investigator he investigates migrants’ attitudes to the welfare state.

debates and wrote in the media on topics such as immigration, poverty, gender and other forms of inequality, the effectiveness of aid, and discrimination in the labour market. They regularly advise public and private institutions and act as consultants. For instance, advice was given to Slachtoffershulp Nederland (in relation to support provided to the families of those who perished in the Malaysian Airlines disaster in Ukraine), the Dutch Ministry of Foreign Affairs, NGOs in Indonesia, Stichting Lezen, Netherlands Institute for Social Research (SCP), SNV Netherlands Development Organization and others. They also give advice on behalf of international data collections (European Social Survey/European Value Survey) and national data collections (DANS-KNAW, Statistics Nederlands (CBS)). Data were collected on funding provided by public and private organizations engaged in development cooperation (Ministry of Foreign Affairs, Cordaid, ICCO, Solidaridad, Hivos and Oxfam-Novib). Conferences were organised on climate change, attitudes to homosexuality, women in managerial positions, and private aid.

Prof. Breedveld served as an expert in the field of sports in various ways: as a consultant for the Dutch Parliament, the Dutch Ministry of Health, Welfare and Sport, accreditation of several HALO curricula and NOC/NSF. Prof. Hoebink advised the Ministry of Foreign Affairs, the Dutch Parliament and several private aid organizations and appeared widely in the media discussing international development cooperation. Prof. Ruben was Director of the Policy and Operations Evaluation department (IOB) of the Netherlands Ministry of Foreign Affairs. Prof. Wolbers is a board member of the European Research Network on Transitions in Youth and treasurer of the Dutch Sociological Association (NSV). Prof. Kraaykamp is National Coordinator for the European Social Survey on behalf of NWO and served on the assessment committee for sociology at Ghent University.

Prof. Scheepers is a member of the Scientific Advisory Board of the European Social Survey and Statistics Netherlands.

Future research
2014 was a successful year for NISCO. Two affiliated professors (Profs. Breedveld and Wolbers) were appointed to work on sport sociology and research on education. Both delivered their inaugural address and will both feed research and contribute to the faculties’ educational programme. Also, new assistant professors were appointed, helping to broaden the scope of NISCO research themes. Both research programmes at NISCO underwent a disciplinary assessment in 2014. The Sociology group received excellent grades for the quality of its research, which underscores their engagement with topical international research themes. The CAOS group received high rewards for the quality of its research, but critical comments on quality. The appointment of a new professor should improve research quality in this group.

The CAOS group will focus on issues related to cultural diversity and its consequences for social inequality. An innovative research programme will be formulated and new initiatives will be started to acquire external funding. Staff are currently closely involved in a SUSO project on the vulnerable position of sex workers. Cooperation with the Sociology group (Prof. Scheepers and Dr Kanas) on ethno-religious conflicts in South-East Asia (Indonesia and the Philippines), which is NWO-funded, will result in four PhD students finalizing their thesis. Furthermore, a research programme funded by NWO/WOTRO, which involves examining value chains in order to gain better insight into the increasing role of the market in development processes will finish in 2015, resulting in four dissertations by Ethiopian PhD students.
Key publications


Dissertations: 5
Scientific publications: 114
Professional publications: 13
Director: Prof. Gerbert Kraaykamp

Prof. Gerbert Kraaykamp is a professor of empirical sociology at Radboud University. Prof. Kraaykamp is (co-)initiator of several large-scale data collections among which the NEtherlands Longitudinal Lifecourse Survey (NELLS), Family Survey Dutch Population (FSDP), and Social and Cultural Developments in the Netherlands (SOCON), and is a board member of the Interuniversity Center for Social Science Theory and Methodology (ICS). Currently, Prof. Kraaykamp serves as Dutch National Coordinator of the European Social Survey (round 7) on behalf of the Netherlands Organisation for Scientific Research (NWO). Publications by Prof. Kraaykamp focus on issues of educational inequality, parental socialization and cultural consumption. He has published on these issues widely, both nationally and internationally.

In the Sociology group the focus is on projects related to the key themes inequality and cohesion. Several PhD students (who are partially funded by NWO) are working on these themes and related publications are expected. Topics that are investigated include the effects of the composition of neighbourhoods for inhabitants, the gender gap in education, the late labour career and the connection between delinquency and victimization. Three PhDs started work in 2014 on the effects of work-family conditions on relationship quality, the role of secularization on socio-political changes and understanding radical right voting patterns. Research mostly has to do with life-course analyses and multi-level modelling, which proved to be of great interest internationally. Dr Lubbers recently acquired a NORFACE grant on migrants’ attitudes to the welfare state. A PhD student and post-doc will start working on this project in 2015. Collaborations between the department of sociology and the SCP and ITS will result in publications for the Dutch Ministries of Education, Culture & Science (OCW) and Social Affairs and Employment (SZW) in 2015.
The Behavioural Science Institute (BSI) conducts research on human behaviour. The aim 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 of 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 Master’s programme in Behavioural Science (www.ru.nl/education/masters/behavioural-science) is taught within the BSI Graduate School, which is officially recognized 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 i) individual factors (cognitive, affective, motivational and psychophysiological processes), ii) social-contextual factors (home, school, peer groups, work and the media), and iii) 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 ‘normal’ behaviour and psychopathology are the subject of research, which involves laboratory experiments and field studies, large-scale longitudinal studies and randomized controlled trials. Studies include behavioural, self-report, psychophysiological, neuroscience, genetic and virtual reality measurements.

BSI research takes place the following seven research groups: Communication Science, Developmental Psychopathology, Experimental Psychopathology and Treatment, Learning and Plasticity, Social Cognition, Social Development, Work, Stress and Health. These groups all work on the three main themes of BSI research.
Development and Learning

We all keep developing and learning new things throughout our lives. Within BSI, the biological, cognitive, and behavioural processes related to life-long learning are investigated. Fundamental research in this theme adds to knowledge on 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 or even 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.

Social Processes and Communication

Because much behaviour is altered by external factors, it is important to examine interpersonal relationships, group dynamics and media influences. Researchers working on this theme investigate how social interactions, whether face-to-face or via electronic media communication, are related to individual mental health and well-being. Interaction between automatic and controlled aspects of social behaviour is studied, for example in face perception, decision-making and creativity, and attitudes toward 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 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. Another focus is 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 both the social environment and the media environment that target groups operate in.

Research facilities

The BSI has excellent research facilities:
- A Virtual Reality Lab for immersive, three-dimensional computer-generated environments
- A Mobile lab to accommodate various experimental setups outside the university
- A Physiological Measurements lab, shared with the Donders Centre for Cognition, for measuring neurocognitive and biomechanical data
- 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 computerized experiments
• A Bar Lab for observational studies of social behaviour in a natural setting
• A Sport Lab for behavioural and psychophysiological measures during exercise
• Through its participation in the Donders Centre for Cognitive Neuroimaging (DCCN), the BSI has full access to neuroimaging facilities.

An increasing number of BSI researchers use mobile technology to collect data. These tablets, smartphones and wearable devices enable the researchers to do many things outside the classic lab setting.

Collaboration
Researchers within the BSI collaborate with numerous 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 of these fellows. BSI fellows in 2014 were Prof. Charles Perfetti (Pittsburgh), Alex Todorov (Princeton), Mitchell Prinstein (North Carolina), Marcel Brass (Ghent), William Bukowski (Concordia), Stefan Hofmann (Boston), Jasper Smits (Austin) and Goran Kecklund (Stockholm).

There are formal collaboration arrangements with numerous universities (e.g., University of Cologne, Australian Catholic University, Indiana University, University of Virginia, University of Southern California), research laboratories (e.g., Addiction Swiss, Haskins Laboratories in New Haven), multiple Dutch Universities, and various institutes for applied research (e.g., Trimbos Institute, TNO, NJI, Juridical Youth Institute). Within Radboud University there are formal collaboration arrangements with the Radboud University Medical Centre, the Donders Centres for Cognition (DCC) and Cognitive Neuroimaging (DCCN), and the Max Planck Institute for Psycholinguistics. The BSI also employs two Principal Investigators at DCCN (Prof. Alan Sanfey and Prof. Karin Roelofs).

The BSI hosts the ZonMw funded centre of excellence ‘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.

Awards and acknowledgments
• Dr Emmanuel Kuntsche received an NWO Vidi grant for a project on the influence of parental alcohol consumption on children’s knowledge about and attitude towards alcohol.
• Dr Willem Frankenhuys, Dr Arne Nieuwenhuys, Dr Simon Ritter and Dr Esther Rozendaal each received an NWO Veni Grant.
• Dr Willem Frankenhuys received the New Investigator Award from the European Human Behaviour & Evolution Association (EHBEA).
• Prof. Ludo Verhoeven received an NWO NRO grant for the project Fostering English reading skills in early secondary education.
• Prof. Bert Steenbergen received a ZonMw Revalidatie III grant for the project Co-creation at hand: The road to independence.
• Prof. Isabela Granic and Prof. Rutger Engels received an NWO Creative Industry grant for the project Development, testing and dissemination of video games that prevent and treat anxiety and depression in children and adolescents.
• Dr Ron Scholte and all partners involved in the Academic Workplace Youth received a ZonMw grant for the extension of the project.
• Dr Roel Hermans received an NWO Food, Cognition and Behavioural grant for the project Take it slow: The use of feedback and persuasive technology to reduce eating rate, and a grant from the province Limburg to stimulate healthy behaviour in primary school children.
• Dr Anna Lichtwarck-Aschoff received a ZonMW grant for the project Fostering English reading skills in early secondary education.
• Dr Ron Scholte and all partners involved in the Academic Workplace Youth received a ZonMW grant for the extension of the project.
• Prof. Rutger Engels, Prof. Alan Sanfey, Dr Maartje Luijten and Dr Kathrin Schuck received a grant from the Dutch Cancer Society for the project Environmental tobacco exposure as a pathway to youth addiction.

Research results
With regard to foetuses, it was found that maternal stress adversely affects early child development. The mechanisms underlying these relations are largely unknown, but necessary for developing preventive intervention programmes. A review revealed less well known and even surprising pathways, e.g. the intestinal microbiota, through which a mother’s stress can affect her foetus. The neural mechanisms in motor learning in children with cerebral palsy and the cognitive mechanisms in behavioural learning in children with intellectual disorders have been identified and built into therapeutic interventions.

With respect to learning, it was shown that word learning facilitates children’s phonological awareness, that there is competition from unheard or unseen novel words in cross-modal lexical learning, that testing helps children to remember words from memory, and that, in the case of bilingual children, linguistic overlap between items in language 1 and language 2 helps to learn words in language 2.
In 2014, Drs Arne Nieuwenhuys, Esther Rozendaal, Willem Frankenhuis and Simone Ritter (left to right) each received an NWO Veni grant. Dr Esther Rozendaal – Assistant Professor of Communication Science – explores an innovative method that is helping children to become more resistant to advertising.

In learning literacy and maths, it has been shown that word repetition fosters early word decoding and early numeracy abilities, and that executive functions and working memory have a great impact on both word decoding and text comprehension. Reading in dyslexic and non-dyslexic readers was found to be qualitatively similar. The results of these studies are used to build ICT-based interventions.

Risky behaviour: it was found that adolescents may be more impulsive than adults, not because they take more risks, but because they value the present more than adults do. Other researchers showed that a tailored smoking cessation programme for parents was highly effective in persuading parents of primary school children to quit.

In clinical psychology, psychological and neural processes underlying risky decisions made by children, adolescents, and adults were investigated, as were cognitive biases in anxious children, and decision-making in novel and experienced clinicians. Treatments reduced relapse rates in abstinent alcoholics (thanks to an alcohol-avoidance training), and socially anxious individuals were trained in automatic social approaches. It was found that 1) patients with social anxiety disorder show decreased cortical-amygdala crosstalk during social stress anticipation, 2) social threat automatically transfers to instrumental behaviour, and 3) it is possible to cause a shift from social avoidance to a more social approach by administering testosterone.

Four randomized controlled trials (RCTs) on the effectiveness of serious games in reducing anxiety and depression in schools and clinical agencies were completed. One of these RCTs was the first to validate a game for clinically anxious children. The studies also suggested that both ‘serious’ and commercially-available games hold immense promise for improving children’s emotional well-being, while imparting no stigma and keeping children motivated and engaged in playful learning.

People suffering from burnout often report cognitive problems, but little is known about their cognitive performance. To investigate this, a clinical burnout group, a non-clinical burnout group, and a healthy control group were compared on cognitive test performance, on self-reported cognitive problems, and on the subjective ‘costs’ associated with cognitive performance. Clinical burnout patients reported most cognitive problems. Whereas there were only mild differences in cognitive performance between the groups, the clinical burnout patients had to invest more effort in maintaining their performance. This study thus provides evidence for impaired cognitive functioning in burnout.

On communication, it was found that the widely accepted ‘risk-framing’ hypothesis is not supported by empirical evidence. It was also found that food advertising is hard for impulsive children to resist, increasing the risk of obesity, but that communication tools promoting health behaviours can be used to prevent obesity. The information researchers showed that media multitasking reduces recall and comprehension of news. Furthermore, it was found that arousing news messages are not appreciated by elderly people. Culture research showed that evaluations of morally ambiguous drama depend on media users’ moral subculture (law enforcement, medicine, psychology) and the theme of the drama (crime, love, health, ...).

Research involving reverse correlation techniques showed that mental images of in-group members are more likeable than mental images of out-group members, demonstrating that group differentiation and stereotyping takes place at a very fundamental level. Research on agency (the capacity of an agent to act in a world) showed that prior priming of an action does not always lead to an increased sense of agency. In fact, it can reduce feelings of agency, and also of responsibility. Various fMRI projects demonstrated the importance of the neural default mode network (in contrast to the task-positive network) in the generation of creative ideas. Finally a highly cited paper, in which a recipe for optimal social psychology replication studies was provided, was published.
Key publications


Dissertations: 32
Scientific publications: 412
Professional publications: 36

Societal impact

Within BSI fundamental research, for example on addiction, food choice, stress, reading acquisition, anxiety and depression, is translated into practical prevention guidelines and interventions. These interventions, in turn, are subjected to scientific investigation, if possible in randomized controlled trials. On the other hand, societal issues, such as adolescent alcohol consumption and children’s reading problems, lead to a more fundamental understanding of such topics. Increasingly, knowledge or actual interventions are spread 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. Most research conducted at BSI stems from societal questions and/or is aimed at solving societal issues. Three examples of this are:
1. In a study conducted in a residential youth care setting, a therapeutic video game using players’ biofeedback as the controller was significantly more effective at reducing anxiety levels in highly impaired youth than treatment as usual. One of the largest residential treatment centres in the country (Pluryn) has decided to implement the video game as regular treatment practice with their most impaired youth. MindLight is a 3D video game developed by BSI researchers and game experts that uses the mind as the game controller. Through neurofeedback mechanics, the game incorporates evidence-based relaxation techniques and attention bias modification methods to produce an immersive game world in which children can learn to face – and overcome – their anxiety and fears.

2. Two BSI PhD students organized symposia on ‘Scientific Research in the Class’ for primary and secondary school teachers, school psychologists and policy makers, and ‘From Developmental Science to Practice’, to help researchers understand how their research may benefit schools, families, etc.

3. BSI coordinated the NWO/NHIC programme ‘The learning child’, which is designed to develop and evaluate new educational forms that do justice to the individual capacities of children in primary education and makes use of the latest insights in the field of brain and cognition research. In each of the projects within the programme, apps and other ICT tools have been developed to facilitate children’s learning. These innovative instruments will be disseminated in collaboration with the Expertisecentrum Nederlands.

Future research
Over the next few years BSI will continue to deliver top-level behavioural research with societal relevance. Most of the grants acquired provide researchers with funding for 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. In 2015 staff meetings will be organized on the acquisition of European grants, technology grants and the cooperation with companies (e.g., the gaming industry, supermarkets) and other relevant partners.

An increasing amount of research will use an integrative approach to behaviour, physiology and neuroscience. Research on the therapeutic applications of BSI findings will intensify, and more and stronger ties with international partners will help with both successful fundamental research and broader dissemination of the results. The BSI will continue with its successful studies with longitudinal designs in children. More projects will be aimed at improving people’s lives. The Institute is increasingly integrative and multi-disciplinary, enabling researchers to capitalize on collective strengths when conducting research, writing grant applications or publishing. The three overarching BSI themes 1) Development and Learning, 2) Psychopathology, Health and Well-Being, 3) Social Processes and Communication are a reflection of this.
The Centre for Language Studies (CLS) carries out top-level research in Linguistics, Language and Speech Technology, and Communication in a stimulating academic environment. Key aspects are innovation, an interdisciplinary approach, and a strong commitment to acquiring research funds, which helps strengthen the profile of research done at the Centre, both in the Netherlands and abroad.

Research at CLS is done within two programmes:
• Researchers working on Language in Mind 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 on Language in Society 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, speech technology designed to improve communication with the disabled and persuasive communication.

