Dutch Research School of Theoretical Physics

ANNUAL REPORT 2009

Landelijke Onderzoekschool voor Theoretische Natuurkunde
Dutch Research School of Theoretical Physics (DRSTP)
Landelijke Onderzoekschool voor Theoretische Natuurkunde (LOTN)

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Preface

The Dutch Research School of Theoretical Physics (DRSTP) is a cooperation between the theoretical physics groups of six Dutch universities: University of Amsterdam (UvA), Vrije Universiteit Amsterdam (VUA), University of Groningen (RUG), Leiden University (UL), Radboud University Nijmegen (RU) and Utrecht University (UU, commissioner) and, as of 2009, of the National Institute for Subatomic Physics (Nikhef). In addition, there are several associated groups and individual researchers. Its main objectives are to implement a joint programme of graduate education and to maintain and strengthen research in theoretical physics.

On 31 December 2009, 91 PhD students were affiliated to the DRSTP, as well as 53 tenured and 56 non-tenured staff (postdocs). The research output led to 15 PhD dissertations and 335 academic publications.

This DRSTP Annual Report 2009 provides an overview of the educational and research activities during 2009. The report also presents two research highlights written by staff members of the Research School. In addition, it offers information, such as a list of the participating staff, of the PhD students, a comprehensive list of publications, as well as other relevant statistics.

The annual report is not the only information that is provided by the DRSTP throughout the year. The DRSTP also publishes a monthly newsletter and a yearly guide of its educational activities. Up-to-date information on the DRSTP is also readily available on internet at: http://www1.phys.uu.nl/drstp/.

We would like to thank all of those who contributed to the Research School during this past year, with a special mention of B. de Wit and B. Meijerman. As of 1 March 2010 prof. dr. B. de Wit ended his term as scientific director of the DRSTP. He skillfully led the Research School, and signed for many improvements in its workings. On 1 December 2009 drs. B. Meijerman resigned from her position as managing director of the DRSTP. She held this position since February 1994. During her 16 years in office, she guided the DRSTP and she played an essential role in its core activities: the postgraduate courses, the biennial symposium ‘Trends in Theory’ and the PhD Day. She assisted and advised the director and the governing board and managed the finances. Major projects she took on were the preparation of the annual reports and the requests for re-accreditation with the Royal Academy of Sciences, in 1999, 2004 and 2009.

prof. dr. R. Loll
Scientific director

prof. dr. K. Schoutens
Chair governing board

August 2010
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1 | The DRSTP in 2009

The Netherlands has a long tradition in theoretical physics which involves research performed at university institutes, industrial laboratories, and government institutions. The strength of this research area is, for a large part, based on the unity of methods employed in a wide range of applications. This manifests itself both in scientific research and in academic education.

To structure and coordinate the graduate education in theoretical physics, the Dutch Research School of Theoretical Physics (DRSTP) was accredited in 1994 by the Royal Netherlands Academy of Arts and Sciences (KNAW) and reaccredited in 1999 and 2004. The school is, at this moment, a cooperation between the theoretical physics groups of six Dutch universities: University of Amsterdam (UvA), Vrije Universiteit Amsterdam (VUA), University of Groningen (RUG), Leiden University (UL), Radboud University Nijmegen (RU) and Utrecht University (UU, commissioner) and of the National Institute for Subatomic Physics (Nikhef). In addition, there are several associated groups and individual researchers.

The main objectives of the Dutch Research School of Theoretical Physics are to implement a joint programme of graduate education in theoretical physics and to maintain and strengthen research in theoretical physics from a broad unifying perspective that exploits the interrelationships between different fields of theory. The DRSTP is based on the conviction that a joint venture of all the moderately sized local theory groups, each with its own profile, offers added value for the achievement of these objectives. The current version of the mission statement and a short description of the DRSTP organization can be found in appendix A.

Nikhef Theory Group
As of 1 January 2009, the Nikhef Theory Group (Nikhef) is formally a partner of the Dutch Research School of Theoretical Physics. In chapter 4 an overview is given of the permanent and temporary staff members. An overview of PhD students is given in chapter 3 (section 6).

The DRSTP graduate programme in 2009
As part of the research training, under the supervision of a member scientist of the corresponding node, the Research School guarantees a wide range of educational opportunities for its PhD students. They consist of postgraduate schools, advanced courses, seminars and topical courses in the Netherlands, and international experience in the form of workshops, summer schools or extended research visits abroad. As in previous years the educational board published the educational guide with an overview of lecture courses in theoretical physics in the Netherlands. In 2009 fifteen students obtained their PhD. The average time between the start of the research and
the date of the PhD exam is 51.2 months. PhD students are admitted on the basis of a so-called “agreement of education and guidance” (plan for training and supervision). The selection and admission procedure is described in appendix B.

The DRSTP research programme
Theoretical physics is based on universal principles. New concepts often have a much wider validity than in the field in which they are discovered, and methods developed in one field are sometimes very useful in another. Hence, theoretical physics is characterized by unity in diversity. The research programme of the DRSTP is organized according to two themes:

- Theme 1: Particle physics, cosmology, quantum gravity and string theory.
- Theme 2: Quantum matter, quantum information, soft condensed matter and biophysics.

To give an impression of the variety of research topics, two highlights are presented in chapter 2. The specific content of the research programme depends on the responsible project leaders, on their creativity as well as their success in acquiring research funding from their home university, from the Dutch research councils of NWO, or from international sources such as European Union programmes.

The 2009 research output of DRSTP members presented in this annual report is presented according to the above research themes.

Symposium Trends in Theory 2009
Every two years the DRSTP Symposium Trends in Theory takes place. On 14 and 15 May 2009 the symposium was held for the eighth time. This symposium is also part of the educational programme for the PhD students, who are encouraged to present a poster on this occasion. The symposium is an opportunity for the permanent staff and postdoctoral fellows to meet and to get an overview of the recent developments in theoretical physics.

In appendix D more information about the symposium is given.

PhD Day
On 9 October 2009 the DRSTP student council organized their second PhD Day. The PhD Day is an annual event of the DRSTP and is part of the educational program for PhD students. This day was aimed at exchanging ideas, inviting former PhD students to discuss career options, to present scientific talks and to discuss recent trends in theoretical physics. Master students, post-docs and staff members were invited. More information can be found in appendix E.

Shell stipends theoretical physics
In 2009 Shell awarded stipends, for the second time, to the best master students in theoretical physics in the Netherlands. With these stipends, Shell intends to draw attention to future career possibilities for graduates in international companies such as Shell. Ten master students in theoretical physics were awarded a Shell stipend. More information can be found in appendix G.
1. The DRSTP in 2009

**Staff mutations in 2009**
Dr. B.L.G. Bakker (VUA) retired per 1 July 2009.

Dr. D. Boer (RUG) was appointed as assistant professor at the Kernfysisch Versneller Instituut on 1 September 2009.

Prof. dr. J.H. Koch (Nikhef/UvA) retired per 1 March 2009.

Prof. dr. E. Pallante (RUG) was appointed as adjunct professor of Theoretical Particle Physics at the Centre for Theoretical Physics at University of Groningen on 1 March 2009.

Dr. M.M. Taylor (UvA) was appointed as associate professor at the Institute for Theoretical Physics on 1 June 2009.

Prof. dr. J. van den Brink (UL/RU) resigned on 1 October 2009 upon becoming Director of the Institute for Theoretical Solid State Physics at Leibniz Institute IFW Dresden. This ended his affiliation with the DRSTP.

Prof. dr. P.A.M.M. van der Schoot (TU/e/UU) was appointed by the Lorentz Fund to the adjunct chair “Theoretical Physics” at the Institute for Theoretical Physics at Utrecht University on 1 July 2009.

Prof. dr. J.-W. van Holten (Nikhef/UL) was appointed by the Lorentz Fund to the adjunct chair “Theoretical Physics” at the Instituut-Lorentz for Theoretical Physics on 1 May 2009.

Prof. dr. ir. W. van Saarloos (UL) resigned on 1 November 2009 upon becoming Director of FOM (Foundation for Fundamental Research on Matter). This ended his affiliation with the DRSTP.


**Changes in the LOTN organisation**
Prof. dr. B. de Wit (UU) ended his position as scientific director of the DRSTP (2005-2009) and as interim scientific director from 1 January until 1 March 2010.

Drs. B.C. Meijerman (UU), managing director of the DRSTP (1994-2009), resigned from the DRSTP on 1 December 2009.

Drs. J.M. van Zee (UU) started his position as managing director of the DRSTP per 1 December 2009.
Guest chair
Prof. dr. K.S. Thorne (Caltech) occupied the Lorentz Chair at Leiden University from 30 May 2009 to 30 June 2009 and from 14 September 2009 to 14 October 2009. He taught a lecture course entitled *Gravitational waves*.

Awards and distinctions
X.D. Arsiwalla (UvA) was awarded the essay prize Breakthrough Idea Challenge for his idea entitled: *Bridging the digital divide - education innovation with an E-chalk* during the TEDx event (Technology Entertainment Design) in November 2009 in Amsterdam.

E.A. Bergshoeff (RUG) was appointed to the Willem de Sitter chair in Theoretical Physics on 9 December 2009.

S.N. El-Showk (UvA) received a Rubicon grant on 7 July 2009 for his research proposal: *What does information loss teach us about quantum gravity?*.

L. Hollands (UvA) received a Rubicon grant on 16 March 2009 for her research proposal: *Krommen, knopen en snaren*.

T. Idema (UL) received a Rubicon grant on 15 December 2009 for his research proposal: *Kruipende cellen*.

K. Schoutens (UvA) was elected member of the Koninklijke Hollandsche Maatschappij der Wetenschappen [The Royal Holland Society of Sciences and Humanities].

Visiting scientists (long term)
P.S. Carney (Beckman Institute, Illinois) was a guest at the Theoretical Physics Group (VUA) from 5 January - 1 June.

D.P. DiVincenzo (IBM, Watson Research Center, New York) was a guest at the Institute for Theoretical Physics (UvA) from 1 January - 31 August.

C.-R. Ji (North Carolina State University) was a guest at the Vrije Universiteit Amsterdam from 10 June - 20 June.

A. Mukherjee (Indian Institute of Technology, Bombay) was a guest at the Vrije Universiteit Amsterdam from 1 June - 30 June.

D. Panja (Akzo-Nobel, Sassenheim) was a guest at the Institute for Theoretical Physics (UvA) from 1 January - 31 December.

S. Sachdev (Harvard University) was the De Sitter Lecturer 2009 at the Centre for Theoretical Physics (RUG). Professor Sachdev gave a course of four lectures on November 16, 17, 19 and 20. On November 18 a public lecture was given entitled: *Unexpected connections in physics: from superconductors to black holes*. 
B.M. Terhal (IBM, Watson Research Center, New York) was a guest at the Institute for Theoretical Physics (UvA) from 1 January - 31 August.

This annual report is organized as follows. Chapter 2 contains two scientific highlights. Chapter 3 gives a description of the educational programme, short summaries of the PhD theses published in 2009, an overview of the scientific and educational activities of the PhD students affiliated to the DRSTP. An overview of the DRSTP scientific staff and associate members is given in chapter 4. The chapters 5, 6, 7 contain, respectively, the 2009 publications, talks and other presentations and science-related activities (public lectures, professional publications). Data on research funding are listed in chapter 8.
This chapter describes two highlights of research in theoretical physics, presented from the personal point of view of members of the Research School who have been actively involved in them. One describes the application of string theoretical techniques to fundamental problems in condensed matter physics. This work belongs to theme 1 of the school and the contribution has been written by Koenraad Schalm. A second highlight belongs to theme 2 and deals with exotic excitations in low-dimensional quantum magnets, for which detailed theoretical predictions have been matched to experiments. This contribution has been written by Jean-Sébastien Caux.

AdS/CMT: strongly coupled quantum criticality and the emergent Fermi-liquid (Koenraad Schalm, Leiden University)

One of the most spectacular developments in the whole of physics is the discovery of an intimate relation between string theory and condensed matter physics. This surprising possibility has materialized with the discovery that string theories naturally describe the strongly coupled regime of quantum field theories. At its most basic level this novel string-field theory duality is another form of the profound insight in modern physics that the effective perturbative degrees of freedom differ in different regimes and that the theory is best formulated in terms of these: microscopically water consists of molecules, but at large distances a wave description is more adequate; solitonic kinks in the Sine-Gordon model behave as fermions at strong coupling; the duality of Maxwell’s equation’s for electromagnetism under the exchange of electric with magnetic fields; etc. The epitome of string-field theory duality is Maldacena’s original Anti-de-Sitter/Conformal Field Theory (AdS/CFT) correspondence with a precise dictionary how gravitational physics in a negatively curved space time encodes the physics of conformal quantum fields. The latter directly relate to a prominent subject in the quantum matter laboratories of condensed matter physics: the quantum critical states of electron systems. The explanation for these states of matter poses great problems of principle for theoretical physics. In strongly coupled, scale invariant states of electrons, Fermi-Dirac statistics cause extra collective entanglements that cannot be handled with the established repertoire of statistical field theory.

The importance of this fundamental research question is that fermionic quantum criticality is believed to be an essential component of the theory of high $T_c$ superconductors. Just above the critical temperature one finds a “strange metal” state with phenomenological properties that point to an emergent scale invariance in the underlying quantum physics. More clear cut examples of this ‘fermionic quantum criticality’ are found in the so-called heavy fermion systems. Here one usually finds some form of very low temperature magnetic order with a phase transition that can
be tuned to zero temperature by applying pressure or a magnetic field (Figure 2.1). At this ‘quantum critical point’ (QPT) one finds that the mass of the Fermi-liquid quasi-electrons tends to diverge at the QPT, while at higher temperatures one finds anomalous transport properties such as a resistivity that is directly proportional to temperature. These systems also share with the cuprates a tendency to superconduct, as if the system wants to avoid a truly zero temperature quantum critical state.

All conventional theoretical explanations of this quantum critical metallic state fail. The origin of our lack of understanding is extremely fundamental. It is about quantum statistics. With systems formed from bosons, the theory of quantum criticality is well understood. One can map the statistical averaging over the finite-density boson-system to a path integral of a thermal quantum field theory. A bosonic quantum phase transition is then similar to a thermal phase transition in euclidean space time and much is known about such bosonic quantum critical states. However, this machinery ceases to work with fermions. Since the fermion path integral is non-probabilistic, one cannot average in the statistical sense. Confronted with an infinity of interacting fermions all one knows to do is to claim that at long distances they renormalize to a Fermi-liquid, a gas of nearly non-interacting quasiparticles dressed by perturbative processes. True insights are blocked by our inability to deal with the ‘fermion-signs.’ Until the arrival of AdS/CFT this past year, nobody had a clue how to describe this very basic ‘Fermi-liquid emergence’ in a mathematical way.