Each programme contains several groups led by a principal investigator, which create platforms for discussing research plans and results, facilitating communication between researchers and helping to support academic integrity.

Professor Asifa Majid studies how people with different language and cultural backgrounds convert concepts related to senses – such as smell – into language.
Research facilities
CLS research is largely empirical, using large databases and experimental 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 increasingly important role. The Executive Board has established Linguistics as a focal area of research for the University and structural investment in CLS research has been used to create a state-of-the-art psycholinguistic laboratory, including a web experimentation site, facilities for making observations with video recordings and a computer lab.

Collaboration
Widespread international collaboration among CLS researchers has contributed to the growing success of international recruitment over the past few years: 25 percent of lecturers have come from abroad to work in Nijmegen, and as many as 45 percent of our 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 researchers from the Donders Institute and the MPI in the Baby Research Centre.

Examples of current formal international collaboration include:
• Collaboration 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) in HealthNar, a programme established to strengthen and consolidate the emerging field of narrative communication in healthcare. The aim is to build a multidisciplinary research exchange network dedicated to the use of 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 is founded by the International Research Staff Exchange Scheme (IRSES).
• Participation in the Marie Curie International Training Network ‘Investigating Speech Processing In Realistic Environments’ (INSPIRE) with the Technical University of Denmark, KU Leuven, Philips Research Laboratories Eindhoven (NL), Technical University Eindhoven (NL), Tampere University of Technology (Finland), Universidad del País Vasco (Spain), University College London (UK), University of Edinburgh (UK), University of York (UK) and University of Sheffield (UK).
• 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’, 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 organizational settings.
• Collaboration in the large-scale, cross-linguistic project ‘Evolution of Semantic Systems’, which is funded by MPI Nijmegen within a consortium of 60 universities across Eurasia. The main aim of the EoSS project is to investigate how meanings vary in space and change over time, by collecting data from at least 50 Indo-European languages.

Research results
In South America there are a large number of indigenous languages (within over one hundred language families), which are extremely
It seems like such a simple thing: pointing at something in the space surrounding us. In spoken language, a pointing finger is completely different from the words we use; it’s called gesticulation. But in sign languages, pointing signs are just one among many types of signs that are used. How is it possible that the same signs are part of the grammar of one language and not of the other? In her thesis, investigating similarities and differences between pointing signs in Sign Language of the Netherlands and pointing gestures in spoken Dutch, Martine Zwets showed that by focusing on the location that is pointed at – instead of on the pointing gesture itself – four different constructions can be distinguished. One of these, the most complicated one, turns out to appear only in sign language, suggesting that pointing signs in sign language evolve to become grammatical parts of the language.

Analysis of literary criticism has so far tended to concentrate on specific case-studies, but Dutch literary criticism as a whole has never before been the subject of research. In the Netherlands Organisation for Scientific Research (NWO) project ‘The Best Intentions: Literary Criticism in the Netherlands 1945-2005’ the expertise of Dutch Literary Studies and Argumentation Studies was combined in order to develop a new method for analysing the strategies used by literary critics. Much has been assumed about what literary critics in different eras found important: at times they considered the structure of the story more important, while at other times they valued educational aspects more. For her thesis, Yvette Linders developed an analysis tool to identify what critics focus on. Using this tool, she analysed 734 reviews and found that certain developments in society, such as ‘depillarization’ (where reviews were no longer based on class and religion) – or in literature – can be identified in book reviews in newspapers.

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 CLS research, plays an important role at CLS. Researchers at the Centre bring together externally funded projects that involve language and speech technology in a dedicated institute: the Centre for Language and Speech Technology (CLST). Through CLST, CLS collaborates with many societal and commercial partners.

Dr Helmer Strik and Dr Catia Cucchiariini have acquired a patent for an ‘Automated system for training oral language proficiency’. As a result of increasing internationalization, there is growing demand from the education and business community for people who speak foreign languages well. Among other things, intelligible pronunciation is regarded as important for successful interaction and social acceptance. However, an important problem is that oral proficiency training requires so much time, feedback and practice, that very often it cannot be sufficiently provided in traditional language classes. For this purpose an automated system has been developed.

A large group of CLS researchers took part in a workshop on linguistics for language teachers in Dutch secondary education. Considerable efforts are made in secondary education to teach students that some of their language forms are ‘ungrammatical’.

Infants learn words from the speakers they hear around them. But how can they identify words in the continuous speech signals they are exposed to? The assumption was that their mothers provide most of the information babies need to learn their native language. The role of other speakers was largely unknown. Christina Bergmann simulated the language acquisition process of babies using computational models, which ‘learned’ words from real speech, without intervening processes that transform the continuous signal into single sounds or words. It turned out that these models can learn words, and that they are even able to successfully simulate babies’ behaviour in experiments. The studies within her thesis revealed that hearing many speakers – both men and women – generally led to success in learning words. In conclusion, a wide range of voices can be very valuable for infants learning to use words.

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In 2014, Drs Lila San Roque, Gerardo Ortega and Tineke Snijders obtained an NWO Veni grant for their innovative proposals in Linguistics. Dr Lila San Roque studies perception-related verbs such as seeing, feeling and hearing. She focuses on child-adult interactions to discover how, why and when we learn to use these verbs and whether this varies among cultures.

Despite these efforts, the use of these constructions in everyday language appears to be ineradicable, which raises the question why these particular grammar rules are so hard to learn, in sharp contrast to the seemingly effortless way in which other elements of grammar are acquired. Prof. Helen de Hoop argued in her lecture that from a grammatical point of view, beter dan ['better than'] is not better than beter als [literally 'better as'], which led to a discussion on the question whether teachers should try to teach their students to use beter dan instead of beter als.

If you want to persuade someone with an unhealthy lifestyle to behave differently, it doesn’t help to confront them with the negative consequences of their bad behaviour, such as frightening images on cigarette packs. Prof. Enny Das examines the origins of individuals’ reluctance to accept risk related- information, and strategies to promote effective health communication. According to her, people become more receptive to messages promoting health when they feel good about themselves. When you first give them the opportunity to think of something positive about themselves, preferably in an area that has nothing to do with their health, – e.g. ‘I am good at playing chess’ or ‘I love art’ –, they are more willing to accept a health-related message. A possible explanation is that a vulnerable ego is more likely to react defensively; this is why it’s important to first reassure the ego.

In January, the written input for the BasiLex corpus was presented. BasiLex is a collection of texts that Dutch elementary school children are typically exposed to, consisting of 11.5 million words that are enriched with keywords (lemmas) and speech information (parts of speech). From this corpus a lexicon of 20,000 words has been extracted with word counts and linguistic annotations. Knowing what words children know at what age is important for researchers and for developers of educational material. As of 2015, the project team, a collaborative venture between Radboud University, Tilburg University, the University of Amsterdam and Leiden University, will continue working on BasLex, a corpus of written language output produced by elementary school children in the Netherlands.

Future research

CLARIAH (Common Lab Research Infrastructure for the Arts and Humanities), a consortium of humanity research institutions, received an NWO grant worth €12 million to develop a digital infrastructure that can be used to combine software and large quantities of data from a range of disciplines in the humanities and to provide user-friendly tools to make these data sets searchable. New digital tools will enable researchers to explore profound questions of cultural and social change across the disciplines. CLARIAH will deliver the infrastructure for the paradigm shift now taking place within the humanities. Many researchers see Digital Humanities as the most important development in the profession but, until now, it has not been possible to get a coherent picture of the increasing volumes of digital data from the separate disciplines. The CLS Language and Speech Technology group will play a pivotal role in the development of CLARIAH.

Dr Gerardo Ortega was awarded an NWO Veni scholarship for his research on the role of gesture during the acquisition of a sign language as a second language. The aim of this project is to investigate how experience with gestures helps speakers of Dutch to learn Sign Language of the Netherlands. It will explore whether learners produce their own gestures for signs that are similar in form and will investigate how the brain processes signs and gestures in a different way.
Key publications


Majid, A. & Burenhult, N. (2014). Odors are expressible in language, as long as you speak the right language. *Cognition*, 130(2), 266-270. 10.1016/j.cognition.2013.11.004.


Dissertations: 14
Scientific publications: 267
Professional publications: 41
Dr Onno Crasborn has acquired funding from the NWO programme ‘Added Value through Humanities’ to set up a website for parents of deaf children. When parents have a deaf new-born baby, they receive mainly medical information. Less attention is paid to the social, cultural and linguistic aspects of being deaf. This is how the idea of ‘Mijn baby is doof’ [My baby is deaf] arose, a website with practical information about, among other things, education for the deaf and Dutch Sign Language. The website www.mijnbabyisdoof.nl will be online by September 2015.

Dr Lila San Roque was awarded a Veni scholarship for ‘Learning the senses: perception verbs in child-adult interaction in two cultures’. While the physiology of perception is the same, the way languages encode perception seems to be astonishingly diverse. How deep do these differences go? San Roque will study child-adult conversation to discover how, why and when we learn to use perception verbs (e.g., see, taste) and whether this is the same in different cultures.

Dr Tineke Snijders was awarded a Veni scholarship for ‘Resonating rhythms in the baby brain - on individual differences in language acquisition’. She will investigate whether babies pick up words better if their brains resonate with speech. Does it help if they hear words in a strict rhythm such as in a song? Do differences between babies in this respect predict later language development? Is this genetically determined?

Prof. Ton Dijkstra and Dr Helmer Strik have obtained funding within the NWO Free Competition Humanities programme for their project ‘Waar Abraham de mosterd haalt: learning Dutch expressions’. Learning how to use expressions in another language properly is difficult. In this project, language learners will practice using a computer programme, and their progress in understanding and production of expressions will be examined. These results, combined with measurements of brain activity and a computer model, will provide insight into learning processes and the way in which learning in the classroom can be improved.
The Donders Institute is dedicated to increasing understanding of the brain in order to gain insights into human cognition and behaviour in health and disease.

Comprehending this extremely complex organ in our heads and how it enables our thoughts, emotions and actions has sparked people’s curiosity for centuries. It’s essential to strive for this understanding to be able to answer fundamental questions about human beings. Recent technological and theoretical advancements are delivering unprecedented insight into the way the brain works, making it possible – for the first time – to answer more applied questions as well.

The Donders Institute is home to about 600 researchers from more than 35 countries who share the common goal of contributing to the advancement of the brain, cognitive and behavioural sciences through investigator and curiosity-driven research, and improving health, education, food, and technology by applying advances in this field. The Institute’s mission 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
Donders is a lively cross-faculty institute that is home to a thriving research community, which enables scientists from different disciplines to collaborate on some of science’s most challenging problems: discovering the basic rules and mechanisms of the brain’s information-processing system, which underlies cognition and behaviour. World-renowned researchers work with young ambitious scientists in smaller research groups that form a highly interactive and collaborative cross-faculty network that tackles research questions which are too complex to be answered by single groups. The Institute has close links on campus with the Centre for Language Studies, the Behavioural Science Institute, and the Max Planck Institute for Psycholinguistics as well as the Erwin L. Hahn Institute at the University Duisburg-Essen, forming one of the most prominent research clusters of its kind worldwide.

This interdisciplinary, cooperative culture – combined with excellent multidisciplinary research – is also at the core of the Donders Graduate School, which integrates a renowned Research Master’s programme with ambitious PhD training. The Master’s programme is structured in four tracks that are fully aligned with the four research themes, thus integrating young students optimally in Donders’ research. The PhD training programme supports young scientists in moving their development towards their own independent lines of research.

Research facilities
The Donders Institute has the very best equipment and technical staff, which allows its researchers to carry out the most advanced research.

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 visualization 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 (tDGS) laboratories.

To decipher underlying biological mechanisms the Institute uses a broad range of equipment, covering all levels from molecular biology to animal behaviour. State-of-art techniques such as next-generation sequencing, neural stem-cell generation, animal MRI, PET and CT/SPECT, 2-photon microscopy, multi-unit in-vivo electrophysiology and optogenetics – just to mention a few – are available and are being further developed locally.

These experimental tools are complemented by high-performance computing facilities, which enable the advanced data analyses, data modelling and simulations for which the Institute is well known. The 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 (in alphabetical order)
• Inti Brazil won a dissertation prize (awarded by the Netherlands Society for Neuropsychology).
• Martin Dresler won a Google Faculty Research Award.
• Guillen Fernandez was elected as a member of the Academia Europaea.
• Wincke Franx was awarded a Radboud Frye stipend.
• Christian Gilissen won the Young Investigator Award (the Netherlands Society for Human Genetics), the European Society of Human Genetics (ESHG) Isabelle Oberle Award, and the European Journal of Human Genetics’ Most Cited Paper Award.
• Umut Güçlü won a Radboud study award for his MSc thesis.
• Peter Hagoort and Paula Fikkert were elected as members of the Koninklijke Hollandse Maatschappij der Wetenschappen.
• Marloes Henckens won a dissertation prize (awarded by the Neuroscience Foundation).
• Carola Janssen won the FENS Young Investigator Award.
• Marijn Kroes won the Hermesdorf International Prize.
• Floris de Lange became a member of De Jonge Akademie.
• Willemin Jeen won the Jacobus Willems Prize of the Netherlands Society for Paediatric Neurology.
• Roaul Memmesheimer received the 2014 Bernstein Award.
• Nael Nadif Kasri and Francesco Battaglia earned an Inscopix DECODE grant award.
• David Norris was elected External Scientific Member of the Max Planck Society.
• Anouk Oerlemans was awarded a Sagvolden Prize from the Netherlands Society for Paediatric Neurology.
• Ivan Toni was awarded a Radboud Science Award.
• Anouk Oerlemans was awarded a Sagvolden Prize from the European Network for Hyperkinetic Disorders.
• Raoul Memmesheimer received the 2014 Bernstein Award.
• Willemijn Leen won the Jacobus Willemse Prize of the Netherlands Society for Paediatric Neurology.
• Floris de Lange became a member of De Jonge Akademie.
• Marijn Kroes won the Hermesdorf International Prize.
• Carola Janssen won the FENS Young Investigator Award.
• Sacha Ondobaka
• Arjen Stolk
• Saskia Haegens
• Tessa van Leeuwen
• Arnt Schellekens
• Guillaume Sescousse
• Tineke Snijders
• Monique van der Voet
• An NWO Vidi grant was awarded to Rogier Mars
• Marie Curie Slowodovska Research Fellowships were awarded to:
  - Ervin Poljac (incoming)
  - Janny Stapel (outgoing)
  - Annelinde Vandenbroucke (outgoing)
  - Lennart Verhagen (outgoing)
• Radboud Excellence Fellowships were awarded to:
  - Nixon Abraham
  - Claudia Civai
  - Jan Engelmann
  - Sara Fabbri

**Personal grants**

**NWO Rubicon grants were awarded to:**
- Sacha Ondobaka
- Arjen Stolk

**NWO Veni grants were awarded to:**
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- Tessa van Leeuwen
- Arnt Schellekens
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**Collaboration**

The 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 – a preferred partner of Radboud University – on the operation of a joint research centre for high-field MR imaging, the Erwin L. Hahn Institute, in Essen.

Furthermore, the Institute actively strives to collaborate in research consortia with leading institutes, industry and other potential users of its research. Joining forces in this way extends research across the borders of the Institute and enables valorisation of research results.

The Institute participates in a number of high-quality, innovative and pioneering consortia, including:

i. **Healthpac (Perception and Action in Health and Disease)** is a European integrative doctoral programme that brings together research institutes in Zürich, London and the Netherlands and seven European companies. The network research focuses on unravelling the neural mechanisms of sensorimotor control and its disorders, and uses this knowledge to enhance the quality of life of patients with movement and sensory disorders. This consortium is led by the Donders Institute.

ii. **Aggressotype** is a large EU-funded project on pathological aggression in children and adolescents with ADHD and conduct disorders. The programme brings together 23 academic and private-sector partners from 11 countries. This consortium is coordinated by the Donders Institute.

iii. **Matrics** is a large EU-funded consortium that focuses on deconstruction of aggression in conduct disorder and callous unemotional traits into different behavioural dimensions, which are linked to imaging and genetic and epigenetic readouts. It brings together 19 European academic and industrial partners and works together with the EU Aggressotype consortium. This consortium is coordinated by the Donders Institute.

iv. **FOCOM** is a project funded by the Provinces of Gelderland and Overijssel and the EU. Test systems are developed that predict the relationship between nutrition and the brain. These systems will help arrive at a better understanding of perception, choice, and eating behaviour. The project brings together three Dutch universities and private-sector partners in the East of the Netherlands. This project is coordinated by the Donders Institute.

v. The Institute is collaborating partner in the Human Brain Project, which was selected by the EU as one of two flagship projects. Researchers from a large group of European, North American and Asian research institutes will use the €1 billion grant to make a leap forward in brain research by developing six platforms, dedicated to neuroinformatics, brain simulation, high-performance computing, medical informatics, neuro-morphic computing and neurorobotics, respectively. The Institute also participates in the US Human Connectome Project. Researchers working in this project are tackling a key aspect of mapping the human brain by elucidating the neural pathways that underlie brain function and behaviour. Deciphering this amazingly complex wiring diagram will reveal much about what makes us uniquely human and what makes each individual different from all others.