Applying the AdS/CFT correspondence we computed the single fermion spectral function in a strongly coupled quantum critical state with fermions (Figure 2.2). This quantity is directly measured by either angular resolved photoemission or (scanning) tunneling spectroscopy on condensed matter systems. Translated to string theory, obtaining the single fermion spectral function equates to computing solutions of the classical Dirac equation in the background of a charged black hole in an anti-de-Sitter space of one dimension higher. The entropy and temperature of the field theory system is set by the Bekenstein entropy and Hawking temperature of the black hole, while the electrical charge of the black hole corresponds to a chemical potential in the field theory. In the absence of a chemical potential — i.e. for an uncharged black hole — the corresponding field theory describes a system of conformal, i.e. quantum critical, and Lorentz invariant fermions at zero density where the response is completely fixed by symmetry: one finds a Dirac cone, where the spectral functions behave as power laws as function of frequency (Figure 2.3). When one now continuously increases the charge of the anti-de Sitter black hole, one raises the density with the effect that the dual field-theoretic description should encode a finite density fermion-system including all the effects of Fermi-Dirac statistics. Indeed, our discovery is that beyond a certain parameter range a Fermi-liquid emerges in the boundary theory [1]. This is a spectacular proof of principle. It demonstrates that a Fermi-liquid can truly emerge from a short distance quantum critical state, explaining for the first time what is seen in experiment (Figure 2.1). It is in strong contrast with the microscopic derivation of the Fermi-liquid as found in the textbooks. Here one always starts from the assumption that at short distances one is dealing with a weakly interacting Fermi-gas, and then demonstrates using perturbative functional renormalization techniques that the interactions become irrelevant operators under many circumstances, with the conclu-
2. Scientific highlights

Figure 2.1: Fermionic quantum criticality as encountered in ‘heavy fermion’ metals [2]. As function of pressure or magnetic field a thermal phase transition to a low temperature quantum critical point. At finite temperatures one finds a V shaped (blue) region where the physical properties reveal an underlying scale invariant quantum physics. The Fermi-liquids (yellow) at low temperature on both sides of the transitions show a diverging quasiparticle mass (red lines) and one finds invariably that near the quantum critical point some exotic phase takes over (purple), like for instance a quantum nematic or a superconductor that does not seem to be destructible by magnetic fields (see [2]).

Figure 2.2: Cartoon of the ‘AdS to Quantum Criticality’ correspondence [7]: to find out the nature of the quantum physics that is responsible for superconductivity at a high temperature or the highly anomalous hydrodynamical behaviors of the quark gluon plasma one studies the way classical radiation gets deflected by the warped space time of a black hole living in a negatively curved space time with one higher dimension.

Our results go beyond this assumption [1]: the Fermi-liquid described by the correspondence is never a nearly weakly interacting gas; it demonstrates that the mass of the quasiparticles of the emergent Fermi-liquid is generically strongly enhanced, while the Fermi-liquid comes to an end at an emergent quantum phase transition.

Our efforts are part of an explosive development in the string theoretical community with rapid progress in exploiting ‘fermionic AdS/CFT’. At the same time as our discovery, Liu, McGreevy and Vegh presented results for single fermionic spectral functions from an identical AdS/CFT construction that suggests a quite different groundstate dynamics [3]. The relation between these two discoveries has not yet been fully understood, and is currently actively investigated. The findings of Liu et al. are highly intriguing from a condensed matter perspective. Different from our discovered emergent Fermi-liquid, they isolate a state that is itself some critical form of Fermion matter. Such states are still characterized by a Fermi-surface, but otherwise different from the conventional Fermi-liquid, and have been discussed in the condensed matter community both on phenomenological grounds [4, 5] and as low-energy theories of Fermi-gases coupled to transversal gauge bosons [6]. Numerous other results confirm the promise of the usefulness of the anti-de-Sitter/Condensed Matter theory correspondence, including an AdS/CMT computation of the anomalous linear resistivity [8], and many expect the near future to fully validate its potential.
Figure 2.3: (A) The single fermion spectral function $A(\omega, k)$ of a fermionic conformal field of dimension $\Delta_{\Psi} = d/2 + m$ as a function of $\omega/T$ for a negligible chemical potential $\mu_0/T = 0.01$ and $m = -1/4$ [1]. The spectral function has the asymptotic branch cut behavior of a conformal field of dimension $\Delta_{\Psi} = 5/4$: it vanishes for $\omega < k$, save for a finite $T$ tail, and for large $\omega$ scales as $\omega^{2\Delta_{\Psi} - d}$. (B) The emergence of the quasiparticle peak as we change the chemical potential to $\mu_0/T = -30.9$ for the same value $\Delta_{\Psi} = 5/4$. The insets show the full scales of the peak heights and the dominance of the quasiparticle peak for $k \sim k_F$.


2. Scientific highlights


Bouncing neutrons off spinons: seeing fractionalization in ladders and cuprates (Jean-Sébastien Caux, University of Amsterdam)

Condensed matter provides many examples of the striking effects that interactions can have on a many-body quantum system. Electrons hopping on a crystal lattice usually lead to metallic behaviour; adding Coulomb repulsion can however cause a ‘traffic jam’, yielding an insulating state known as a Mott insulator. Although charge transport is frozen within such an insulating state, quantum mechanics allows virtual processes whereby the spin states of neighbouring electrons are exchanged, and the effective model becomes that of nearest-neighbour coupled quantum spins (known as a Heisenberg magnet). Since neighbouring spins then prefer to be anti-aligned, we say that the system is antiferromagnetic. Excitations are not anymore thought of in terms of propagating electrons; a starting point is to view them as ‘spin waves’ (spatial waves in the spin configuration). This transformation from ‘electronic’ to ‘spin wave’ degrees of freedom is an (admittedly simplistic) illustration of transmutation and fractionalization: constituent particles are superseded by collective excitations carrying only part of the original quantum numbers.

It turns out that such magnetic insulators are an extremely fertile source of exotic physics. Considering different materials allows to effectively play with geometry, each configuration leading to its own type of behaviour. Most prominently, materials in which the spin couplings are very much stronger in one direction (as to effectively become one-dimensional) give realizations of exotic phases of matter. The effectively reduced dimensionality substantially enhances the effects of interactions, leading among others to phases such as spin Luttinger liquids, in which no long-range order survives and spin wave excitations fractionalize further into exotic particles known as ‘spinons’, which are akin to antiferromagnetic domain walls (albeit with substantial quantum dressing). From the theory side, reduced dimensionality also opens up the door to many powerful approaches, including recent breakthroughs in the fully nonperturbative, quantitative calculations of observable response functions [1,2] of 1d magnets.

The ultimate experimental method to probe magnetic phenomena is Inelastic Neutron Scattering (INS). Neutrons are chargeless particles, and can thus easily penetrate matter. On the other hand, they have a magnetic moment which can couple to the local magnetic moments present in the sample. In INS, a collimated pulse of neutrons is targeted at a piece of crystal. The incoming neutrons deposit energy and momentum by creating local magnetic excitations, and are thus slowed down and deflected. Measuring this slowing down and deflection allows to ascertain the energy $\omega$ and momentum $k$ deposited. The measured scattering intensity as a function of $\omega$ and $k$ gives very detailed information about the magnetic state and excitations of the compound under study.

Providing detailed matching between theory and experiment on quasi-one-dimensional magnetic systems has thus recently become realizable. This highlight illustrates two examples of this, in two different compounds.
The fractionalization of spin waves into spinons (which can be understood as ‘spinon deconfinement’) was investigated in a recent joint experimental-theoretical study [3] of the ladder-like material \((\text{C}_5\text{H}_{12}\text{N})_2\text{CuBr}_4\). By tuning the magnetic field, it was possible to do a systematic study of various physical regimes from fully spin polarized to quantum disordered and Luttinger liquid phases. Since INS provides full momentum and energy resolved scattering amplitudes, which can also be computed from first principles using the theory developed in Amsterdam, excellent detailed quantitative fits were obtained (see Figure 2.4) providing striking evidence for field-induced fractionalization of spin waves upon entering the Luttinger liquid regime.