**Societal impact**

Research conducted at the Institute has considerable potential for benefiting society, especially in education, neuromedicine, neurotechnology and food. A key aim is to enhance understanding of the human brain by disseminating expertise and knowledge to a variety of stakeholders.
To inform the general public, Donders researchers regularly appear on national television (ranging from popular scientific programmes such as ‘De Kennis van Nu’ to entertainment programmes, such as ‘Tijd voor Max’), in numerous national and international newspapers (including the New York Times, NRC, de Volkskrant, de Gelderlander), on radio (e.g. Dutch National Radio, BBC, the Voice of America) and on many websites. Marijn Kroes, who received the 2014 Hermesdorf International Prize, successfully used the media to explain his research on using electroconvulsive therapy to erase the memories of patients with post-traumatic stress disorder, to a general audience. At the start of 2014 the successful blog ‘DondersWonders’ was launched. Here researchers at the Institute share their knowledge by writing non-specialist articles on neuroscientific topics. The blog appears bi-monthly in de Gelderlander.

Donders scientists disseminate new findings and knowledge to industry, mostly through numerous 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). These contacts are mutually beneficial in terms of scientific expertise and/or the use of facilities. In 2014 the Institute acquired funding for four projects in NWO’s Food & Cognition and Light, Cognition, Behaviour & Health programmes, in collaboration with companies. The Institute is also involved in ‘Radboud Research Facilities’, an initiative by the province Gelderland to stimulate the regional economy by contributing to innovation by small and medium-size enterprises applying scientific knowledge.

Implementing new findings in clinical practice is part of the daily work of the Donders clinicians as is education of peers, patients and patient organizations through lectures, meetings and forums (e.g. Parkinssonet.nl). Donders researchers participate actively in e-science developments such as the digital Parkinson polyclinic and Parkinson TV, partly in collaboration with patient organizations, thus directly promoting the impact of research.

Together with major national publishers of school materials, (e.g. Malmberg) Donders researchers actively participate in educational development. Recent insights into cognitive, social and emotional aspects of early human development are used to develop learning programmes for primary schools as well as those focusing on anxiety, habits and perception.

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. At the national level, researchers at the Institute serve on committees of research policy organizations 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) and with the Netherlands Forensic Institute (NFI).
Theme 1: Language and communication

The mission of the Language and Communication theme (LC) is to understand something that is uniquely human: language. LC theme researchers have three key objectives: a) to understand core language and communication operations, including processing, learning and development, and to determine how these are related to other domains of cognition, including perception, action, memory, attention and sociality; b) to determine how the human language faculty 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. Since these objectives require an interdisciplinary approach, LC uses neuroscientific, behavioural, linguistic, genetic and computational techniques and seeks explanations at multiple levels (neurobiological, psychological and linguistic). The ultimate goal is to link these domains and thus move towards a full understanding of the human language ‘machine’, from the molecular to the societal level.

An important feature is the substantial involvement of researchers from the two affiliated institutes of the Institute. The theme has affiliated Principal Investigators (PIs) and Research Fellows at the Max Planck Institute for Psycholinguistics and at the Centre for Language Studies. This report presents only the activities of PI groups in the Centres of the Institute itself.

Research results
LC researchers examined the neural systems underlying understanding of contextually-constrained indirect meanings (as, for
example, when someone says “It’s hard to give a good presentation” when they actually mean “Your talk was a mess!”). Functional MRI data was collected as participants listened to indirect replies in spoken dialogues. The resulting pattern of brain activity suggests that listeners take the speaker’s perspective at both cognitive (theory of mind) and affective (empathy-like) levels when working out what the speaker really means.

In a study bridging language and memory research, researchers taught participants new words in only one modality and found (a day or week later) that those words influenced recognition of similar-sounding words in the other modality. That is, new words that had been seen but never heard influenced spoken-word recognition (and similarly for words that had been heard but never seen). These findings show that mental representations of new words are formed not only from perceptual input but also internally, through cross-modal transfer.

Other LC research explored the left-hemisphere pathways connecting the temporal to inferior frontal cortex that underlie speech production. Computational analyses revealed that the WEAVER++/ARC model accounts for the typical patterns of impaired and spared language performance associated with the classic aphasias. These simulations support the view that production is based on a dorsal pathway (via the arcuate fasciculus).

LC theme researchers examined the brain mechanisms underlying multilingual speakers’ ability to switch between languages. Results from an fMRI study in which Dutch/English/German trilinguals named pictures (in blocked and mixed-language contexts) indicated that language switching recruits brain areas that are not language-specific. Multilinguals thus use domain-general inhibition when switching between languages.

Future research
The current multi-level approach will continue. A major impetus for the theme was the award of the ‘Language in Interaction’ Gravitation grant worth €27.6 million in 2013 to a consortium which is headed by Professor Peter Hagoort. Interdisciplinary PhD projects in the consortium have been awarded to Profs. Fisher, Hagoort, McQueen, Roelofs and Schriefers. These projects span a range of disciplines and topics, including the interaction between perception and production processes in second-language learning, the role of thalamocortical control mechanisms in speech production and the neurogenomics of vocal learning in songbirds. The first results of these projects are expected in 2015. Funding rounds within the consortium in 2015 should contribute further to LC’s multi-disciplinary objectives. Researchers working on the LC theme aim to apply for European Horizon 2020 funding, especially for those programmes involving consortia, since these can directly contribute to the multi-level approach.

Key publications


The mission of the Perception, Action and Control (PAC) theme is to understand the causal relationships between neuronal and cognitive mechanisms of perception-action integration in relation to perceptual inference, sensorimotor functions, cognitive control and social interactions. The PAC theme is concerned with understanding how the integration between perception and action is achieved (during sensorimotor integration), regulated (during decision-making) and exploited (during social interactions).

At the level of 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. At the level of social interactions, researchers study how the perception-action cycle is used in the interaction with other agents. At each level of investigation, researchers focus on understanding alterations of the perception-action cycle in neurological and psychiatric populations and with the social implications of this research as well.

PAC researchers address these issues at the system level; from genes to neuromodulators, from single neurons to brain circuits, from individual organisms to multiple interacting agents. Our studies cover multiple levels of organization by combining several techniques, from electrophysiological and neuroimaging methods to clinical and psychopharmacological studies, from genetic and neurobiological methods to developmental and psychophysical studies, from computational modelling to theoretical analyses.
This multidisciplinary and multi-level approach creates the opportunity to experience different analytical and theoretical perspectives, providing a fertile ground for effective interactions between fundamental and clinical neuroscientists: basic neuroscientists can test hypotheses on clinically and genetically homogeneous models of cerebral alterations; clinical neuroscientists can define pathophysiological mechanisms using state-of-the-art biomarkers and models of cerebral function.

**Research results**

Researchers from this theme have revealed motor programmes stored in subcortical structures, opening the way for exploiting those programmes in rehabilitation programmes following cortical lesions. In the domain of visual perception, researchers have identified differences in the neural signals elicited by expected and un-expected events, a crucial observation for understanding the computational mechanisms of attention, expectation, and adaptation. This theme has also provided important contributions to our understanding of social interactions. First, it has been shown that socially dominant people strongly rely on learning from other agents, in stark contrast to aggressively dominant individuals that do not use that source of information even when it is freely available and beneficial. Second, researchers have gained a clearer understanding of how prior conceptual knowledge gives structure to predictions during movement observation. Third, researchers from this theme have found a neurophysiological marker for the emergence of meaning during a communicative interaction, showing that mutual understanding arises from shared conceptualizations of a signal’s use across communicators, and independently from responses to transient signals.

**Future research**

Researchers working on this theme will focus on the mechanisms that make humans so unusually cooperative among primates, exploring the cerebral mechanisms that support that ability. Work on behavioural addictions will be focused on gambling, using both brain imaging and app-based research to isolate the factors leading to this condition. Researchers will also explore the neurocomputational bases of a new and pervasive human skill, namely the ability to interact motorically with the two-dimensional and symbolic world of touch screens. Ongoing large-scale integrated projects will deepen our knowledge of the behavioural and neural correlates of perception-action coupling in dynamic environments, and of the neuro-endocrine mechanisms supporting of social emotional actions.

**Research funding**

Key publications


Researchers working on the Plasticity and Memory (PM) theme aim to understand the mechanistic underpinnings and behavioural consequences of long-term changes in neural structure and function. More specifically, their mission is to find out how such neuroplasticity supports neurodevelopment, adaptation to external and internal challenges, as well as learning and memory. The PM theme combines a focus on major medical problems with the ability to have an impact on other areas such as education.

Research is organised in three closely interacting subthemes: a) development, studying the mechanisms and consequences of normal as well as abnormal neurodevelopment, the latter with a main focus on neurodevelopmental disorders, i.e. psychiatric ones and intellectual disability; b) adaptation, focusing on the neurobiological mechanisms underlying the effects of external and internal challenges, such as environmental factors, stress, and brain damage, as well as their behavioural and clinical consequences as observed in stress-related disorders; c) learning and memory, investigating the neural and cognitive mechanisms underlying normal and impaired learning and memory and translating these mechanisms into clinically and educationally relevant constructs. The clinical focus of this subtheme is Alzheimer disease.

Multidisciplinarity and interdisciplinarity are the core principles of the PM theme, as they integrate all levels of research from molecule – via cell and animal – to patient and population and from fundamental work to clinical practice. This theme is closely integrated with the Radboudumc research themes "Neurodevelop-
mental disorders’, ‘Stress-related disorders’, and ‘Alzheimer disease’. The network creates opportunities for powerful approaches, ranging from state-of-the-art genetic, epigenetic and genomics techniques, through in vitro models (e.g. induced pluripotent stem cells) and a variety of animal models, animal and human functional neuroimaging approaches, experimental psychology and neuropsychological research, through to clinical research.

Research results
Researchers working on the subtheme Development were very successful in identifying new causes for intellectual disability and autism using exome and whole-genome sequencing. Moreover it was explained how genetic alterations in the X-linked mental retardation protein OPHN1 can impair synapse maturation and plasticity. Using bioinformatics, a protein network regulated by microRNA-137 was identified, which may help explain its role in schizophrenia. What’s more, researchers showed for the first time that common genetic variation in monoaminergic genes can explain part of the hyperactivity/impulsivity symptoms in ADHD.

Within the subtheme Learning and Memory it was shown that sleep deprivation interferes with the normal nightly down-regulation of cerebrospinal fluid β-amyloid 42, suggesting that chronic sleep deprivation might increase the risk of Alzheimer disease. Researchers successfully challenged the claim that there are distinct neural systems for explicit and implicit memory by demonstrating that a formal single-system model predicts the pattern of recognition memory (explicit) and repetition priming (implicit) in amnesia. It was found that a single application of electroconvulsive therapy following memory reactivation in patients with unipolar depression disrupted reactivated, but not non-reactivated, memories affecting an emotional episode.

Researchers in the subtheme Adaptation, used mouse models to provide evidence for a relationship between apoE and brain connectivity, possibly mediated by vascular risk factors and by the efficiency of apoE as a synaptic modulator in the brain.

Future research
In 2015, new research will include the following projects. A European Training Network, which is coordinated by Prof. Franke and also involves Profs. Buitelaar and Arias-Vasquez, Schenck, and Rommelse, will employ 15 PhD students to work on the aetiology of the neurodevelopmental disorders ADHD and autism using experimental psychology and animal models, animal and human functional neuroimaging approaches, as well as experimental psychology and neuropsychological research, through to clinical research.

Key publications


Academic publications 414
Dissertations 13
Professional publications 11
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 focus is 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 methodology, spanning the full range from recording individual neurons in animals to human imaging of brain networks. The experimental methods are complemented by the development of 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 involving 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 with members working on the other themes at the Donders Institute, as well as in national and international collaborations.

The aim of the BNNC theme is to make theories, method developments and state-of-the-art techniques available to the broader community. This is achieved through various proactive...
efforts to disseminate and educate, including making toolboxes and databases publicly available. Its members arrange and contribute actively to various teaching efforts, both nationally and internationally.

Research results
The functional role of oscillatory brain activity was explored at several levels. For instance, the oscillatory dynamics associated with place field and sequence recall was investigated in rats. In humans, fMRI and EEG have been combined to investigate how the flow of representational specific information detected in the BOLD signal is routed by oscillatory brain activity. Theoretical ideas have been developed to shed light on the dynamics associated with routing and integration of information in the brain.

In terms of human data brain-imaging data there have been important advances in multiband recordings of fMRI data with the promise of dramatically increasing the speed of data acquisition. Analysis methodologies have been developed which help to interpret the functional role of brain activation at the network level, both in terms of resting state data and tasks.

Future research
BNNC will keep advancing data acquisition techniques while combining methods. MR multiband acquisition will be refined to further reduce the scan times for functional brain imaging. Imaging with laminar resolution will be improved by developing a statistical model to extract laminar time courses.

Analysis and modelling approaches will be improved using sophisticated mathematical techniques that have their origin in artificial intelligence, physics, machine learning and statistics. Analysis approaches will be scaled to the large datasets that are now available thanks to new developments in experimental neuroscience.

Laminar recordings across distributed cortical networks will complement multi-unit recordings in single synapse-to-network recordings in freely behaving animals. These recordings will continue to be combined with optogenetic neural control to both engage and disengage neuronal populations to mechanistically dissect the contribution of identified neural circuits to behaviour.

The findings in humans and animals will be integrated with the aim of providing a system neuroscience perspective on neuronal dynamics. A common interest is the functional role of neuronal synchronization and oscillations.

Collaborations on clinical research will be extended to include 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 – by disabled patients.

Key publications


Every procedure in clinical practice and public health should take place on the basis of proof, rather than intuition or just ‘experience’. The mission of the Radboud Institute for Health Sciences (RIHS) is to improve clinical practice and public health by providing evidence about the efficacy and efficiency of existing and new tests, treatments and policies, by training young researchers in the methodology needed to obtain such evidence, and by developing new methodologies for more effective research in this field.

The starting point for research in the RIHS is a concrete medical or biomedical problem in clinical practice or public health for which a solution is required. Researchers working at the Institute typically investigate such problems through probabilistic studies among groups of (real or simulated) people. In line with the Radboudumc’s mission (‘to have a significant impact on healthcare’), the Institute tries to bridge the gap between science and society, e.g. by getting involved in developing and evaluating guidelines and protocols. Societal impact is at the core of the Institute’s ambitions.

The RIHS received accreditation from the Royal Netherlands Academy of Arts and Sciences (KNAW) in 2014.

Research at Radboudumc is organized in 19 research themes. Four of these are supported exclusively by the Donders Centre for Neuroscience and one exclusively by the Radboud Institute for Molecular Life Sciences. Since very few RIHS researchers work on the theme ‘Cancer development and immune defence’, we report here on the remaining 13 themes.
Healthcare improvement science  
**Theme leader: Prof. Pim Assendelft**  
The focus of research is to study the structure, process and outcomes of healthcare, with the aim of improving performance and delivery of care. The primary concern is providing direct value for patients. A further aim is to develop efficient and effective research methods and designs. Studies include the context, facilitators and barriers within which improvements in care around patients can be achieved, throughout the transmural care chain.

Infectious diseases and host response  
**Theme leader: Prof. Mihai Netea**  
Infections are caused by viruses, bacteria, fungi, and parasites. The main aim within this theme is to better understand the interaction of the host immune system with pathogens by combining cutting-edge research in immunology, microbiology and systems biology with translational and implementation research. The ultimate goal is to identify personalized approaches to the diagnosis and treatment of patients with infections.

Inflammatory diseases  
**Theme leader: Prof. Irma Joosten**  
In the Western world chronic inflammation is among the leading causes of morbidity and mortality. This theme involves understanding and controlling inflammatory disease for the benefit of patients by i) unravelling the immune pathogenesis of inflammatory disease processes; ii) elucidating the role of tissue specific factors in the regulation of 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 within this theme is to better understand the cellular bioenergetics in health and disease at all levels of complexity. Knowledge thus gained will enable the development of preventive measures and make a substantial contribution to treatment strategies for mitochondrial diseases.

Poverty-related diseases  
**Theme leader: Dr Teun Bouwma**  
Health can be improved worldwide through basic, clinical and translational research in poverty-related diseases. Researchers working on this theme aim to contribute to the academic development of professionals and institutes in the Netherlands as well as in low and middle-income countries. The aim is to understand the immunology, microbiology and systems biology of malaria, tuberculosis, HIV/AIDS and dengue, and to improve disease prevention and treatment, including the national health systems and health financing mechanisms in which they are embedded with translational and implementation research.

Staff  

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Tenured  
Full Professors 28.4 FTE  
Associate Professors 9.0 FTE  
Assistant Professors 41.2 FTE  
Researchers 76.2 FTE

Non-tenured  
Researchers 154.0 FTE  
Doctoral candidates 170.1 FTE

Research funding

- Core
- Grants
- Contracts
Rare cancers
Theme leader: Prof. Winette van der Graaf
Despite the rarity of each of the 186 ‘rare’ cancers (i.e., an incidence <6/100,000 per year), they represent in total about 22% of all cancer cases. They pose particular challenges due to their low frequency, including i) late or incorrect diagnosis; ii) lack of access to appropriate therapies and clinical expertise; iii) a very limited number of clinical trials due to the small number of patients; iv) lack of interest in developing new therapies due to market considerations; v) few available registries and tissue banks. The aim is to improve diagnosis and prognosis for this patient group in a national and international collaborative setting.

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 i) regenerative medicine and ii) nano-medicine, for personalized care and cure of patients needing reconstructions of lost or damaged tissues. This will be 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 considerably improved. To achieve this, researchers working on this theme aim to i) increase knowledge of the molecular and immunological basis of rare glomerular and tubular disorders; ii) develop biomarkers for optimal prediction of outcome; and iii) apply strategies for preventing renal disease and improving renal replacement therapy.

Sensory disorders
Theme leader: Prof. Anneke den Hollander
The research focus here is to improve our understanding of the molecular mechanisms of retinal diseases, hearing impairment and deaf-blindness. By developing and improving diagnostic and predictive tests for sensory diseases, researchers working on this theme aim to bring new personalized rehabilitation strategies and therapies into the clinic, including gene therapy and retinal implants.

Tumours of the digestive tract
Theme leader: Prof. Iris Nagtegaal
The research done within this theme focuses on improving the prognosis and treatment of patients with tumours of the digestive tract, in particular colorectal and pancreatic cancer. Key objectives are i) developing diagnostic tools for staging and therapy response; and ii) innovation in surgical techniques and immunotherapy. Increasing 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
Research involves identifying and evaluating the utility 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 for public health.

Vascular damage
Theme leader: Prof. Gerard Rongen
Primary prevention, early detection, and optimal treatment of atherosclerosis (to preserve end organ function) and implementation of effective diagnostics and therapies in practice are the key focus areas within this theme. The aim is to increase understanding of the causes and consequences of vascular injury and translate this knowledge into improved personalized cardiovascular healthcare.

Women’s cancers
Theme leader: Prof. Leon Massuger
The goal of this theme is to improve the patient-centred quality of care in women’s cancers (breast, ovarium, cervix, vulva, endometrium as well as pregnancy-related cancer. This is done in partnership with patients through prevention, early diagnosis or 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 post-treatment individualized care.

Research facilities
In the Radboudumc, many facilities for research are brought together in a platform of Technology Centers, which is coordinated by Prof. Alain van Gool (see www.radboudumc.nl/Research/TechnologyCenters). Examples include:
- The Radboudumc Biobank, which contains large databases and biobanks of general population samples (the Nijmegen Biomedical Study) and of specific patient groups (e.g. congenital malformations, cancer, rheumatoid arthritis and inflammatory bowel disease).
- A clinical trial center offering logistics and data management for adult and paediatric human intervention studies.
- Consultation facilities for biostatistics, health economics and research with electronic health records.
- The Minimal Invasive Technology expert Centre (MITEC) field lab, which is used to evaluate surgical innovations.

In addition to these technology centers, examples of RIHS research facilities are:
- Academic networks of GP practices (including the GP Continuous Morbidity Registration), nursing homes,
Dr Rob Baltussen – Associate Professor International Health Economics – received an NWO Vici grant to establish a team of researchers to work on the prevention and treatment of HIV infections in South Africa and Indonesia.

Academic Collaborative Centre AMPHI the Institute collaborates with seven Dutch Community Health Services (GGDs). RIHS has collaborated with the Comprehensive Cancer Centre the Netherlands (IKNL), the National Expert and Training Centre for Breast Cancer Screening (LRCB), the RIVM, NIVEL, and the Dutch Ministry of Public Health, Well-being and Sports (VWS) for many years.

Research results
In 2014 the graduate school of the Radboud Institute for Health Sciences obtained formal accreditation from the Royal Netherlands Academy of Arts and Sciences (KNAW), indicating that the PhD training and supervision as well as the organization meet all the necessary criteria.

Some examples of research highlights are listed below.

Healthcare improvement science
Dr René Melis showed that mental health-related symptoms are likely predictors of multimorbidity, suggesting a strong impact of mental disorders on the health of older people (Melis et al. PLoS One 2014).
Key publications


Infectious diseases and host response
Prof. Marlies Hulscher and colleagues showed that appropriate antibiotic use in patients with a complicated urinary tract infection reduces the length of hospital stays and thus improves patient outcome, while reducing healthcare costs (Spoorenberg et al. Clinical Infectious Diseases 2014).

Inflammatory diseases
From a study among >4,000 smokers with mild-to-moderate COPD Dr Tjard Schermer and colleagues concluded that sex and age should be taken into account when assessing airflow obstruction. This observation has contributed to changing the recommendation on how to diagnose airflow obstruction (Akkermans et al. The European Respiratory Journal 2014).

Mitochondrial diseases
Dr Chris Verhaak and colleagues published the results of a randomized controlled trial on the effects of an online outpatient clinic for adolescents with T1Diabetes called Sugarsquare, showing that it improves communication between adolescents and healthcare professionals as well as quality of life in patients (Boogerd et al. Pediatric Diabetes 2014).

Poverty-related diseases
A novel malaria drug combination was developed and tested that kills both malaria parasites and mosquitoes. A study by Dr Teun Bousema and colleagues showed that the combination of a standard antimalarial with the mosquitocidal drug ivermectin was safe and efficacious in malaria patients (Ouédraogo et al. Clinical Infectious Diseases 2014).

Dr Teun Bousema and co-workers reported the first ever dose-ranging trial of the transmission-blocking drug primaquine, showing that the WHO’s previous recommendation of 0.75mg/kg can be changed to 0.4mg/kg or lower without any effect on preventing malaria transmission and without safety concerns in individuals with G6PD deficiency (Eziefula et al. Lancet Infectious Diseases 2014).

Rare cancers
Dr Anne de Waal showed that re-excision of low-stage melanoma has little value (de Waal et al. Virchows Archiv 2014).

Prof. Hans Kaanders’ group reported that accelerated radiotherapy, combined with carbogen breathing and nicotinamide increases tumour control rates in anaemic head and neck cancer patients. This is the first report ever describing a method that can improve the currently dismal outcome of patients with neoplasia-associated anaemia (Janssens et al. Clinical Cancer Research 2014).
Dissertations: 81
Scientific publications: 1980
Patents: 2
Reconstructive and regenerative medicine
The team led by Prof. Nico Verdonschot won the international Grand Challenge competition. This competition, which is sponsored by NIH, is a worldwide endeavour in which researchers are challenged to predict loads in the knee joint of a patient with a total knee replacement.

In an international collaboration between Dr Roeleveld’s group and researchers from Denmark, Sweden and the USA, several new genes were identified that increase the risk of hypospadias (Geller et al. Nat Genet. 2014).

Renal disorders
Prof. Luuk Hilbrands and colleagues presented the results of a large randomized clinical trial on the use of the anti-B-cell agent rituximab as induction therapy after renal transplantation. The study showed that rituximab has beneficial effects in sensitized patients (Joosten et al. Transplant immunology 2014).

Sensory disorders
Prof. Carel Hoyng participated in a research team that found that people who reported having allergies had a significantly reduced risk of developing age-related macular degeneration (AMD), the most common cause of vision loss in elderly (Ristau et al. Investigative Ophthalmology & Visual Science 2014).

Tumours of the digestive tract
Prof. Kampman’s team showed that intake of dietary B vitamins and methionine has no effect on the risk of colorectal cancer in patients with Lynch syndrome (Jung et al. Cancer Causes Control 2014).

Urological cancers
Maarten de Rooij and Prof. Jelle Barentsz were awarded the ‘Lauterbur Award’ for the best scientific MRI-related work at a conference in New Orleans. Their study shows the ability of multiparametric MRI and MR-guided biopsy to improve prostate cancer diagnosis and demonstrates that this MRI strategy appears to be cost-effective compared to standard care (de Rooij et al. European Urology 2014).

Prof. Bart Kiemeney and colleagues identified a new susceptibility locus for bladder cancer at chromosome 20p (Rafnar et al. Human Molecular Genetics 2014).

Anne Grotenhuis showed that the genetic risk markers for bladder cancer have little prognostic value for the disease (Grotenhuis et al. PLoS One 2014).

Vascular damage
The EU-funded Tailored Implementation in Chronic Diseases project, led by Prof. Michel Wensing, published, as first in the world, methodological studies of tailoring methods (Wensing et al. PLoS One 2014).

Dr Dick Thijssen has described – for the first time – that exercise training leads to responders and non-responders in terms of improvement of endothelial function and identified ‘success factors’ for improved endothelial function (Green et al. Journal of Applied Physiology 2014).

Thijssen’s group also showed that exercise training can normalize elevated levels of retrograde shear and that these changes are related to the sympathetic nervous system. (Scholten et al. American Journal of Physiology - Heart and Circulatory Physiology 2014).

Women’s cancers
Dr Mireille Broeders participated in the EUROSCREEN Working Group, which proposed a review of studies on breast cancer screening effectiveness (Paci et al. CEBP 2014).

Dr Ruud Bekkers and colleagues completed a large randomized controlled screening trial in 45,000 non-responders to cervical cancer screening (Verhoef et al. Lancet Oncology 2014).

Awards and acknowledgements
• Prof. Bart Kiemeney was listed in Thomson Reuters’ ‘The world’s most influential scientific minds 2014’ list.
• Prof. Maroeska Rovers was invited as visiting professor to give a Grand Round on evidence-based surgery at Oxford University.
• Dr Nynke Scherpbier received the ‘Heert Dokter’ award from The Dutch College of General Practitioners for her research paper on telenephrology.
• Dr Simone van der Burg was awarded the Dutch L’Oréal UNESCO Fellowship for Women in Science.
• Prof. Richard Grol received the prestigious Donabedian International Award for Leadership in Quality of Care.

Societal impact
Much RIHS research is immediately implemented in clinical care or public health. Achieving societal impact is, in fact, one of the main aims. Some highlights in 2014 were:
• Prof. David Burger was one of the authors of the International Antiviral Society’s HIV Treatment Guidelines 2014.
• Dr Lisette Schoomhoven chaired the group that launched international clinical practice guidelines for the prevention and treatment of pressure ulcer.
The Institute will continue to invest in research facilities such as biobanks as well as in large national and international networks. Future research will increasingly be on personalized health-care as biobanks as well as in large national and international networks. 

**Future research**

The focus of research will be on personalized health-care and patient-centred interventions. For example, Dr Mireille Broeders’ group will start a study on the acceptability of personalized risk-based approaches in breast cancer screening in collaboration with the Karolinska Institute and the University of Manchester. With a Kolff post-doc grant from the Dutch Kidney Foundation Dr Loes van der Zanden will develop prognostic models for hypospadias and renal function.

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. Four research groups will perform research on healthcare costs and effectiveness with grants from the ZonMw programme ‘Doelmatigheids-Onderzoek’: Prof. Anne Speckens (Mindfulness training in ADHD), Dr Dirk Kunst (Diagnostic strategies in patients with asynrne-trical hearing impairment or symptoms suspected of vestibular schwannoma), Dr Nanda Lambregs-Rommelse (Restricted elimination diet in children with ADHD) and Dr Erwin van Geenen (Fluid hydration to prevent complications after Endoscopic Retrograde Cholangiopancreatography).

Two RIHS researchers will extend their research with prestigious personal grants: Dr Rob Baltussen was awarded a NWO Vici grant for the project ‘Balancing efficiency, equity and feasibility in HIV treatment in South Africa’. Dr Teun Bousema received an ERC starting grant for the project ‘Commitment, maturation and infectivity of sexual stage malaria parasites’.

Prof. Barentsz and colleagues will investigate the value of multi-parametric MRI and MR-guided biopsies in the detection of significant prostate cancer with an Alpe d’HuZes grant. Other projects that received awards from the Dutch Cancer Society are: ‘Identification of germline mutations in extremely early-onset bladder cancer’ (Prof. Bart Kiemeney and Dr Sita Vermeulen), ‘Cancer Related Fatigue in Childhood Cancer Survivors’ (Dr Jacqueline Loonen), ‘Efficacy of FDG-PET in the Evaluation of Cytological indeterminate Thyroid Nodules prior to Surgery’ (Dr Dennis Vriens), ‘A randomized Phase II feasibility study on the treatment of early stage rectal cancer’ (Prof. Hans de Wilt), ‘The influence of the oral microbiome and salivary proteome on oral complications in hematopoietic stem cell recipients’ (Prof. Nicole Blijlevens), ‘Early tubectomy with delayed oophorectomy to improve quality of life as alternative for salpingo-oophorectomy in BRCA mutation carriers’ (Dr Rosella Hermens, Dr Joanne de Hullu) and ‘The effectiveness of blended therapy on psychological distress in colorectal cancer survivors’ (Prof. Judith Prins).

Early detection of breast cancer through screening and subsequent treatment improves outcomes. The group led by Dr Chris de Korte will work on improving 3D automated volumetric breast scanning (ABVS) with an STW Open Technology grant.

With an EU Innovative Medicines Initiative (IMI) grant Profs. Bart Jan Kullberg, Marlies Hulscher and Inge Gyssens and their research partners will develop new economic models to provide incentives...
for antibiotic discovery and development activities while safeguarding the efficacy of antibiotics.

Prof. Maroeska Rovers is developing a methodology for the early integrative evaluation (efficacy, costs, value) of surgical innovations. This requires a paradigm shift from the traditional sequential processes: development, assessment and appraisal.

Prof. Gert Westert and colleagues will start the new ‘Roadmap to de-implementing low-value services in Dutch hospital care’, financed by the Citrien Fund (ZonMw). Prof. Westert leads the research group on behalf of the eight university medical centers that are involved.
Researchers at the Radboud Institute for Molecular Life Sciences (RIMLS) seek to achieve greater insights into the molecular basis of disease. 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 personalized healthcare.

RIMLS is a leading research institute in molecular mechanisms of disease, which brings together research groups from the Radboud university medical center (Radboudumc) and the Faculty of Science (FNWI). Clinical and fundamental scientists specialised in diverse areas of the life sciences work together closely to understand the underlying causes of disease. In line with the Radboudumc’s strategic vision to “have a significant impact on healthcare”, research is bundled into clinically-orientated research themes from moleculeto-man (M-2-M). The RIMLS international Graduate School integrates a dedicated two-year Research Honours MSc degree in Molecular Mechanisms of Disease (MMD) and a follow-up four-year PhD programme, thus creating a challenging yet enriching learning environment where researchers at all levels are exposed to societally relevant multidisciplinary research questions related to the molecular basis of disease.

Cancer development and immune defence
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 microenvironments 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.
Disorders of movement
Disorders of movement are common in patients with neurological abnormalities in the central or peripheral nervous system. A deeper understanding of these aberrations will help improve diagnostic, prognostic and therapeutic strategies for these patients. The emphasis is on understanding the behavioural characteristics, the underlying pathophysiology and the associated neuroplasticity.

Infectious diseases and host response
Infections are caused by infectious agents, such as viruses, bacteria, fungi, and parasites. Researchers aim to understand the interaction of the host immune system with pathogens by combining cutting-edge research in immunology, microbiology and systems biology with translational and implementation research. The ultimate goal is to identify personalized approaches to the diagnosis and treatment of patients with infections.

Inflammatory diseases
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 (immune)pathogenesis of inflammatory disease processes; ii) elucidating the role of tissue specific factors in the regulation of 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
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 gained will make it possible to develop preventive measures and contribute substantially to the development of treatment strategies for mitochondrial diseases.

Nanomedicine
This mechanism-based theme focuses on the design, synthesis and characterization of molecules and molecular assemblies in order to elucidate structure and function of natural systems. Knowledge gained is applied to developing nanostructured devices for diagnostics, targeted delivery and tissue repair. Examples include artificial cells, molecular probes and tissue-mimetic materials.

Rare cancers
Despite the rarity of each of the 186 rare cancers, they represent in total about 22% of all cancer cases. Examples include head and neck cancer, sarcoma, thyroid cancer, neuroendocrine cancer, brain tumours, lymphoma, and paediatric cancer. The mission here is to improve diagnosis and prognosis for this patient group in both a national and international collaborative setting.
Reconstructive and regenerative medicine
This theme focuses on the development and clinical translation of innovative diagnoses and therapies – including regenerative medicine and nanomedicine – for personalized care and cure of patients needing reconstruction of lost or damaged tissues. This is achieved by transdisciplinary research between leading research groups in medicine, dentistry, biochemistry, chemistry, biology and materials science.