Figure 2.4: [3] Excitation spectrum in the Luttinger liquid phase \((T_N < T < T_{LL})\) at \(B = 10.1\) T \((m \approx 0.5)\) after subtraction of the zero–field background. (a) Measured (left) and simulated (right) INS intensities. Solid lines mark the edges of the two–spinon continuum. (b,d) Constant–\(E\) scans taken along maxima of the transverse structure factor (insets: scan trajectories in white). (c) Constant–\(Q\) scan at \(Q = [0.5 0 0.61]\). Black dashed lines in (b)–(d) are based on a \(\delta\)–function spinon spectrum [solid lines in panel (a)], red solid lines and shading on a full continuum calculation.

A deeper comprehension of magnetic excitations in insulating materials might also help shed light on another well-known condensed matter conundrum: high-tempera-
ture superconductivity. Unlike in traditional superconductors, in which pairing is a consequence of electron-phonon coupling, superconductivity in high-$T_c$ materials might be driven by strong and highly energetic magnetic fluctuations. One unresolved problem concerned the mismatch between the observed intensities of spin fluctuations seen in INS, and that expected from fundamental sum rules, leading to ‘missing intensity’. High-$T_c$ materials are inherently composed of two-dimensional copper-oxide planes. This family of compounds also includes effectively one-dimensional cousins like Sr$_2$CuO$_3$ (see Figure 2.5), which was the subject of a separate joint experimental-theoretical study [4]. Here, the detailed theoretical predictions for the INS response function, including multispinon scattering contributions, allowed to discriminate between ionic and covalent bonding pictures at the microscopic level (see Figure 2.6), allowing to unambiguously associate the ‘missing intensity’ with effects of covalency, and indicating the need for a reinterpretation of many earlier results on other materials.

Figure 2.5: [4] Crystal structure and electronic orbitals in Sr$_2$CuO$_3$. a, Corner-sharing CuO$_4$ square plaquettes form chains along the b axis. Spheres with half of the corresponding ionic radii show copper (small) and oxygen (large) ions. b, Covalently hybridized Wannier wavefunction of the unpaired magnetic electron in Sr$_2$CuO$_3$ obtained from the ab initio LDA + U calculation. The equal-density surface at $|\psi(r)|^2 = 0.05$ Å$^{-3}$ is shown. c, Similar depiction of the Cu$^{2+}$ ionic wavefunction of the 3$d(x^2−y^2)$ orbital typically used for magnetic form factor calculations. d, e, The equal-level surfaces of the magnetic form factor squared at $|F(Q)|^2 = 0.13 \simeq 1/e^2$ for the wavefunctions in a and b, respectively.
The success of these studies rested on outstanding progress made in the last decade in both experimental techniques and theoretical methods, and were rendered possible by the combination of new large, high-quality crystals, more powerful time-of-flight neutron scattering instrumentation, advances in first-principles calculations for Wannier functions and the long-awaited appearance of detailed, quantitative Bethe Ansatz results for the correlation functions describing the neutron scattering intensity. Considering that new, yet more powerful instruments will soon come online, and that more extensive theory predictions are under way, we can expect a very bright future indeed for exotic magnetism in condensed matter.

![Graphs](image)

Figure 2.6: [4] Selected constant-energy cuts through the data as a function of momentum transfer parallel to Cu-O chains. The lines are fits to the exact two- and four-spinon scattering functions for the spin-1/2 Heisenberg chain, using the ionic Cu$^{2+}$ magnetic form factor (a, c) and the LDA + U covalent magnetic form factor (b, d). The in-chain exchange coupling and the intensity prefactor were the only parameters varied in these fits. Noticeably better agreement is achieved by using the covalent form factor.


[3] B. Thielemann, Ch. Rüegg, H.M. Rønnow, A.M. Läuchli, J.-S. Caux, B. Nor-

3 | PhD programme

This chapter provides an overview of the educational programme and of the PhD degrees granted in 2009. Research projects of current PhD students and data on their scientific and educational activities in 2009 are given.

The DRSTP offers a joint programme of graduate education leading to a PhD. The educational programme is based in part on the regular advanced courses, seminars and topical courses offered at the participating universities. The DRSTP organizes at least two postgraduate schools every year. Furthermore, students can gain international experience by attending (international) workshops or summer schools and, in certain cases, by making extended research visits abroad. The governing board is advised on educational matters by the educational board. Regular advanced courses at the universities are published in a nationwide survey at the beginning of each academic year.

The governing board of the DRSTP decides on admission of individual PhD students and monitors their progress. The affiliation of students is based on the ‘agreement of education and guidance’ (plan for training and supervision), drawn between each individual student and his/her advisor(s). This document is submitted to the governing board before a decision is taken about the formal affiliation. An extended description of the selection and supervision procedure is presented in appendix B of this annual report.

On 31 December 2009 ninety-one PhD students were affiliated with the DRSTP. Fifteen PhD students obtained their PhD in 2009.

3.1 Educational programme

3.1.1 Postgraduate courses (AIO/OIO schools)

The following courses were held in 2009:

Theoretical High Energy Physics (THEP)

The DRSTP Postgraduate Course (AIO/OIO school) Theoretical High Energy Physics was held from 16 to 27 February 2009 in Hotel Bergse Bossen, Driebergen. The programme was organized by E. Pallante (RUG) and J.P. van der Schaar (UvA) and included the following lectures (8 hours each):

E. Bergshoeff (RUG): Introduction to supersymmetry
M. Postma (Nikhef): Inflationary cosmology
V. Rychkov (SNS, University of Pisa): Beyond the standard model at the LHC
K. Schalm (UL): *Strings and strongly coupled gauge theory*

In addition to these lecture courses, daily discussion/problem sessions were held in the afternoon (8 hours each week).

Evening seminars were given by G. ’t Hooft (UU) entitled: *The CKM matrix: a question of flavor*, and by J.-S. Caux (UvA) entitled: *Transmutation and fractionalization, or when 1 plus 1 isn’t simply 2*. Other evening presentations of 15 minutes each were given by the PhD students.

Thirty students participated. Twenty-six of them were from the Netherlands, one was from Belgium (KU Leuven), one was from Denmark (NBI Copenhagen) and two participants came from Germany (Freiburg).

Further information is given in appendix C.

Statistical Physics and Theory of Condensed Matter (SPTCM)

The DRSTP Postgraduate Course (AIO/OIO school) Statistical Physics and Theory of Condensed Matter was held from 23 March to 3 April 2009 in Hotel Bergse Bossen, Driebergen. The programme was organized by J.-S. Caux (UvA) and C. Storm (TU/e) and included the following lectures:

G. Barkema (UU/UL): *Computational physics hands-on*
J.-S. Caux (UvA): *Refresher course: Quantum many-body theory*
R. Duine (UU): *Theory of spin transfer*
B. Nienhuis (UvA): *Refresher course: Statistical physics*
K. Schoutens (UvA): *Quantum phases for rotating bosons*
J. Snoeijer (Twente): *Statics and dynamics of dense granular matter*

In addition to these lecture courses, ‘debate sessions’ were organized (8,5 hours in the first week and 7 hours in the second week).

Evening seminars were given by D. DiVincenzo (IBM Watson Research Center, NY) entitled: *Pioneers of quantum computing*; E. Laenen (Nikhef/UvA/UU) entitled: *Theory@LHC* and B. Meijer (TU/e) entitled: *Why we cannot make life*. Other evening presentations (15 minutes each) were given by the PhD students.

Twenty students participated. All participants were from the Netherlands.

Further information is given in appendix C.

3.1.2 Symposium Trends in Theory 2009

The 8th biennial DRSTP Symposium Trends in Theory 2009 was held on 14 and 15 May 2009 in Mooirivier Congreshotel, Dalfsen. One hundred and thirty-six (136) people participated. The programme included the following lectures (40 minutes each):

G. Barkema (UU/UL): *Memories of string-like objects*
D. Bouwmeester (UL): *Macroscopic quantum superpositions and knots of light*
R. Duine (UU): *Gauge fields in spintronics*
Y. Levin (UL): *Stellar and gas dynamics near supermassive black holes*
D. Lohse (UT): *Turbulent thermal convection: a unifying view*
F. MacKintosh (VUA): *Non-equilibrium behavior of active gels and living cells*
3. PhD programme

D. Roest (RUG): *Cosmic acceleration in string theory*
B. Schellekens (Nikhef/RU): *The standard model, string theory and the anthropic principle*
M. Taylor (UvA): *Holography and its applications*
B. Terhal (IBM Watson Research Center, NY/UvA): *How to make a stable quantum memory*

In addition to these lectures, poster presentations were held on both days. Seventy-two posters were presented. Irene Niessen (RU) won this year’s poster prize with a poster entitled: *Supersymmetric phenomenology in the mSUGRA parameter space* (see page 160).
A performance lecture was given on Thursday evening 14 May by Theater Adhoc. Further information is given in appendix D.

3.1.3 PhD Day

On 9 October 2009 the second PhD Day was organised at Utrecht University by the members of the PhD student council, aimed at exchanging ideas, inviting former PhD students to discuss career options, presenting scientific talks and discussing recent trends in theoretical physics. Also master students, post-docs and staff members were invited.

One hundred and ten people attended of which sixty-three were PhD students of the DRSTP, seven were PhD students of other research schools, thirty-five were master students from partner institutes of the DRSTP, two were staff members, two were post-docs of the DRSTP and one participant/lecturer was a former PhD student who is now employed at Shell. The program included the following lectures (35 minutes each):

R. Andringa (RUG): *Supergravity and supersymmetry*
K. Gubbels (UU): *Quantum matter*
L. Hartgring (Nikhef): *LHC phenomenology*
J. van der Horst (Shell): *From high energy physics to petrophysics, how can a physicist help searching for and extracting oil and gas?*
B. van Rees (UvA): *Gauge/gravity duality*
E. Woldhuis (UL): *Granular matter*

Further information is given in appendix E.

3.2 PhD degrees and subsequent employment

In 2009 fifteen (15) PhD students received their PhD degree. Eight (8) of them accepted postdoctoral positions in France (1), USA (6) and in the Netherlands (1). Three (3) accepted a position at a commercial company; three (3) accepted research positions not related to theoretical physics and one (1) PhD student accepted a position as a high school teacher in the Netherlands. More information on career moves of former PhD students during the last six years can be found in appendix H.
3.3 PhD degrees granted in the DRSTP in 2009

In this section a short summary of the PhD theses published in 2009 is given. The summaries are written by the students themselves.

El-Showk, S.N. (UvA)
thesis title: Puzzles in quantum gravity
advisor: prof. dr. J. de Boer
date: 15 September 2009
present position: postdoctoral fellow, Commissariat à l’Énergie Atomique (CEA), Saclay, Paris, France

My research focused on two broad topics unified under the aegis of conceptual lessons in quantum gravity. The first topic is the incorporation of quantum effects in the description of black holes, how this introduces several paradoxes (first outline by Stephen Hawking) and how the resolution of these paradoxes might teach us something about the principles underlying quantum gravity. The second topic of my research is topological string theory on “G2 manifolds” (special 7 dimensional spaces that play an important role in string theory). Many theories, including string theory, are defined only partially, describing only how the theory behaves when perturbed around a particular fixed background configuration. A more general understanding of the theory is obviously desirable so here we study a simplified version of string theory which, nonetheless, mirrors the full theory hoping to learn how to go beyond this “perturbative” approach.

Hollands, L. (UvA)
thesis title: Topological strings and quantum curves
advisor: prof. dr. R.H. Dijkgraaf
date: 3 September 2009
present position: postdoctoral fellow, California Institute of Technology (Caltech), California, USA

This thesis presents several new insights on the interface between mathematics and theoretical physics, with a central role for fermions on Riemann surfaces. First of all, the duality between Vafa-Witten theory and WZW models is embedded into string theory. Secondly, this model is generalized to a web of dualities connecting topological string theory and $N = 2$ supersymmetric gauge theories to a configuration of D-branes that intersect over a Riemann surface. This description yields a new perspective on topological string theory in terms of a KP integrable system based on a quantum curve. Thirdly, this thesis describes a geometric analysis of wall-crossing in $N = 4$ string theory. And lastly, it offers a novel approach to construct metastable vacua in type IIB string theory.
Idema, T. (UL)
thesis title: Structure, shape and dynamics of biological membranes
advisor: prof. dr. H. Schiessel
co-advisor: dr. C. Storm
date: 19 November 2009
present position: postdoctoral fellow, University of Pennsylvania, Philadelphia, USA

Membranes are everywhere in living cells - they form the boundary layer between the
cell and its surroundings, and also the boundaries of the various organelles within
the cell. The different membranes found in the cell exhibit a broad range of chemical
compositions as well as a rich variety of (sometimes exotic) shapes. Over the last ten
years there has been a vivid discussion in the biophysics community as to whether
the different molecules that make up the cell membrane (generically known as lipids)
are organized into domains (called rafts) within the membrane or not. Such domains,
if they exist in living cells, are too small to observe by optical microscopy; in artificial
systems however, they can grow large and have indeed been seen. Using differential
geometry, we have developed a model for the shape of such artificial membrane vesi-
cles, which takes several properties of the membrane as parameters. Some of these can
be measured directly, the remaining ones can now be obtained by fitting this model
to the actual shapes, which we do in collaboration with the experimental biophysics
group. The numbers we get out can be applied to living cells to determine conditions
for domains to exist there and decide on which biological processes may be involved.

Janssen, T.M. (UU)
thesis title: The infrared sector of quantum fields on cosmological space-times
advisor: prof. dr. G. ’t Hooft
co-advisor: dr. T. Prokopec
date: 6 July 2009
present position: postdoctoral fellow, Netherlands Cancer Institute (NKI), Amster-
dam, the Netherlands

In this thesis the infrared properties of massless scalar fields, with a possible coupling
to the Ricci scalar on a cosmological background are studied. Our background space-
time is a homogeneous, flat FLRW space-time, with the additional constraint that
the deceleration parameter is constant. It has been known for a long time that the
propagator of such a scalar field diverges at the lower end of the integration over the
momenta when evaluated for the Bunch-Davies vacuum. The resolution we propose
to this problem is to work on a spatially compact universe. This effectively gener-
ates an infrared cut-off in the integral over the mode functions. To see what the
physical effect of this approach is, we calculated the expectation value of the stress
energy tensor. Using the infrared regulated propagator, we find in the ultraviolet
that we correctly reproduce the Bunch-Davies result. In the infrared the discussion
can be split in two parts. If the universe is accelerating we found that, although we
see a growth in energy due to the production of infrared particles, this energy will
always dilute away faster than the energy present in the background space-time. In
a decelerating universe the situation is quite different. We find that, since in a de-
celerating universe, the Hubble radius grows faster than physical scales, the cut-off scale actually enters the Hubble volume. This results in a large effect which is thus not due to particle creation, but is due to the fact that the influence of the cut-off grows more and more profound as time goes on. We also calculated the one loop effective action in a theory where both gravity and a scalar field produce quantum fluctuations. The mixing between the dynamical degrees of freedom in such a case leads to more complicated expressions, but in the end the final answer is very similar to the obtained expectation value of the stress energy tensor for just a single massless scalar field. Also for the graviton we find that at one loop order all growth in energy due to the creation of infrared modes is cancelled by the redshift of these modes. As a second application we used the cut-off regulated propagator to calculate the one-loop effective potential for a massless scalar field, with a coupling to the Ricci scalar and a quartic self interaction. We calculated the effective action by assuming that the background field has the same time dependence as the Hubble parameter. While this is true at the classical level, this scaling turns out to be broken by the quantum corrections. Furthermore we find that initially, the quantum corrections can induce a phase transition, by generating minima in the potential for nonzero field values. However the growing infrared contributions are such that, after a sufficient amount of time, the effective potential will always end up with only one minimum at the origin. Thus the infrared modes have restored the symmetry of the potential.