Renal disorders
Current and future care of patients with renal and renal-related disorders can be improved considerably. To achieve this, researchers working on this theme aim i) to increase knowledge about the molecular and immunological basis of rare glomerular and tubular disorders; ii) to develop biomarkers for optimal prediction of prognosis; and iii) to apply strategies for the prevention and improvement of renal replacement therapy.

Sensory disorders
Research focuses on improving our understanding of the molecular mechanisms of retinal diseases, hearing impairment and deaf-blindness. By developing and improving diagnostic and predictive tests for sensory diseases, researchers hope to bring new personalized rehabilitation strategies and therapies, e.g. gene therapy and retinal implants, into the clinic.

Tumours of the digestive tract
Research here focuses on improving the prognosis and treatment of patients with tumours of the digestive tract, in particular colorectal and pancreatic cancer. Key objectives are i) the development of diagnostic tools for staging and therapy response; ii) innovation in surgical techniques and immunotherapy. Increasing knowledge of the aetiology, epidemiology and genetics of these tumours will improve cancer therapy in high-risk patients.

Urological cancers
Research in this field 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 keep the theme’s focus on ‘utility’ for the patient and/or public health.

Vascular damage
Early detection of atherosclerosis, primary and secondary prevention of atherosclerosis, optimal treatment of atherosclerosis to preserve end organ function, and implementation of effective diagnostics and therapies in practice are the key focus areas of this theme. Researchers working on this theme probe the causes and consequences of vascular injury and translate this knowledge into improved personalized cardiovascular healthcare.

Women’s cancers
Central to this theme is improving patient-centred quality of care in women’s cancers (breast, ovarian, cervix, vulva, endometrium and pregnancy-related) in partnership with patients. This includes prevention, early diagnosis or implementation of new management strategies, supported by a better understanding of carcinogenesis and tumour development, with special attention for hereditary causes, preservation of fertility and individualised care after treatment.

Research facilities
The Radboudumc has state-of-the-art facilities for research and education, which are part of the Radboud Research Facilities. Through this cooperation, a wealth of expertise is available that

Dr Shih-Chin Cheng (a postdoc studying Internal Medicine) and Dr Sadia Saeed (a visiting scientist from Imperial College London) made a major contribution to a 2014 Science paper by Chin, S.C. et al. See list of key publications.
can be used to answer a wide variety of research questions. These facilities include:

- The Central Animal Facility offers expert advice and access to facilities for animal testing and ample disease-related animal models.
- The Radboud Biobank is a standardized and controlled infrastructure for the collection, storage and delivery of biomaterial and associated clinical data.
- The Center 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 Clinical Trials technology centre facilitates investigators involved in clinical trials so that they can be performed efficiently and within the applicable national and international laws and guidelines.
- The Genomics technology centre can has four subunits: DNA isolation, DNA biobanking, high-throughput sequencing using targeted strategies and genome-wide sequencing strategies.
- The MITeC technology centre integrates the development and evaluation of medical technology to deliver image-guided treatment in a patient-centred and cost-effective way.
- 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.
- 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 intravital multiphoton microscopy, automated microscopy and 3D electron microscopy.
- 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.

Collaboration

This multidisciplinary nature of RIMLS ensures not only high-quality research within the molecular life sciences, but also ensures excellent education at BSc, MSc and PhD level. Building options for inter-institutional collaboration e.g. visiting professorships/lecturers, exchange possibilities for Masters and PhD students, technology workshops, is a key ambition for the years ahead and contacts in this regard are welcome. The aim is to complete fully translational disease pipelines from molecule-to-man, and back again.

Molecule-2-Man (www.molecule2man.eu)

The RIMLS is an active participant in Molecule-2-Man (M2M), an innovative multidisciplinary imaging platform strategically located at the University and Radboudumc, both of which have a long history of interdisciplinary research, education and healthcare. M2M is built on the strengths and proven track record of leading Nijmegen institutes: Molecules and Materials, Molecular life-sciences, Cognitive Neuroscience and Medical Sciences. Its aim is to reinforce existing local and national infrastructures by concentrating expertise and facilities in order to create a top European health technology campus in Nijmegen, which will implement and advance imaging technologies from the molecular level to entire organs and the human body itself (i.e. from molecule to man) and take translational research from the laboratory into the clinic (from bench to bed). M2M provides an ideal platform for exchange of knowledge and for access to state-of-the-art instrumentation. It also facilitates collaboration with research institutes, small and medium-sized enterprises, and larger companies.

Locally, RIMLS is allied with the Institute for Molecules & Materials, the Radboud Institute for Health Sciences and the Donders Centre for Neuroscience, providing a solid platform for integrating chemical synthesis, nanomedicine and neuroscience with molecular life sciences and health sciences. Nationally, RIMLS has contacts with other Dutch UMCs and universities as well as with Dutch public-private partnerships. Within Europe, there is increasing cooperation with the University of Duisberg-Essen, specifically the Graduate School of Biomedical Science (BIOEME). A recently awarded EU COST grant will serve as a forum for building partner relationships with other participants from universities in Münster, Glasgow, Poland and beyond. As part of the Glasgow–Radboud Memorandum of Understanding, there have been several exchanges (visiting lectureships) between RIMLS and the Institute of Molecular, Cell and Systems Biology, University of Glasgow, Scotland. These exchanges will be further developed as an integral part of the Masters and PhD programmes. In 2014, a double PhD retreat exchange was organized with the Institute for Research in Biomedicine (IRB), Barcelona, in which first students from IRB attended the Nijmegen PhD retreat, and then vice versa. This successful formula, built on experiences in 2013, will be extended in 2015.

Research results

In two ground-breaking publications in Science, Prof. Henk Stunnenberg (Cancer development and immune defence) and Prof. Mihai Netea (Infectious diseases and host response) published new information contributing to our understanding of 1) epigenetics and 2) energy metabolism in host defence and
Key publications


immunity. This information will help researchers to further understand and manipulate immune-mediated responses as well as develop novel therapies to fight human diseases. Both papers received broad media coverage due to their importance for medical science.

Dr Dirk Lefeber (Disorders of movement), published – in the New England Journal of Medicine – the application of a novel high-resolution glycoprofiling method that can be used for the early diagnosis and personalized treatment of Congenital Disorders of Glycosylation, a rare group of disorders comprising inborn errors of metabolism leading to abnormal glycosylation of proteins. Also related to energy metabolism, Dr Richard Notebaart (Mitochondrial diseases) described new computational tools for understanding evolutionary biology (Proc. Nat. Acad. Sci.). A central unresolved issue in evolutionary biology is how metabolic innovations emerge. The developed in-silico model demonstrates that the genetic basis of evolutionary metabolic adaptations is predictable and could be used in applications from bioengineering to medical genetics, including understanding gain-of-function mutations in tumour development and the evolution of antibiotic resistance.

Dr Frank Hoentjen (Inflammatory diseases) published in Gastroenterology, incidence and risk factors of ulcerative colitis, a form of inflammatory bowel disease common disease in the western world. Data from this nationwide case-control study will help develop endoscopic surveillance guidelines for the detection and potential removal of precancerous lesions. In the same journal, Dr Marjolijn Litenberg (Tumours of the digestive tract) published new clinical data, which should lead to a reduction in the number of colonoscopies in relatives of patients suspected of Lynch syndrome. Lynch syndrome is the most frequent cause of hereditary colorectal cancer. First-degree relatives of these patients are advised to undergo colonoscopy every two years, because they may have an as yet undetectable germline mutation. The data increases our understanding of colorectal cancer genetics and both the frequency and starting age of colonoscopies can be reduced for these patients.

Understanding the genetic causes of disease was also given a boost by Prof. Joost Hoenderop (Renal disorders) and Prof. Frans Cremers (Sensory disorders). The former group published in Plos Genetics data on brain development and seizures in patients with hypomagnesemia. Usually hypomagnesemia results from genetic and drug-induced renal disorders, involving a variety of defects in filtration and tubular transport. By combining genetic diagnosis with magnesium transport assays in cellular and zebrafish loss-of-function models, researchers identified novel gene mutations that can cause hypomagnesemia. These results open up new avenues for patient screening. The latter group published new research (in Am. J. Hum. Genet.) on the genetic cause of visual impairment in people with cone-rod dystrophy, an inherited eye disorder causing a breakdown of the cone photoreceptors of the retina and ultimately causing problems with seeing...


colours and details. Using high-throughput DNA sequencing, researchers identified mutations in a new gene that had not previously been associated with this disorder. Genes play an important role in transport in rods and cones and could serve as a novel therapeutic target.

Developing new molecular imaging techniques to improve detection and staging of disease is essential. Prof. Otto Boerman (Nanomedicine) published a new tool for intra-operative imaging of prostate cancer in *Cancer Research*. Despite advances in diagnostic procedures and clinical management, prostate cancer remains associated with significant morbidity and is the second leading cause of cancer-related deaths in men in the western world. The current research demonstrates the feasibility of dual-modality imaging of prostate cancer lesions and image-guided resection of malignancies in mice. In the Journal of Nuclear medicine, Dr Henri Timmers (Vascular damage) presented new data on pheochromocytomas and paragangliomas (PPGLs) tumour characterization by 18F-labeled fluorodeoxyglucose (FDG) PET in vivo imaging. Changes in tumour metabolism translate into genotype-specific differences in 18F-FDG uptake imaging. The authors found that the uptake of 18F-FDG is particularly high in tumours with an underlying succinate dehydrogenase (SDH) mutation. These results will allow improved identifications of patients with tumours that are prone to metastasize.

Dr Sander Leeuwenburgh (Reconstructive and regenerative medicine) has developed novel materials for bone regeneration. Reversible, non-covalent interactions are often regarded as insufficient to construct macroscopic materials of substantial integrity and cohesion. Inspired by nature, RIMLS researchers developed injectable nanocomposite hydrogels with unprecedented self-healing capacity and adhesiveness to mineral surfaces such as enamel and hydroxyapatite. The results, which were published in *Biomaterials*, will further the development of novel biomaterials for bone regeneration.

**Societal impact**

RIMLS’s mission is in line with the Radboudumc’s strategic vision to “have a significant impact on healthcare” and to advance “personalized medicine”, one of the major societal themes at the University. The importance 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 they will form the new generation of scientists and biotechnology entrepreneurs who will develop novel treatments and diagnostics. In 2014, the RIMLS Research Master MMD was chosen as the best MSc programme in the life sciences in the Netherlands, according to the 2014 Dutch Master’s programme information guide, illustrating a strong commitment to excellent education.

RIMLS researchers contribute actively to the dissemination of research results via public conferences, teaching in schools...
and colleges as well as in the media. Prof. Anneke den Hollander and Prof. Carel Hoyng (Sensory disorders) were awarded the Radboud Science Award 2014 by the University’s Science Node (Wetenschapsknooppunt) to allow them to translate their research on teaching materials suitable for primary school pupils. At the opposite end of the spectrum, Astrid Joosten presented a public evening addressing the important question: “How far are we from a custom-made personalized kidney? In front of 200 members of the public, scientists, clinicians and other stakeholders, she discussed state-of-the-art research on developing a biological artificial kidney, ethical dilemmas, and expectations for the future.

Other examples of media appearances in 2014 included: a new gene discovered in blood formation (Dr Bert van der Reijden), the safety and efficacy of a new malaria drug combination (Dr Teun Bousema) and a new vaccine for bowel cancer (Prof. Jolanda de Vries and Prof. Nicole Hoogerbrugge).

RIMLS researchers are actively involved in enhancing disease diagnosis, prevention and treatment. Their efforts have been acknowledged through high-level awards. Of particular note in 2014, Prof. John Jansen and Prof. Jelle Barentsz were honoured with the Knight of the Order of the Dutch Lion in light of their services to medical research. Prof. John Jansen also received the Isaac Schour Memorial Award for his valuable contributions to tissue engineering, tissue regeneration, stem cell and biomaterials research. Together with Prof. Han van Krieken they were both elected as members of the Academia Europaea. Prof. Han van Krieken was recently ranked by Lab Times magazine is among the top 30 European pathologists.

Clinical groups interact with patients and their relatives at Radboudumc on a daily basis, have close ties with patient organizations, and are involved in public and strategic policy. Prof. Joost Drenth (Renal disorders) was elected as a member of the Governing Council of the World Gastroenterology Organization (WGO) as chairman of the National Society Committee of the United European Gastroenterology Federation (UEG).

Future research
The following impressive Veni, Vidi and Vici grants from the Netherlands Organisation for Scientific Research (NWO) were awarded to members of RIMLS, forming the basis for important future research.

• Prof. Jolanda de Vries (Cancer development & immune defence) was awarded a NWO Vici grant worth €1.5 million for her proposal entitled: “Theranostics for the development of successful natural dendritic cell vaccines to combat and prevent cancer.”
• Three RIMLS researchers were awarded NWO Vidi grants, each worth €800,000 to develop innovative lines of research. Dr Sander Leeuwenburgh (Reconstructive and regenerative medicine): “Towards load-bearing bioceramics: smart toughening of calcium phosphate cements.” Dr Taco Kooij (Poverty-related disorders): “Unravelling the Plasmodium mitochondrion: systematic functional characterization of an essential organelle for anti-malarial drug target identification.” Prof. Jelle Goeman (Cancer development & immune disorders): “Making uncertainties in rankings visible.”
• Dr Marleen Ansems (Cancer development & immune defence) received a NWO Veni grant worth €250,000 for her proposal, which involves examining how certain cells of our immune system can be primed for use as cancer therapy.

Furthermore, in 2014, a number of large (consortium) grants were obtained. Full details can be found on the RIMLS website but particular highlights are:

• An STW ‘Perspective’ Grant worth €4.3 million to form the Biomarker Development Center, a public-private partnership to accelerate the validation and development of biomarkers, was awarded to Prof. Alain van Gool (Urological cancers) and colleagues.
• Dr Gerben Ferwerda, Dr Dimitri Diavatopoulos and Dr Marien de Jonge (Infectious diseases and host response) further consolidated the collaboration with the National Institute of Public Health (RIVM). They were awarded three grants financed by the RIVM’s Strategic Programme (SPR), totalling €1.7 million to study respiratory syncytial virus, a major cause of lower respiratory tract infections.
• Prof. Frans Russel and Dr Rick Greupink (Renal disorders) received an NWO/ZonMw consortium grant worth €1.6 million. This project will integrate molecular mechanisms and clinical data to support non-animal based hazard and risk assessment for chemicals and drugs, concerning cholestasis, allergic contact dermatitis and liver cancer as endpoints. The consortium is building upon a strong public-private partnership, which is led by TNO, and in addition to Radboudumc, consists of partners from the Universities of Groningen and Maastricht, the RIVM, Janssen Pharmaceutica NV, and SimCyp Ltd.
• Dr Theo Plantinga (Rare cancers) and Dr Anniiek van der Waart (Cancer development and immune defence) each received a Bas Mulder Award 2014 (€850,000) from the Alpe d’HuZes fund of the Dutch Cancer Society (KWF) to carry out research on therapy resistance mechanisms in thyroid cancer and on optimized treatment in stem cell transplantation, respectively.
• Dr Harry Dolstra, Dr Jeannette Cany and Dr Michel Schaap, (Cancer development & immune disorders) received a €567,000 KWF Grant for translational Natural Killer (NK) cell research in acute myeloid leukaemia. Dr Annemiek van Sprriel (same theme) was awarded a KWF Grant (€566,000) to unravel the function of CD37, as key plasma membrane organizer in B-cells, in protection against development of B-cell lymphoma. Dr Richarda de Voer (Tumours of the digestive tract) was awarded a KWF Fellowship (€357,000) for fundamental research on genetic predisposition to colorectal cancer.”
Dr Tom Nijenhuis (Renal disorders) obtained a Senior Kolff post-doc grant (€400,000) to further unravel the role of the TRPC6 calcium channel in proteinuria and renal function.

Prof. Roland Brock (Nanomedicine) and Dr Rick Wansink (Disorders of movement) were awarded €250,000 from the Prinses Beatrix Spierfonds. This project will develop targeted delivery of antisense oligonucleotides to eliminate toxic molecules in myotonic dystrophy, a fatal neuromuscular disorder.

Academic integrity

Use of honest and transparent working ethics as well as clear rules of accountability play a pivotal role in all research and RIMLS researchers comply with the academic integrity policies laid down by the University. These regulations are published on the University and RIMLS websites. Promoting awareness of academic integrity is equally important and RIMLS continues to raise awareness of this topic in Masters and PhD training programmes. Since the academic year 2012/13 special attention was paid to important aspects of appropriate scientific conduct in the MSc Science and Society course. In addition to such issues and technology assessment, time is allocated to discussing integrity, scientific misconduct and the ethics of scientific authorship (under the supervision of Prof. Hub Zwart of Philosophy & Science Studies). In this way students are made aware of aspects of academic misconduct such as fraud and plagiarism and they discuss appropriate scientific behaviour.

Furthermore, the topic data management has now been included in the MMD introduction course. The objective here is to teach students about proper data management such as storage of large data sets, proper use of data and appropriate ways of generating figures especially for microscopic images. In the compulsory introductory course of the PhD programme and in dedicated workshops specific attention is also devoted to academic integrity and ethics. In 2014, a compulsory integrity workshop for 2nd year PhD students was set up and two senior researchers were appointed as contact persons in cases of a suspected breach of University policy in this area.
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 the IWWR is to become a world-class multidisciplinary 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 organization: from cellular levels via organisms to ecosystems. Another important strand of research is explaining the ways in which plants, animals and micro-organisms adapt to changes in water quantity and quality. 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, post-docs 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 organization. As a whole the IWWR covers stress responses to water problems from molecular mechanisms to changes on a global scale.

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 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. The success of researchers working in Microbiology can be attributed to intensive national and international collaboration with experts covering a wide range of disciplines (Geology, Biochemistry, Structural Biology, Genetics and Metagenomics) and these also include wetland bio-geomichists 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 located 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:

- Large aquarium facilities for freshwater and seawater fish; for zebrafish research there is modern equipment, expertise and permits for producing transgenes.
- Light microscopy and electron microscopy facilities for ultra-structural analysis of micro-organisms, animals and plants.
- PHYTOTRON – a unique national research facility for detailed ecological research on sub-surface processes of terrestrial and semi-aquatic vegetation.
- Gas Chromatography and Mass Spectrometry (equipped with a direct thermo-desorption unit).
- Extensive bioreactor and culture facilities for Micro-organisms extended in 2014 with a brand new lab to accommodate the Gravitation research of Microbiology wetland plants and animals, as well as for plant-soil interactions.
- 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.
- A new greenhouse together with state-of-the-art climate room facilities was built in 2014.

**Collaboration**

Collaboration within the Institute opens up avenues for novel interdisciplinary research as well as more opportunities for funding. 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 for innovation have been started. Researchers working on the Plant Stress Response theme have approached several companies in their research on multiple plant stressors and obtained substantial grants from the Top sector Agrofood and Horticulture and The Dutch Technology Foundation (STW).

The Ecological Microbiology and Aquatic Ecology groups have been involved in plans for regional development in which provinces, water management authorities and companies (including spin-off company B-Ware) interact. These plans have considerable relevance for the Top sector Water. 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; there was considerable interest in interactive courses on fish welfare in the Netherlands.
To join forces with complementary research groups outside IWWR and to achieve successful valorisation, research is also conducted in close collaboration with over 100 national and international research groups, research institutes, companies, governmental organizations and NGOs.

Research results
A collaborative effort between animal and plant ecologists at the Institute and partners from SOVON (the Dutch centre for field ornithology) – resulted in a paper on the correlation between neonicotinoid pesticide concentrations and declining bird populations, which was published in Nature (Hallmann et al. 2014). This work received a great deal of media attention: questions were asked in the Dutch parliament and national and international newspapers, many blogs, as well as television news programmes covered the item.

Among a number of major studies, the microbiologists at the IWWR investigated the role of the unique prokaryotic organelle in anammox bacteria. They were able to isolate this organelle and analyse its protein and lipid content, as well as its role in hydrazine turnover. This study was published in Molecular Biology (Neumann et al. Mol. Micr. 2014).

Aquatic ecologists at the Institute focused on the interactions between climate change, carbon and nutrient cycling, and ecosystem functioning and services in a range of wetland types, both in temperate and in tropical regions. Their research included the interesting role of mutualism interactions between keystone species (plants, animals and micro-organisms) in ecosystem responses to disturbance as well as ecosystem resilience.

Environmental scientists at IWWR have integrated human and ecological risk assessment (HERA) in Life Cycle Analysis (LCA) (PhD thesis by Golsteijn). Likewise, eutrophication and acidification dose-response curves have been developed to allow for a combined assessment of major environmental issues. Models have been developed to describe diffusion and, for the first time, active transport of (polar) substances as a function of their chemical properties (PhD thesis by O’Connor).

This year saw the birth of the Plant Science group (a fusion of three research groups) giving further impulse to research on Solanum dulcamara (one project was supported by the Chinese Scholarship Council and one was funded by NWO-ALW), but also to strategic research on genetic variations in crop plants such as tomato and bell pepper (one funded by TopSector and the other funded by STW).

The Jena Biodiversity experiment i.e. a large experiment devoted to investigating the ecosystem consequences of plant biodiversity, resulted in the first publications by the IWWR’s plant ecologists. They found that communities with higher diversity produce more root biomass, as expected, but also that these roots are more aggregated, which contradicts some influential hypotheses on how diversity is maintained (Ravenek et al. 2014 Oikos).

The Organismal Animal Physiology group continued its research on pain perception in fish and the consequences of stress load on fish performance in Dutch and European aquaculture practices (catfish, salmon, sea bream and sea bass). Important papers were published on bone physiology (fish scales as a model for bone formation) in transgenic zebrafish. The group completed studies on a drug screening assay for osteoporosis with transgenic zebrafish bone as the target.

The Animal Ecology & Ecophysiology group published some high-profile papers in 2014 in Biological Reviews on the effects of grazing on small invertebrate species and in Ecology (larger reserves provide better survival opportunities than a series of smaller ones with the same total surface area). Together with the Plant Ecology group, a study was published in PNAS (Scheper et al. 2014) on the diet of bees in the Netherlands, comparing present-day diets with those a century ago using pollen diagrams collected from museum bee specimens.

Awards
• Prof. Mike Jetten’s second ERC Advanced Investigator Grant (to study the ecology of methane oxidizing micro-organisms) started on January 1st 2014
• Dr Sebastiaan Luecker was awarded a Veni grant by the Netherlands Organization for Scientific Research
• Dr Boran Kartal received an ERC Starting Grant
• Muriel van Teeseling and Olivia Rasigraf received a Frye Stipendium
• Prof. Mike Jetten was elected as a member of the EMBO
• Onno Calf won a student poster prize at the international Symposium for Insect Plant interactions (SIP) in Neuchatel, Switzerland (August 2014)
• Marjolein Bruining received the Van Nieuwenhoven Award
• The Unilever Research Prize 2014 was awarded to Dina in ’t Zand.

Societal impact
The IWWR establishes 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 organizations, water boards, and national, regional and local authorities.

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.

The aquatic ecologists at IWWR work closely with the spin-off company B-Ware, which valorises biogeochemical and ecological knowledge related to nature management and water management, together with a number of governmental organizations. One of the collaborative programmes in 2014, which was financed by the European Regional Development Fund (ERDF), involved developing innovative solutions for combining water storage, water purification and biomass production.

Applications in nature management are used to enhance the value of the Conservation Biology theme at IWWR. The societal importance of this theme, which was formulated in collaboration with partners at Natuurplaats, was illustrated in a Nature publication on bird decline in relation to neonicotinoid insecticides. In addition to media attention worldwide, major newspapers (as well as Nature itself) wrote commentaries that were picked up in blogs, etc. Questions were also asked in the Dutch parliament. The paper was ranked in the top 100 of the 2014 Altmetric score for media attention and impact, and it was the only such paper in the field of environment science. The authors received several invitations to give public lectures about their results.

Other successful applications of IWWR research include long-standing collaborations with seed companies aiming to improve plants’ responses and tolerance to environmental stress factors such as heat and insect attacks. Biotechnology companies also use IWWR results e.g. to improve fish welfare. In addition, courses for various stakeholders were organized.

Future research

The microbiologists at IWWR will continue to investigate the role of anaerobic methane and ammonium oxidizing 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. The microbiome of several relevant wetland plant and animal species will be investigated (together with the aquatic ecologists at the IWWR). Various anaerobic microbial processes will be investigated in the SIAM Gravitation Consortium. Work on the cell biology and biochemistry of anammox bacteria will focus on the elucidated cell wall and various protein complexes.

The current biogeochemical and ecological research of the Aquatic Ecology group will be extended to include novel applications related to the restoration of heavily disturbed wetlands (e.g. the Wadden Sea, peatlands and lakes), wet agriculture (paludiculture), coastal protection and the prevention of land subsidence.

The objective of future research in Plant Science is to explore natural variation in plants (including projects in collaboration with the Experimental Garden and Gene Bank of the University) and to identify new traits that can help plants to adapt to their environment. The plasticity of genetic networks and plants’ responses to a range of environmental cues will be studied in collaboration with external colleagues. This work is linked to the plans of the Experimental Plant Ecology group, continuing their focus on root interactions in relation to environmental stressors and their effort to apply this knowledge to crop responses to drought and nutrients, as well as managing dike vegetation.
Institute for Water and Wetland Research

Key publications


Dissertations: 18

Scientific publications: 188

Professional publications: 12
The Organismal Animal Physiology group is increasingly focusing on topics related to fish welfare. Facilities for studying fish behaviour (zebrafish phenotyping) are being explored in conjunction with commercial companies. 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: Prof. Hans de Kroon

Hans de Kroon has been Professor of Experimental Plant Ecology at Radboud University since 2000. He graduated from Utrecht University, 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 applied with partners from Natuurplaza on the campus. This collaboration resulted in a paper in Nature in 2014 on the relationship between bird decline and neonicotinoid insecticides. The paper, which was read with interest worldwide, led to Prof. de Kroon receiving the University’s Hermesdorf Award in January 2015.

Institute for Water and Wetland Research

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The Institute for Molecules and Materials (IMM) is an interdisciplinary research institute in chemistry and physics at Radboud University. Its mission is to fundamentally 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.

The IMM is composed of twenty research groups, each headed by a full professor. The four research themes are:

1. Structure and Dynamics of Molecules
2. Molecular Life-like Systems
3. Quantum Matter

The mechanical properties of a new type of semi-flexible polymer hydrogels are easy to control (by altering concentration, polymer length and/or temperature).

The institute employs around 140 PhD students and every year some 30 of them graduate. There is a strong focus on interdisciplinary research between theorists and experimentalists as well as between physicists and chemists.

Structure and Dynamics of Molecules
The focus within this research theme is on the constellation and motion of the atoms within molecules, molecular complexes, molecular and atomic collisions, and even chemical reactions. Examples include small organic molecules, non-covalently bounded complexes, and collisions between diatoms and noble gases. Experiments are often based on advanced spectroscopic techniques such as Nuclear Magnetic Resonance (NMR), various laser techniques, and velocity-map imaging. Theoretical approaches include ab initio calculations, simulations and DFT methods.
Molecular Life-like Systems
This research theme involves the design, synthesis and characterization of molecules and molecular assemblies in order to elucidate the structure and function of natural systems. Examples include artificial cells and organelles, enzyme-mimetic structures, orthogonal chemistry in living cells and analysis of biomolecular interactions. This research is based on expertise in bio/organic chemistry, supramolecular chemistry, microfluidics, microscopy, NMR spectroscopy techniques, and data analysis/chemometrics.

Quantum Matter
Researchers working on this theme focus on studying the properties of matter that is dominated by interactions between quantum particles, quantum coherence, and quantum correlations and topology. The goal is to understand and develop new materials and concepts based on collective, emergent quantum effects. Examples include the study and control of magnetic materials at energy and time scales of the exchange interaction, sub-nanometre metal clusters (including metal-oxide clusters), and graphene and quantum dots. Properties are often studied under extreme conditions such as high magnetic fields, ultra-short laser pulses, and low temperatures.

Nanostructured Materials
This research theme involves the design, growth, synthesis and characterization of materials in which the properties partly stem from their nanoscale dimensions, with the aim of exploring novel property-function relationships. This includes supramolecular assemblies, nanoreactors, self-assembled monolayers, chiral clusters and solar cells. These materials are typically studied using microscopy (including SPM) and X-ray diffraction.

Research facilities
The national and international position of the IMM is enhanced by the availability on the university campus 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 in 2017 is being constructed.
- Free Electron Lasers for Infrared and Terahertz Experiments (FELIX) Laboratory. The infrared lasers (FELIX/FELICE) and the terahertz laser (FLARE) are fully tunable between 3 and 1,500 microns.
- A Large-Scale Facility for high-resolution liquid NMR and a Solid-State NMR Facility for advanced material science, including an 850 MHz proton NMR instrument.
- A Scanning Probe laboratory (NanoLab) with a wide range of Scanning Tunnelling Microscopy (STM) and Atomic Force Microscopy (AFM) techniques.
- A Trace Gas Facility for the application of laser diagnostics in biology and medicine.

In March 2014 the HFML set a new world record by generating a continuous magnetic field of 37.5 Tesla in a purely resistive (i.e. non-superconducting) magnet.

Collaboration
The organic chemistry groups at the IMM have a longstanding collaboration with the Institute for Complex Molecular Systems (ICMS) at the Eindhoven University of Technology and the Stratingh Institute for Chemistry at the University of Groningen. The IMM also collaborates intensively with the Catholic University of Leuven in Belgium and several organic chemistry groups collaborate with the University of Barcelona. Within graphene research, the groups at the IMM led by Profs. Katsnelson and Maan collaborate closely with their ex-colleagues Profs. Geim and Novoselov, who now work at the University of Manchester. Prof. Katsnelson also works closely together with scientists at the Universities of Uppsala, Hamburg, and Moscow. There are numerous bilateral collaborations with other research groups,
including those at a range of European and non-European universities e.g. Tsinghua, Jilin, and Peking University in China, are numerous.

The IMM is a partner in two formal collaborations with the Foundation for Fundamental Research on Matter (FOM). One partnership relates to the relocation and the decade-long exploitation of the free electron lasers ‘FELIX and FELICE’ in Nijmegen, and the other involves the joint running of the HFML and the promotion of materials research with high magnetic fields. The Engineering and Physical Sciences Research Council (EPSRC, UK) transferred a research contract on solid-state physics with free electron lasers to Nijmegen.

The EU-FP7 project on the European Magnetic Field Laboratory (EMFL), which is coordinated by HFML, involves investigating all legal, financial, organizational, and employment issues required for a Founding Agreement for the EMFL. On 27 November the three founding partners (Radboud University, Helmholtz Zentrum Dresden-Rossendorf (HZDR) and le Centre National de la Recherche Scientifique (CNRS) in Grenoble/Toulouse) signed an agreement to formally start working together as a single entity that develops and operates world-class high magnetic field facilities.

Scientists and research facilities at the IMM will be part of a large pan-European partnership focusing on innovation in ‘raw materials’. The consortium ‘RawMatTERS’ includes more than 100 partners from 22 countries in the EU, representing leading partners from science, industry, research and academia. This ‘Knowledge and Innovation Community’ will stimulate the competitiveness and growth of the European raw materials sector through intensive innovation and entrepreneurship.

Research results

Highlights are listed below under the Institute’s four main research themes.

Structure and Dynamics of Molecules

Dr Rijs and her colleagues at Molecular and Biophysics have imaged peptides in unprecedented detail using far-infrared spectroscopy. Conformation selective far-infrared action spectroscopy – in combination with the novel Born-Oppenheimer Molecular Dynamics theoretical method – has proved to be a promising new tool for the detailed structural characterization of peptides.

Dr Harren and his colleagues at Molecular and Laser Physics have carried out broadband mid-infrared dual-comb spectroscopy with a two-crystal optical parametric oscillator, measuring absorption and dispersion spectra in gas phase simultaneously. The broad spectral coverage and the fast acquisition time associated with extreme sensitivity will enable extensive spectral studies of rarefied samples and real time monitoring of processes. (Optics Letters)

The Molecular Structure and Dynamics group (led by Prof. Oomens) has carried out infrared spectroscopy of negatively charged gaseous polyaromatics, which are probably present in the interstellar medium. The experimental IR spectra provide an important benchmark for quantum-chemical calculations of IR spectra. Comparison of experimental and theoretical spectra suggests that good agreement can be obtained.

Dr Cuppen, Dr de Wijs, and their colleagues at Theoretical Chemistry have studied the interactions of adsorbed CO₂ on water ice at low temperatures. Interstellar water ice is thought to be the precursor of cometary ice and even water on Earth. Whether, how, and in what form interstellar ice survives during the evolution of a dense molecular cloud into a planetary system is far from understood. (Phys. Chem. Chem. Phys.)

Molecular Life-like Systems

Prof. Pruijn and his colleagues at Biomolecular Chemistry have studied the specificity of protein citrullination, which is involved in several physiological processes. These include regulation of gene expression and are associated with various diseases, such as cancer, multiple sclerosis, rheumatoid arthritis and Alzheimer’s disease. (Biochim. Biophys. Acta)

Prof. Buydens and her colleagues at Analytical Chemistry have linked odours to compounds identified in data from gas chromatograph and mass spectrometers using a chemometrical data science approach. They have developed two approaches that revolutionize the interpretation and speed of this analysis. These approaches were demonstrated via analyses of flavoured beverages from Heineken.