Kampmeijer, L. (UvA)
thesis title: *On a unified description of non-abelian charges, monopoles and dyons*
advisor: prof. dr. F.A. Bais
date: 27 February 2009
present position: postdoctoral fellow, Corus, IJmuiden, the Netherlands

One of the roads towards unravelling confinement in four dimensional non-abelian gauge theories, starts with the proposal of ’t Hooft and Mandelstam to think of confinement in terms of the breaking of a dual or magnetic symmetry by a condensate of magnetic monopoles. Although this idea has been very fruitful, it has not yet led to a rigorous proof of confinement. One reason for this is that the magnetic symmetry is not manifest in the standard formulation of a gauge theory, even proving its existence has turned out to be a formidable challenge on its own. It is therefore difficult to study magnetic symmetry breaking in detail. One way to circumvent this is to use a dual formulation of the theory such as given for example by Seiberg-Witten theory. Despite the success of this strategy, the effect of monopole condensation on the electric degrees of freedom cannot be seen directly. Moreover, it has become clear that there is not necessarily a unique excitation whose condensate may cause electric confinement. What is needed is a framework where both the electric and magnetic symmetries are manifest. Such an approach has been very successful in understanding condensation and confinement in two-dimensional theories. With this motivation we start out in this thesis to study hidden symmetries of gauge theories. Our first main results are obtained in chapter 3 where, inspired by a recent paper of Kapustin and Witten, we study and interpret the classical fusion rules for smooth BPS monopoles. In chapter 4 we concentrate on the dyonic sectors and propose a novel formulation of a gauge
theory which explicitly involves an electric as well as a magnetic symmetry group. Moreover, we find that our unified framework also matches a proposal of ’t Hooft in which the large distance scale behaviour of the original gauge theory is described by an effective electric theory with magnetic monopoles. We expect that our results can be used for further investigations on the phase structure of non-abelian gauge theories.

Kanitscheider, I.R.G. (UvA)
thesis title: Precision holography and its applications to black holes
advisor: prof. dr. J. de Boer
co-advisor: dr. M.M. Taylor
date: 18 December 2009
present position: postdoctoral fellow, Department of Brain and Cognitive Sciences, University of Rochester, New York, USA

One of the most inspiring conjectures of the last fifteen years in search of a theory of quantum gravity is the conjecture of a holographic principle. In analogy to an optical hologram, which stores a three-dimensional picture on a two-dimensional photographic plate, this conjecture states that all gravitational phenomena in a \((d + 1)\)-dimensional spacetime can be described by a \(d\)-dimensional quantum field theory without gravity. The best elaborated example of such a holographic duality is the so-called \(AdS/CFT\) correspondence. This thesis discusses two different aspects of the \(AdS/CFT\) correspondence: On the one hand we apply the correspondence in order to examine a microscopic theory of black holes which was proposed about ten years ago and which contains promising features to solve long-standing black hole paradoxes, the fuzzball proposal. This application of a holographic duality is discussed in chapter 3 and 4. Before that, we provide an introduction to holography in chapter 1 and an introduction to the fuzzball proposal in chapter 2. On the other hand, the last part of the thesis, chapter 5 and 6, discusses a generalization of the \(AdS/CFT\) correspondence to cases in which the \(d\)-dimensional quantum field theory does not have conformal symmetry. We lay down the basics in chapter 5 and look at applications on the hydrodynamic limit of the quantum field theory in chapter 6.

Koetsier, A.O. (UU)
thesis title: Strongly interacting fermions in optical lattices
advisor: prof. dr. H.T.C. Stoof
date: 6 July 2009
present position: quantitative associate, Morgan Stanley, Investment Banking, London, UK

This thesis explores certain extraordinary phenomena that occur when a gas of neutral atoms is cooled to the coldest temperatures in the universe — much colder, in fact, than the electromagnetic radiation that permeates the vacuum of interstellar space. At those extreme temperatures, quantum effects dominate and the collective behaviour of the atoms can have unexpected consequences. For example, Bose-Einstein condensation may occur where the atoms lose their individual identities to coalesce into a macroscopic quantum particle. Although such ultracold atomic gases
are interesting in their own right, much of the excitement generated in this field is due
to the possibility that studying these gases could shed light on intractable problems
in other areas of physics. This is predominantly due to the uniquely high degree of
control over various physical parameters that ultracold atomic gases afford to experi-
mentalists. Recent technological advances exploit this advantage to study quantum
phenomena in a detail that would not be possible in other systems. For instance,
atoms can be made to attract or repel each other, the strength of this interaction
can be set to almost any value, and external potentials of various geometries and
periodicities can be introduced. In this way, atoms can be used to model phenom-
ena as diverse as the quark-gluon plasmas arising in high-energy particle physics, the
colour superfluids conjectured to exist in the core of neutron stars, and the high-
temperature superconductivity exhibited by electrons on the ion lattice of certain
compounds. Indeed, ultracold atomic gases also have a demonstrated applicability to
quantum information and computation. Due to a subtle interplay between electronic
and nuclear spins known as the hyperfine interaction, atoms can have either an integer
or half-integer total spin quantum number, making them either bosonic or fermionic at
low temperatures, respectively. With the exception of chapter 7, the work presented
here concerns fermionic atoms in periodic potential formed by interfering laser beams.
Indeed, the standing light wave created by the interfering beams gives rise to a lattice
potential because of the Stark effect which couples the electronic energy levels of the
atoms to the spatially undulating electric field. Furthermore, fermionic atoms can be
prepared in two different hyperfine states corresponding to the "spin-up" and "spin-
down" quantum states, and as such mimic electrons moving in the lattice structure
of solids. This system is well described by the famous Hubbard model which we in-
troduce in chapter 2 and, under certain conditions, undergoes a phase transition into
the Nel state which believed to be a precursor to superconductivity in certain high-
temperature superconductors. In chapter 3, we calculate precisely how the Nel state
may be achieved in an ultracold fermionic atom gas. When the number of spin-up and
spin-down atoms is unequal the system becomes spin-canted and exhibits both ferro-
and antiferromagnetic characteristics, as we show in chapter 4. We also find there are
topological excitations present in the quantum spin texture known as merons which
have never unambiguously been observed before. In order to form a Bose-Einstein
condensate, fermionic atoms must first form pairs, and can do so in two contrasting
ways. The relationship between these two qualitatively different forms of pairing is
described in chapter 5, and we examine how these two types of pairs transform into
one another in an optical lattice in chapter 6. Finally, chapter 7 is a detailed field-
theoretic study of pairing as it occurs in an ultracold Bose gas. There, we find there
is an intriguing bosonic analogy of the two forms of fermion pairing and explore the
properties of these pairs.