Researchers in the Bio-Organic Chemistry group (led by Prof. Van Hest) studied enzymatic cascade reactions in multicompartment polymersomes. A simple cell mimic with subcompartments was created based on polymer building blocks. The final product of the cascade reaction was produced locally and confined in an organelle subcompartment if the last enzyme of the reaction sequence was enclosed in the same compartment. These concepts may lead to a better understanding of the structure and functioning of the living cell. (Angew. Chemie Int. Ed.)

Prof. Huck and his Physical Organic Chemistry group are exploiting reaction-diffusion systems in smart materials. Chemistry in a traditional round-bottom flask is completely different from chemistry within a living cell, where the typical diffusion times of components are of a magnitude that is similar to their reaction times. These so-called reaction-diffusion systems can reveal extremely complex behaviour and the aim is to understand and harness this complexity. (Angew. Chem. Int. Ed.)
The Spectroscopy of Surfaces and Interfaces group (led by Prof. Rasing) studied laser induced spin precession in a granular film of FePt. This will be the recording medium used in next generation hard disk drives as it has an exceptionally high magneto crystalline anisotropy that allows for higher data storage densities than can be achieved with current recording media. (Appl. Phys. Lett.)

Profs. Katsnelson and Fasolino (Theory of Condensed Matter) have studied the use of moiré patterns as a probe of interplanar interactions. The superposition of crystalline layers – with either slightly different lattice constants or different orientations – creates moiré patterns. The strain distribution and out-of-plane displacement in moiré patterns can provide direct information on the interplanar interactions in van der Waals heterostructures. (Phys. Rev. Lett.)

Nanostructured Materials

The group led by Prof. Hussey (Correlated Electron Systems, HFML) obtained experimental support for proposed supersolid phase in a magnetically frustrated metal. Magnetically frustrated materials are those in which the preferred alignment of electronic spins cannot be achieved due to the geometrical arrangement of atoms on the crystal lattice. Evidence was found for intriguing additional magnetic transitions within the proposed supersolid phase. (Phys. Rev. B)

Dr Zeitler and his colleagues at Semiconductors and Nanostructures, HFML have found a temperature-driven transition from a classical semiconductor to a two-dimensional topological insulator. Topological insulators are a new state of quantum matter, which is characterized by an insulating gap in the bulk and gapless edge states. The Spectroscopy of Surfaces and Interfaces group (led by Prof. Rasing) studied laser induced spin precession in a granular film of FePt. This will be the recording medium used in next generation hard disk drives as it has an exceptionally high magneto crystalline anisotropy that allows for higher data storage densities than can be achieved with current recording media. (Appl. Phys. Lett.)

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Key publications


of easily controllable variables (concentration, polymer length and temperature) on the mechanical properties of semi-flexible polymer hydrogels. The outlook is a class of materials for which the mechanical properties can be readily adjusted by changing the external conditions. (Nature Communications)

Prof. Nolte and his colleagues at Molecular Nanomaterials are developing a molecular Turing machine. A great challenge for the future is how to develop computers that can perform calculations at the molecular level. This molecular Turing machine should be able to read and write data on a polymer chain using information from a ring attached to a molecular device that moves along this chain. (J. Am. Chem. Soc.)

Dr Elemans (Scanning Probe Microscopy) used an STM tip to induce chemical reactions with manganese porphyrins at a solid/liquid interface. Besides using an STM for observations, an exciting possibility is to use it to trigger local chemical reactions. This opens up the possibility of manipulating chemical reactions locally at the nanoscale, in particular at solid/liquid interfaces. (J. Am. Chem. Soc.)

The Solid State NMR group (led by Prof. Kentgens) demonstrated high-resolution solid-state NMR of nanolitre sample volumes. The resolution achieved makes it possible to exploit the proton chemical shifts for structural assignments in the solid-state. The group will use this setup to study specific regions of polymers and aligned polymer fibers to arrive at new insights into their local physical properties.

Awards and grants

Prof. Hussey and his team from the HFML acquired an extremely prestigious – and substantial – grant (€14.9 million) from the National Roadmap for Large-scale Research Facilities. They will use it to build new magnets and to further expand the operating capacity of the laboratory. In addition, the HFML participates in an approved FOM Program (€2.9 million) on conducting interfaces in insulating oxides, together with four other Dutch universities.

Prof. Rasing and colleagues at the Technical University Eindhoven and the University of Twente obtained one of the six grants for a FOM Free Program (€2.2 million) on ‘Exciting Interactions’. This programme focuses on the non-equilibrium states of magnetic systems and the time dependence of the magnetic exchange interaction. Moreover, Dr Kimel and Dr Van de Meerakker were each granted an award in the FOM Project Ruimte.

Dr Kimel also obtained a MegaGrant from the Ministry of Education and Science of the Russian Federation. This grant is worth 90 million roubles (€1.2 million) for three years. During this period Kimel will establish a state-of-the-art lab specialized in developing novel methods for ultrafast control of magnetization and electric polarization at Moscow State Technical University for Radio Engineering, Electronics and Automation.


Institute for Molecules and Materials

Prof. Huck acquired a prestigious NWO TOP-PUNT grant (€2 million) – together with colleagues at Delft and Groningen Universities – for the bottom-up construction of a synthetic cell using complex enzymatic networks. Prof. Buydens, Dr Jansen, and Dr Cuppen each received an NWO ECHO subsidy. Dr Jansen also obtained a project on in-flow multidimensional particle analysis that is funded through TA-COAST.

Profs. Parker and Rowan each acquired a Horizon 2020 grant for an Innovative Training Network. Dr Redlich obtained a subsidy from the COMPASS (Coherent Optical Microwave Physics for Atomic-Scale Spintronics in Silicon) project for measurements at the FELIX Laboratory. COMPASS is subsidized by the Engineering and Physical Sciences Research Council (EPSRC) in the UK. Dr Hauptmann was awarded a prestigious fellowship from the “Alexander von Humboldt Foundation” for postdoctoral researchers.

Prof. Rowan received the 2014 Soft Matter and Biophysical Chemistry Award from the Royal Society of Chemistry for his pioneering work on processive catalysis, functional self-assembly and the development of biomimetic extracellular matrices. Dr Rijs was awarded the Mildred Dresselhaus Award, which includes a guest professorship at the Hamburg Centre for Ultrafast Imaging. Prof. Katsnelson became an elected member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

Emeritus Prof. Van der Avoird received a Royal decoration (Knight in the Order of the Dutch Lion) for his lifelong contribution to theoretical chemistry and training students. Emeritus professors Janner and Janssen were awarded the tenth Ewald Prize for the development of super-space crystallography and its application to the analysis of aperiodic crystals.

Societal impact
IMM has cooperative arrangements with leading companies in the Netherlands, including ASML, DSM, Philips, NXP, Solvay, Unilever and AkzoNobel. And, in recent years, the IMM has given birth to many spin-off companies, including Chiralix, Encapson, FutureChemistry, Mercachem, ModiQuest, NovioTech, Pansynt, ReRaSystems, SensorSense, Sphere Fluidics, Spinnovation, SynAffix, Syntarg, Synthon, TeraOptronics, and tf2 devices.

Grants for new chemical innovations (the so-called KIEM subsidy) were awarded to Prof. Pruijn, Prof. Rutjes, and Dr Feiters. Prof. Pruijn and NovioSmart plan to develop a new blood test for detecting the antibodies that are specifically related to rheumatoid arthritis. Dr Feiters and Okklo Life Sciences aim to make a medicine that will avoid the accumulation of harmful substances in the body, caused for instance by a genetic disorder. Profs. Rutjes and Pansynt will focus on a new class of compounds that look like very promising antibiotics. These compounds can only be produced under high pressure.

On 2 October 2014 the Radboud Research Facilities, which give mainly small and medium-sized enterprises access to state-of-the-art equipment for research and development, were officially opened. Selected research equipment from the IMM is included in these facilities and is thus made more widely available. The Radboud Research Facilities are partly funded by a ‘Robuuste Investeringsimpuls’ from the Province Gelderland worth €6 million.

Future research
A continuing challenge is provided by a €27 million grant from the national investment in large infrastructures (NWO-BIG) in 2006 for the Nijmegen Centre for Advanced Spectroscopy (NCAS). This exceptional grant provides the resources IMM needs to construct

Nigel Hussey (Professor of Experimental Physics and director of the High Field Magnet Laboratory (HFML). In 2014 Nigel Hussey and his team received from the Ministry of Education, Science and Culture (OCW) and NWO a Roadmap subsidy for large-scale infrastructure (worth €14.9 million) to build new high-power magnets and extend the cooling system.
Director: Prof. Elias Vlieg

Elias Vlieg has been Professor of Solid-State Chemistry at Radboud University since 1998. After a post-doc at AT&T Bell Laboratories, he was a group leader at the FOM Institute AMOLF from 1990-1997. With a background in physics, his profile illustrates the combined chemistry and physics approach of the IMM. His research focuses on understanding crystal growth and, as head of the Applied Materials Science group, on the use of thin film deposition for solar cells and electronic devices. He is vice-president of the International Organization for Crystal Growth.

a new 45 Tesla hybrid magnet for the HFML (which will be ready in 2017) and a Free Electron Laser for research using Terahertz radiation (FLARE). HFML's new hybrid magnet will create new research opportunities based on world-leading magnet technology. FLARE, which is part of the FELIX Laboratory, is used for studying magnetic excitations in molecules and for low-energy spectroscopy on large molecules and biomolecules. Moreover, these free electron lasers are suitable for various kinds of spectroscopy on electrons in high magnetic fields.

The national Sector Plan for Physics and Chemistry (SNS) was approved in 2010 with a very positive outcome for Radboud University. Two new initiatives in Chemical Biology and Advanced Spectroscopy of functional molecules and materials started then within IMM. This has led to exciting scientific results and, after two successful progress evaluations, the expectation is that SNS will continue as a structural source of funding after 2015.

The annual operational hours of the HFML have increased to 2,000 per year in 2014 and these will continue to increase in 2015. This growth is thanks to a partnership between Radboud University and FOM (2011) and two grants (worth €11 million and €15 million, respectively) from the National Roadmap for Large-scale Research Facilities in 2012 and 2014. A continuing challenge is the search for structural funding for the operation of the HFML at the target level of 3,000 hours per year.

The successful implementation and exploitation of the ‘Gravitation’ Research Centre for Functional Molecular Systems (FMS) – in collaboration with partners in Eindhoven and Groningen – is of the utmost importance for IMM. Many highly talented students have been hired and several meetings were organized to encourage greater scientific interaction.

The Radboud Nanomedicine Alliance, a joint initiative of Radboud UMC, NCMLS, and IMM, focuses on developing new effective medicines and materials for the treatment of diseases, tailored to the situation of individual patients. The available research facilities will be open for intense cooperation with chemical and biomedical industrial partners.

In 2015, all leading scientists at the IMM will continue to make their on-going research projects a big success and to acquire substantial new funding for future projects. In this way the IMM will continue to build on its strong national and international reputation.
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
This department focuses on three interdisciplinary themes, Mathematical Physics, Algebra & Topology and Applied Stochastics, which all have well-established links with physics and computer science. The traditional areas of algebra, logic, analysis, geometry and stochastics are embedded within these themes.

Astrophysics
Researchers in this department focus on observational and theoretical research on three areas of astronomy: astroparticle physics, compact objects, and the structure and stellar populations in galaxies. Their main goals are to reveal the sources, propagation and detection of the highest-energy particles in the universe, in order to understand the physics and populations of compact objects and the sources, propagation and detection of gravitational waves, and to explain the evolution and structure of galaxies and their stellar populations.

High-energy physics
This group carries out and analyses experiments in elementary particle physics at the smallest distance and the highest mass scales attainable. This research includes both accelerator-based and cosmic ray experiments and explorations of the theoretical foundations of elementary particle interactions, including gravity. There is a particular focus on electroweak symmetry breaking.
and the Higgs boson as an attempt to gain more insight into the structure of the vacuum.

**Research facilities**

The experimental groups make use of the following leading national and international astronomical and astroparticle observatories: ESO, La Palma, LOFAR, Virgo, HST, Kascade-Grande and Pierre Auger, and high-energy particle accelerator (Large Hadron Collider [LHC]). 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 by, and in collaboration with, scientists all over the world. The research facilities and collaborations are therefore also of an international nature. Moreover, IMAPP includes many international researchers.

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.

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 within the framework of the top research school NOVA and 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 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. Kleiss en Prof. Beenakker received a FOM Vrij Programma grant
- Prof. Falcke and Dr Hörandel received an NWO TOP1 grant
- Dr Vidotto received an NWO Veni grant
- Dr Buitink received an ERC Starting grant
- Dr Mărcut received the André Lichnerowicz Prize in Poisson Geometry
- Prof. Falcke was elected in the Royal Netherlands Academy of Arts and Sciences (KNAW)
- Prof. Moerdijk was elected in Academia Europaea
- PhD student Stienstra won the KHMW-ASML prize for best Master’s thesis in mathematics
- PhD student Iseppi won the Philips prize at the Dutch Mathematical Conference
- Prof. De Groot led the Radboud University group for the National Roadmap for Large-Scale Research Facilities grant (for upgrading the LHC)
- Drs Nissanke, Ribeiro, Farnes, Ryan, Kaad and Román each received a Radboud Excellence Fellowship.

**Research results**

The Mathematical Physics department continued its research on Representation Theory, Special Functions, Noncommutative Geometry, Algebraic Groups, Quantum Groups, Algebraic Geometry, Differential Geometry, Quantum Field Theory, and Foundations of Quantum Mechanics. In noncommutative geometry, Dr van Suijlekom’s new textbook on the subject was published by
null
theories of gravity, and laying the technological foundations for proving or disproving asymptotic freedom in Horava-Lifshitz gravity. In addition, applying quantum gravity techniques to the spectral action contributed to interdisciplinary research at IMAPP.

**Societal impact**

IMAPP is involved in research at the forefront of science and is training researchers for academia, government and industry. It is essential for society to have well-trained researchers. IMAPP’s research is related to fundamental questions about the universe and the building blocks of nature. Many results will only reveal their full impact in future decades, but they could then have far-reaching consequences, changing the way we view the world. IMAPP plays an important role in national discussions on science and mathematics in secondary education. Involvement with Pre-University College of Science – with a founding director of IMAPP, the Mathematics Tournament, the HiSPARC project, monthly observation nights, and the national Kangeroe mathematics competition, continues. The recent connection of the Applied Stochastics department with the Biostatistics group will have an impact on important health-related statistical problems. The successful Statistical Helpdesk will be further expanded in 2015. Dr van den Essen and Profs. Falcke and Groot appeared in the radio/tv-programme ‘Kennis van Nu’. Dr van den Essen also featured in a documentary (Perelman) which was performed by the theatre company ‘Compagnie Perelman’. Prof. Falcke was listed in the ‘most prominent thinkers’ review of the ‘Volkskrant’ Christmas edition.

**Future research**

With proposals for the BlackHoleCAM, MeerLICHT, BlackGEM and CTA projects underway, these are becoming a strong focus for research in the Astrophysics department. Industrial collaboration ties in with the Dutch ‘top’ sector High-Tech Systems & Materials. Collaboration within IMAPP (Applied Stochastics & Astrophysics)
Key publications


Erik Koelink, who graduated from Leiden University and has worked at the National Aerospace Laboratory in Amsterdam, Katholieke Universiteit Leuven, University of Amsterdam, and Delft University of Technology, became Professor of Analysis at Radboud University in 2007. His research focuses on the interaction between the representation theory of Lie algebras and quantum groups on the one hand and special functions on the other, with applications in mathematical physics. He is a member of the NWO cluster Geometry and Quantum Theory.

and FNWI has started as the core of cross-institute research involving computer science, stochastics and astrophysics.

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 researches for SUSY and quantum gravity will be extended.

The Mathematical Physics department will concentrate on methods originating in the mathematical foundations and analysis of quantum theory, applying these in quantum information theory, noncommutative geometry, theoretical physics and pure mathematics. The Algebra & Topology group will profit from cross-fertilization between Topology and Algebraic Geometry. In the near future the Applied Stochastics group will focus on greater cooperation, both within IMAPP and within the Science Faculty.
While computing is becoming increasingly pervasive, there are growing problems with software in terms of security (breaches of information access restrictions or privacy), reliability (the system behaves erratically), safety (use of the system is harmful), trustworthiness (low reliability of system services), efficiency (the system is unable to handle problems of a particular size) and conformity with requirements. The inherent complexity of computer-based artefacts – together with the slow pace of software development, high costs and fierce competition – further complicates the search for solutions.

The Institute for Computing and Information Sciences (iCIS) 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 some Netherlands Organisation for Scientific Research (NWO) grants in 2014. Also we welcomed Prof. Dexter Kozen from Cornell University who was a visiting professor in the Radboud Excellence Initiative. Work at the Institute is inspired by problems encountered in society as well as by issues arising in other disciplines.

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
Research within iCIS is organized within three themes:

**Model-Based System Development (MBSD)**
The approach used is to explore various formal methods for model construction, implementation, testing and validation, with the explicit aim of bridging the gap between theory and practice through collaboration with stakeholders from industry, in other application areas and in companies.

**Digital Security (DS)**
Researchers develop theories and formal methods, which they use to analyse and improve the security of the digital world. The scope of the research includes software and hardware (in particular smartcards and RFID), identity management, security protocols, applied crypto, quantum computation and legal aspects.

**Intelligent Systems (IS)**
The aim here is to develop and apply intelligent systems that are able to learn knowledge and reason with it. The long-term research goal is aligning computer-based intelligent systems with their users, answering questions such as how to optimally combine knowledge from human experts with measurement data, how to enable users to guide computerized proof assistants and how to let humans profit optimally from this large repository of structured knowledge.

**Collaboration**
International cooperation is essential to the work done at iCIS, because developments in computing take place around the globe. Partners include the Dutch Ministry of Internal Affairs for a project on business process reengineering (BPR), the University of Grenoble Joseph Fourier, France (Tarot), KU Leuven (EU project FutureID, ESF Cost network TRUDEVICE), IBM Research Zurich (EU project FutureID), Makerere University Kampala, Uganda (NUFFIC), TNO Delft, the Netherlands, Aalborg University, Denmark (Artiste) and Océ Technologies, Venlo, the Netherlands (Octopus), the Dutch Foundation for Internet Domain Registration (SIDN), the Dutch Banking Association (NVB, Amsterdam), Radboudumc (ParkinsonNext project), Thales and TNO-ESI, Eindhoven (Metis) and TILT (University of Tilburg).

**Research results**
In the Intelligent Systems group, Dr Freek Wiedijk worked on integrating technology from different proof assistants, notably Mizar, HOL and HOL-light, and cooperated with the Cambridge HOL research group on formalizing the C language. Dr Josef Urban and Daniel Kuehlwein MSc continued their research on integrating proof assistants with machine learning and ATP approaches, in cooperation with Prof. Herman Geuvers, Prof. Tom Heskes and other from iCIS and Dr Cezary Kaliszyk from the University of Innsbruck and Dr Jiří Viskocil from TU Prague. The aim is to build better automation support for proof assistants, and provide this as a service via the web. This has led to various tools and system developments and a number of publications, notably in the *Journal of Automated Reasoning* and at Conferences on Intelligent Computer Mathematics (Drs Daniel Kuehlwein has finished his PhD on this topic). Prof. Herman Geuvers studied the fundamental representation of data and programs in the lambda calculus and in a newly developed system called continuations calculus.

Dr Alexandra Silva, Prof. Jan Rutten, Dr Helle Hansen and Henning Basold MSc, together with Prof. Dexter Kozen (from Cornell, visiting iCIS on a Radboud Excellence Professorship), Prof. Bart Jacobs from DS and others have worked on co-algebraic approaches to languages and systems and on co-inductive and...
co-algebraic programming principles. Of special interest are the research on NetKAT, a domain-specific language and logic for specifying and verifying network packet-processing functions, and the co-algebraic version of the Chomsky hierarchy.

Prof. Tom Heskes’ Machine Learning group is involved in three EU projects designed to unravel the causal mechanisms behind complex diseases. The group continued its successful line of research on causal discovery. In causal discovery, the goal is to learn the structure of causal processes (“smoking causes cancer”) from observations (“a correlation between smoking and cancer”). A novel method was developed that is used to discover cause-effect relations from data sets containing both discrete and continuous variables with missing values. This is specifically useful for applications in medicine.

In collaboration with researchers at the Donders Institute for Brain, Cognition, and Behaviour, Prof. Tom Heskes’ group developed novel probabilistic methods for inferring brain networks from resting state functional magnetic resonance imaging (fMRI) time series, guided by structural information from diffusion-weighted magnetic resonance imaging (DWI). Joint work with the Donders Institute on the reconstruction of perceived images from brain activity improved existing methods for the analysis of rapid event-related fMRI. The new approach not only provides more accurate reconstructions, but also automatically infers semantic categories from low-level visual areas of the human brain.

Prof. Tom Heskes’ group developed various Bayesian methods for the analysis of “omics” data, in particular for the analysis of proteomics data and protein-protein interactions. In both cases, the current state of the art was improved by cleverly combining data with prior knowledge in a probabilistic framework.

In 2012, Model Based System Development group introduced a new programming paradigm, called Task-Oriented Programming, which should make the development of distributed web-enabled multi-user systems much easier. In 2013 an implementation of this idea, the iTask system, was elaborated in order to be able to develop more realistic applications in collaboration with industrial partners. This practical applicability has been investigated in two areas. For the Dutch Coast Guard the iTask system is being used to design a new prototype for the coordination of their Search and Rescue actions. TNO has been using the iTask system to investigate new ways of working on navy vessels in the hope that these can be operated with a much smaller crew. The iTask system turned out to be very useful. TNO has decided to use the system as standard tool for these types of investigations.

iCIS research on automata learning is very relevant in the security setting, as it makes it possible to obtain models of the behaviour of malware (botnets, for instance) and to discover security vulnerabilities in the communication protocols that are used in for instance bank cards. Significant funding was obtained to continue research in this area through an NWO Free Competition proposal ALSEP, project LEMMA that was funded in the context of the NWO Cyber Security programme.

Research on e-Health continued in collaboration with clinical partners at Radboud University Medical Center (Radboudumc). The aim of this research is patient empowerment and at the same time to improve the quality of healthcare while reducing its costs. Patients are supported by means of smartphones equipped with an intelligent reasoning engine that is able to interpret signs, symptoms and sensor data (blood pressure, lung function and results of biochemical lab tests) and offer them feedback on their health status. The 1st phase STW valorisation award was succeeded by a 2nd phase STW valorisation award to pursue commercial exploitation of the research. It was shown that the new concept of multi-level Bayesian network offers useful tools for exploring the temporal evolution of disease interaction in very large healthcare datasets. This research was done in close collaboration with NIVEL. In addition, an NWO Free Competition Grant was used to explore state-based Bayesian network structure learning. New frameworks of probabilistic logic were further developed, both at the fundamental level and in the context of surveillance applications in collaboration with Thales.

In the area of protection of privacy-sensitive information, the Digital Security group has been active on several fronts. Technically, this related mostly to attribute-based authentication, via the IRMA system that was developed in Nijmegen. This technology has been integrated into the client software of the European Future ID project. Also, the ‘ecosystem’ for IRMA cards has been extended, allowing for instance login to computer systems. In collaboration with colleagues with a legal background the sociotechnical consequences of attribute-based credentials (ABCs) was investigated, resulting in a publication entitled ‘The ABCs of ABCs’. More broadly, the new European eIDAS guidelines for electronic identities were analysed.

Much work has been done in the area of analysis of software and hardware, primarily from a security perspective, but also for instance from a resource consumption (energy) perspective. Also in the energy sector work has been done on the design of a smart grid communication infrastructure and a security analysis of smart charging electronic cars. More broadly, the group has been successful in applying automated learning techniques to the analysis of security protocols used in hardware and software. Additionally, specific cryptographic implementations were verified. Dr Peter Schwabe specialises in the design and efficient implementation of cryptographic algorithms, supported by a NWO Veni grant.

Side-channel analysis is developing into a local expertise centre that is now supported by an NWO Vidi grant (Dr Lejla Batina).
The Digital Security group not only addresses these concerns through its research, but also plays an active role in public debates on these issues. The group’s expertise is in heavy demand both from the public and from the private sector, on topics such as the smart grid (especially smart electricity meters and smart charging of electric vehicles), the security of web applications, electronic payment systems, electronic voting, and identity cards. Many of these consultations involve short-term contract research projects via LaQuSo. Research continued on the privacy and security of medical data in collaboration with Radboudumc (the Parkinson-Next project). Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on cybersecurity issues and Dr Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting (‘Electronisch stemmen in het stemlokaal’) set up by the Dutch Ministry of the Interior. Further evidence of societal relevance and impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) now 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 localize sources of activity in the brain and to improve the performance of brain-computer interfaces. The iCIS ‘Web Deduction’ system (www.prover.cs.ru.nl) is used to teach logic in a number of courses at several universities.

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 to analyse and describe clinical and pathological data which can be used to understand and improve the prognosis, diagnosis and treatment of several diseases, such as neuro-degenerative diseases, testing ‘mindfulness’, etc.) 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 smart-phone apps is one of the first examples where part of the hospital treatment management has been moved to the home environment using off-the-shelf equipment. Within the METIS project support is provided to Thales (exploring new techniques for maritime surveillance) and TNO and the Dutch Ministry of Defence (new techniques for task planning).

Cyber security and privacy are increasingly important in today’s information society. Public interest in these topics continues to grow, making headlines in the news almost on a daily basis. The Digital Security group not only addresses these concerns through its research, but also plays an active role in public debates on these issues. The group’s expertise is in heavy demand both from the public and from the private sector, on topics such as the smart grid (especially smart electricity meters and smart charging of electric vehicles), the security of web applications, electronic payment systems, electronic voting, and identity cards. Many of these consultations involve short-term contract research projects via LaQuSo. Research continued on the privacy and security of medical data in collaboration with Radboudumc (the Parkinson-Next project). Prof. Bart Jacobs is a member of the National Cyber Security Council, which advises the Dutch Cabinet on cybersecurity issues and Dr Jaap-Henk Hoepman is a member of the Dutch commission on electronic voting (‘Electronisch stemmen in het stemlokaal’) set up by the Dutch Ministry of the Interior. Further evidence of societal relevance and impact is the fact that the Dutch Banking Association (NVB, Nederlandse Vereniging van Banken) now 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 localize sources of activity in the brain and to improve the performance of brain-computer interfaces. The iCIS ‘Web Deduction’ system (www.prover.cs.ru.nl) is used to teach logic in a number of courses at several universities.

Awards and acknowledgements

Dr Lejla Batina received an NWO Vidi grant. Prof. Tom Heskes received a Top Grant. Prof. Dexter Kozen was a visiting Professor in the Radboud Excellence Initiative and Dr Fabian Gieseke came to Nijmegen on a Radboud Excellence Fellowship. Dr Alexandra Silva received an ‘honourable mention’ in connection with the Christiaan Huygens Prize.
Key publications


Dissertations: 11
Scientific publications: 243


Herman Geuvers has been a professor of Computer-Assisted Reasoning since 2006 at the Institute for Computing and Information Sciences and since 2007 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, after which he worked at Eindhoven University of Technology. He specializes in logic in computer science, lambda calculus and type theory, and computer-assisted proving.

Future research
In the context of a new NWO TOP project, Prof. Tom Heskes’ group will start developing and analysing novel algorithms for causal discovery from ‘Big Data’. The methods will be applied to ecological data (in collaboration with Prof. Mark Huijbregts, IWWR) and cognomics data (in collaboration with Prof. Barbara Franke and Prof. Jan Buitelaar at Radboudumc. In 2015 new collaboration with Dr Simon van Heeringen and Dr Kees Albers of the RIMLS – on the statistical analysis of Big functional genomics data – will start. The aim is to improve prediction of the response of breast cancer cells to drug treatment. 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 underlying brain diseases. Research on side-channel analysis and on fast and safe implementations of cryptography will intensify following the start of the NWO Vidi project led by Dr Lejla Batina. Ongoing work on privacy-friendly authentication using attributes has received a new boost with a research project funded in the context of the National Security Research Agenda, with project partners KPN and Surfnet. This will bring Nijmegen’s IRMA technology (see www.irmacard.org) to mobile platforms. Further e-Health research, including 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.

In the new joint FNWI project with the Analytical Chemistry group at Radboud University (Prof. Lutgarde Buydens), Dr Elena Marchiori’s team will develop algorithms based on deep learning to improve pre-processing of chemometric data. Within the NWO MacBrain project on the analysis of bio-medical data from different sources, the development of machine learning techniques will continue in order to unravel and merge relevant features from these data. Within a recently granted NWO TOP project, machine learning methods for the study of complex systems will be developed and applied. These are described by means of networks, with a focus on community detection in real-world Big (network) Data.
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<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tr>
<td>(c)</td>
<td>Extraordinary chair</td>
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<tr>
<td>(o)</td>
<td>Ordinary chair</td>
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<td>(p)</td>
<td>Personal chair</td>
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<tr>
<td>BSI</td>
<td>Behavioural Science Institute</td>
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<td>CLS</td>
<td>Centre for Language Studies</td>
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<td>CMBI</td>
<td>Centre for Molecular and Biomolecular Informatics</td>
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<td>CMR</td>
<td>Centrum voor Migratierrecht – Centre for Migration Law</td>
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<td>CNR</td>
<td>Centrum voor Notariële Recht – Centre for Notarial Law</td>
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<td>DCC</td>
<td>Donders Centre for Cognition</td>
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<td>DCCN</td>
<td>Donders Centre for Cognitive Neuroimaging</td>
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<td>DCN</td>
<td>Donders Centre for Neuroscience</td>
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<td>DFG</td>
<td>Deutsche Forschungsgemeinschaft – German Research Foundation</td>
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<td>DFN</td>
<td>Diabetes Fonds Nederland – Dutch Diabetes Research Foundation</td>
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<td>DI</td>
<td>Donders Institute for Brain, Cognition and Behaviour</td>
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<td>ERC</td>
<td>European Research Council</td>
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<tr>
<td>FELICE</td>
<td>Free Electron Laser for IntraCavity Experiments</td>
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<td>FELIX</td>
<td>Free Electron Laser Infrared Experiments</td>
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<td>FLARE</td>
<td>Free-electron Laser for Advanced spectroscopy and high Resolution Experiments</td>
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<tr>
<td>FOM</td>
<td>Stichting voor Fundamenteel Onderzoek der Materie – Foundation for Fundamental Research on Matter (Netherlands)</td>
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<tr>
<td>FP7</td>
<td>EU Framework Programme 7</td>
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<td>FTE</td>
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<td>FTE 1st</td>
<td>Full-time equivalent for research directly funded by government (core funding)</td>
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<td>FTE 2nd</td>
<td>Full-time equivalent for research funded by KNAW or NWO (research grants)</td>
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<td>FTE 3rd</td>
<td>Full-time equivalent for research funded by other public and/or private organizations (contract research)</td>
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<td>HFML</td>
<td>High Field Magnet Laboratory</td>
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<td>HLCS</td>
<td>Institute for Historical, Literary and Cultural Studies</td>
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<td>ICIS</td>
<td>Institute for Computing and Information Sciences</td>
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<td>IMAPP</td>
<td>Institute for Mathematics, Astrophysics and Particle Physics</td>
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<td>IMM</td>
<td>Institute for Molecules and Materials</td>
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<td>Institute for Management Research</td>
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<td>IRUN</td>
<td>International Research Universities Network</td>
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<td>IWater</td>
<td>Institute for Water and Wetland Research</td>
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<td>KNW</td>
<td>Koninklijke Nederlandse Akademie van Wetenschappen – Royal Netherlands Academy of Arts and Sciences</td>
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<td>KWF</td>
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<td>Max Planck Institute for Psycholinguistics, Nijmegen</td>
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<td>NHS</td>
<td>Nederlandse Hartstichting – Netherlands Heart Foundation</td>
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<td>NIAS</td>
<td>Netherlands Institute for Advanced Study</td>
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<td>NIH</td>
<td>National Institutes of Health</td>
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<td>NISCO</td>
<td>Nijmegen Institute for Social &amp; Cultural Research</td>
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<td>NSM</td>
<td>Nijmegen School of Management (i.e. Faculty of Management Studies)</td>
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<td>NWO</td>
<td>Nederlandse Organisatie voor Wetenschappelijk Onderzoek – Netherlands Organisation for Scientific Research</td>
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<td>OO&amp;R</td>
<td>Onderzoekscentrum voor Onderneming &amp; Recht – Business and Law Research Centre</td>
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<td>PTR</td>
<td>Research Institute for Philosophy, Theology and Religious Studies</td>
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<td>Spinoza</td>
<td>The most prestigious prize for scientists in the Netherlands who are the highest-achieving researchers, awarded by NWO</td>
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<td>RIHS</td>
<td>Radboud Institute for Health Sciences</td>
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<td>RIMLS</td>
<td>Radboud Institute for Molecular Life Sciences</td>
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<td>SteR</td>
<td>Onderzoekscentrum voor Staat en Recht – Centre for State and Law</td>
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<td>STW</td>
<td>Technologiestichting STW – Technology Foundation STW (Netherlands)</td>
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<td>Radboudumc</td>
<td>Radboud university medical center</td>
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<tr>
<td>Veni grant</td>
<td>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</td>
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<td>Vidi grant</td>
<td>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</td>
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<td>Vici grant</td>
<td>Personal grant from NWO awarded over a period of five years to senior researchers who wish to establish their own research group</td>
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<td>ZonMw</td>
<td>ZorgOnderzoek Nederland NWO Medische Wetenschappen – Netherlands Organisation for Health Research and Development</td>
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