Kuipers, J. (UU)
thesis title: Theory and simulation of nucleation
advisors: prof. dr. G.T. Barkema and prof. dr. H. van Beijeren
date: 29 September 2009
present position: postdoctoral fellow, Nikhef, Amsterdam, the Netherlands
Nucleation is the process where a stable nucleus spontaneously emerges in a metastable environment. Examples of nucleation abound, for instance the formation of droplets in undercooled gases and of crystals in undercooled liquids. The process is thermally activated and is key to understanding various subjects in biophysics, polymer physics and chemistry. The physics behind it has long been studied and the simplest version is known as classical nucleation theory. This thesis reveals a serious shortcoming of this classical theory, namely the assumption that nucleation is described by a memoryless stochastic process. A method to test for this so-called Markov property is developed and is applied to the nucleation process in the Ising model. To overcome this shortcoming, a non-Markovian theory for droplet growth is developed. This theory is validated with simulation results of the mass of growing droplets in the Ising model. More interesting quantities, of course, include the time scale and rate at which stable droplets arise. These times are typically very long, so that brute force simulations do not give useful results. Therefore, an efficient Monte Carlo method, called pathway recombination, is developed to measure transition times over large energy barriers. An adapted version of this method is used to determine nucleation rates of Ising models with various dynamics. These rates are then compared to the rates predicted by both the non-Markovian droplet theory and the classical one. Finally, a different activated process is discussed, namely the reversal of the Earth’s magnetic field. Various time series of geomagnetic dipole moments are analyzed and theoretical, simulation and experimental results are compared.

Messamah, I. (UvA)
thesis title: Unknitting the black hole: black holes as effective geometries
advisor: prof. dr. J. de Boer
date: 9 June 2009
present position: postdoctoral fellow, Physics Department, Brown University, Providence, USA

In this thesis, we tried to shed some light on the origin of black hole geometries in the context of the fuzzball proposal. The claim is that black holes are an effective description of an exponentially large number of smooth geometries. These geometries are hardly distinguishable from the black hole geometry outside the black hole horizon, and hence, can be thought of as a manifestation of the black hole degrees of freedom whose number should reproduce the black hole entropy. We have studied two stringy systems which are tamed by their symmetries. The first one is the $D1 - D5$ system which turns out to be a successful testing ground for most of the fuzzball ideas. Even though things are less concrete with the second stringy system, $1/2 - BPS$ solutions of $N = 2$ four-dimensional supergravity, we still managed to learn very important lessons from their study. We argued that gravity alone is in general not enough for the study of black holes. We have also shown in a simple set up that quantum effects are enhanced to large macroscopic distances of the order of the black hole horizon.
Sepkhanov, R.A. (UL)
thesis title: *Light scattering by photonic crystals with a Dirac spectrum*
advisor: prof. dr. C.W.J. Beenakker
date: 20 May 2009
present position: research scientist, ASML, Veldhoven, the Netherlands

Photonic crystals are artificial materials with macroscopic arrangements of periodic modulation of dielectric and/or magnetic constant. In a two-dimensional photonic crystal with inversion symmetry the band gap may become vanishingly small at corners of the Brillouin zone, where two bands touch as a pair of cones. Such a conical singularity is also referred to as a Dirac point, because the two-dimensional Dirac equation has the same conical dispersion relation. Motivated by an electronic analogue (graphene), we have predicted a unique signature of the conical singularity: near the Dirac point the photon flux transmitted through a slab of photonic crystal is predicted to scale as $1/L$ with the thickness $L$ of the slab. The $1/L$ scaling is called “pseudo-diffusive” due to its reminiscence of diffusion through a disordered medium although here it appears for Bloch modes in the absence of any disorder inside the photonic crystal. The Dirac equation imparts a spin-one-half degree of freedom on the photon, which gives rise to other unusual effects. These include a Berry phase of $\pi$ upon rotation over 360 degrees and the resulting extinction of coherent backscattering.

Stavenga, G.C. (UU)
thesis title: *Soft radiation in quantum chromodynamics*
advisor: prof. dr. E.L.M.P. Laenen
date: 14 September 2009
present position: postdoctoral fellow, Fermilab, Particle Physics Division/Theoretical Physics, Chicago, USA

We study the effect of soft radiation in QCD to all orders in perturbation theory. The eikonal approximation is generalised to next-to-leading order, and factorises in the sum over all Feynman diagrams. This results in an exponential form for the cross-section at next-to-eikonal order.

van Kessel, M.T.M. (RU)
thesis title: *The path-integral approach to spontaneous symmetry breaking*
advisors: prof. dr. R.H.P. Kleiss and prof. dr. E.N. Argyres
date: 3 February 2009
present position: research scientist, ASML, Veldhoven, the Netherlands

A quantum field theory, like the Standard Model, can be set up in two ways. The first, and mostly used, way is by canonical quantization. This means one takes a classical field theory and imposes commutation or anti-commutation relations on the canonical fields and their conjugated momenta. In this way one can eventually find the Feynman rules of the theory and calculate probabilities for scattering processes. The second way to set up a quantum field theory is by postulating a path integral. In this case the path integral determines the Green’s functions, which give the probabili-
In principle both ways of setting up the QFT give identical results. So both ways are merely different formalisms: similarly, quantum mechanics can be formulated via the Schrödinger equation and via the Feynman path integral.

For some theories however, the canonical approach and the path-integral approach do not yield identical results. This is the case for theories that exhibit spontaneous symmetry breaking in the canonical approach. In these models, although both approaches satisfy the same fundamental Schwinger-Dyson equations, results are different. This difference has been the main topic of this thesis, and has been investigated for two models: the Euclidean $N = 1$ linear sigma model and the Euclidean $N = 2$ linear sigma model.

A manifestation of the difference between the canonical and path-integral approach can also be found in the literature. For some theories exhibiting spontaneous symmetry breaking it was known that the effective potential calculated in the canonical approach is non-convex, whereas from the path integral one can prove that such an effective potential is always convex. This contradiction is known as the convexity problem. As soon as one realizes that the canonical and path-integral results do not have to be the same this convexity problem is resolved.

The convexity problem is discussed thoroughly, and also resolved, in the literature. However a clear discussion of the difference between the canonical and path-integral formalism does not exist. It is not clear whether the different results from both approaches also indicate different physics, i.e. different probabilities for actual scattering processes.

In this thesis we have investigated both approaches for the case of two simple Euclidean quantum field theories. In the case of the $N = 1$ linear sigma model we have presented the canonical approach and the path-integral approach. Results for the Green’s functions and the effective potential are clearly different. The effective potential calculated from the path-integral approach is nicely convex, as it should be, whereas the effective potential from the canonical approach is not. In the case of the $N = 1$ linear sigma model we have also considered a path-integral formalism where we fix the paths all over space to have a given value at some time. In this case the Green’s functions came out to be the same as in the canonical approach. But to obtain this we had to introduce the somewhat artificial path-fixing constraint.

In the case of the $N = 2$ linear sigma model we have also presented the canonical and the path-integral approach. Here the calculations in the path-integral approach are more complicated than in the $N = 1$ linear sigma model, because the minima of the bare potential form a continuous set. To this end we had to investigate also how one can formulate a path integral in terms of polar field variables. In the end we demonstrated again that the Green’s functions from the canonical and path-integral approach are different.

Although we have established that, in general, canonical and path-integral results (i.e. Green’s functions) differ, in the case of a theory that exhibits spontaneous symmetry breaking, it is not yet clear what this means for the physics of both approaches. Of course the physics of the canonical approach is known, but the physics of the path-integral approach requires more research. Several exciting questions remain within this approach: are the Green’s functions of a Minkowskian quantum field theory in
the path-integral approach also different than in the canonical approach? Are the Green’s functions for a theory with local gauge invariance also different in both approaches? Is the physics of the Standard Model different if we formulate this model via the path integral? Is there something like the Higgs mechanism in this approach? Is there even a Higgs particle in this approach? The present thesis can be considered a first step towards finding answers to these fundamental questions.

Wagenaar, J.W. (RU)

thesis title: Pion-nucleon scattering in Kadyshevsky formalism and higher spin field quantization

advisor: prof. dr. R.H.P. Kleiss

co-advisor: dr. T.A. Rijken

date: 10 July 2009

present position: postdoctoral fellow, Energie Research Centre of the Netherlands (ECN), Petten, the Netherlands

This thesis contains two parts, the first part deals with pion-nucleon/meson-baryon scattering in the Kadyshevsky formalism and the second one with higher spin field quantization in the framework of Dirac’s Constraint analysis.

In the first part we have presented the Kadyshevsky formalism in chapter 2. Main (new) contributions here, are the study of the frame dependence, i.e. $n$-dependence, of the integral equation and the second quantization.

Couplings containing derivatives and higher spin fields may cause differences and problems as far as the results in the Kadyshevsky formalism and the Feynman formalism are concerned. This is discussed in chapter 3 by means of an example. After a second glance the results in both formalisms are the same, however, they contain extra frame dependent contact terms. Two methods are introduced, which discuss a second source extra terms: the Takahashi-Umezawa (TU) and the Gross-Jackiw (GJ) method. The extra terms coming from this second source cancel the former ones exactly. We have discussed and extended both TU and GJ formalisms: the TU method is a more fundamental one, which makes use of an auxiliary field and the GJ method is a more systematic and pragmatic method. It is particularly useful for studying the frame dependence. Both formalisms, however, yield the same results. With the use of (one of) these methods the final results for the S-matrix or amplitude are covariant and frame independent ($n$-independent). At the end of chapter 3 we have introduced and discussed the $\bar{P}$-method and last but nog least we have shown that the TU method can be derived from the BMP theory.

After discussing the Kadyshevsky formalism in great detail we have applied it to the pion-nucleon system, although we have presented it in such a way that it can easily be extended to other meson-baryon systems. The results for meson exchange are given in chapter 4 and those for baryon exchange in chapter 5.

Chapter 5 also contains a formal introduction and detailed discussion of so-called pair suppression. We have formally implemented ”absolute” pair suppression and applied it to the baryon exchange processes, although it is in principle possible to also allow for some pair production. For the resulting amplitudes, we have shown, to our knowledge for the first time, that they are causal, covariant and $n$-independent.
Moreover, the amplitudes are just a factor $1/2$ of the usual Feynman expressions. This could be intercepted by rescaling the coupling constants in the interaction Lagrangian. The amplitudes contain only positive energy (or if one wishes, only negative energy) initial and final states. This is particularly convenient for the Kadyshevsky integral equation. It should be mentioned that negative energy is present inside an amplitude via the $\Delta(x - y)$ propagator. This is, however, also the case in the academic example of the infinite dense anti-neutron star.

The last chapter of part I (chapter 6) contains the partial wave expansion. This is used for solving the Kadyshevsky integral equation and to introduce the phase-shifts. In the second part we have quantized the (massive) higher spin fields $j = 1, 3/2, 2$ both in the situation where they are free (chapter 8) and where they are coupled to auxiliary fields (chapter 9). We have done this using Dirac’s prescription. For the first time a full constraint analysis and quantization is presented by determining and discussing all constraints and Lagrange multipliers and by giving all equal times (anti) commutation relations. Using free field identities we have come to (anti) commutation relations for unequal times, from which the propagators are determined. In the free fields case (chapter 8) it is explicitly shown that they are non-covariant, as is well known.

In chapter 9 we have coupled auxiliary fields to gauge conditions of the free, massless systems. Introducing mass terms for these auxiliary fields in the Lagrangian brings about free (gauge) parameters. The requirement of explicit covariant propagators only determines the gauge parameter in the spin-3/2 case.

After obtaining all the various (covariant) propagators we have discussed several choices of the parameters and the massless limits of these propagators. We have shown that the propagators do not only have a smooth massless limit but that they also connect to the ones obtained in the massless case (including (an) auxiliary field(s)).

When coupled to conserved currents we have seen that it is possible to obtain the correct massless spin-$j$ propagators carrying only the helicities $\lambda = \pm j_z$. This does not require a choice of the parameter in the spin-1 case, but in the spin-3/2 and in the spin-2 case we have had to make the choices $b = 0$ and $c = \pm \infty$, respectively. We stress however, that in the spin-3/2 and the spin-2 case this limit is only smooth if the massive propagator contains ghosts.

Wessels, E. (VUA)

thesis title: *Signatures of gluon saturation in high energy scattering*

advisor: prof. dr. P.J.G. Mulders
co-advisor: dr. D. Boer
date: 17 June 2009

present position: high school teacher, Stellingwerfcollege, Oosterwolde, the Netherlands

Atomic nuclei are composed of protons and neutrons, collectively known as nucleons. These in turn consist of smaller particles called quarks and gluons. The exact way in which nucleons are built from quarks and gluons remains unknown. However, in scattering experiments the densities of quarks and gluons can be probed at different energies. While these densities cannot be calculated using perturbative methods, it
is possible to theoretically determine their dependence on the energy scale at which they are probed. According to theoretical arguments, the gluon density rises very quickly as the energy increases. As a result, this density must eventually saturate as the gluons start to overlap. The energy scale at which saturation occurs is known as the saturation scale. We study whether saturation of the gluon density is visible in available data from the hadron collider RHIC. This is done by theoretically identifying measurable effects of saturation, most importantly geometric scaling, and analysing the data for the presence of these effects. Contrary to previous claims in the literature, no such effect, neither geometric scaling nor the characteristic dependence on transverse momentum, can be resolved in present data. We also consider the question whether saturation effects can be expected to be resolved by the new hadron collider LHC, at which collision experiments of unprecedented energies are to be performed. We have shown that these experiments are expected to be sensitive to saturation effects. Most likely the characteristic dependence on transverse momenta will be especially well visible. Also, we show that measurements of the polarization of produced hyperons may offer a direct probe of the saturation scale itself, and of its energy dependence.

Zwanikken, J.W. (UU)
thesis title: *Looking deeper into emulsions and suspensions ionic screening, fractionation, and adsorption*
advisor: prof. dr. H. van Beijeren
co-advisor: dr. R.H.H.G. van Roij
date: 29 June 2009
present position: postdoctoral fellow, Northwestern University, Evanston, Illinois, USA

In this thesis an attempt is made to understand recent observations that revealed remarkable underlying structures in emulsions and suspensions at the length scale of a micrometer. Whereas the droplets in emulsions, and particles in suspensions could be monitored directly by means of microscopy, the smaller components, like salt ions and solvent molecules, could not be mapped due to their smaller size. By means of theoretical analysis, however, the distribution of salt ions around the observed droplets and particles can be predicted, together with the physical consequences, often leading to an explanation of the behaviour at larger length scales. In this way we 'look deeper into emulsions and suspensions', deeper than directly observable, still connected to the observable.

3.4 Other PhDs advised by DRSTP staff

Opoku, A.A. (RUG)
thesis title: *On Gibbs properties of transforms of lattice and mean-field systems*
advisors: prof. dr. C. Kuelske; prof. dr. A.C.D. van Enter; prof. dr. H.W. Broer
date: 4 September 2009
Present position: postdoctoral fellow, Mathematical Institute, Leiden, the Netherlands

Schoonover, R.W. (VUA)
thesis title: Studies in singular optics and coherence theory
advisor: prof. dr. T.D. Visser
date: 29 May 2009
Present position: postdoctoral fellow, Illinois Institute of Technology, USA

3.5 PhD students (31-12-2009)

This section gives an overview of the PhD students affiliated to the DRSTP on 31 December 2009. The projects are chronologically ordered according to starting date. The research themes mentioned refer to particle physics, cosmology, quantum gravity and string theory (theme 1) and quantum matter, quantum information, soft condensed matter and biophysics (theme 2).

University of Amsterdam (UvA)

• Galistu, G.M. as of 1 December 2003 with A.M.M. Pruisken.
  project: experimental determination of electronic structure of low-dimensional electron systems, with emphasis on quantum critical phenomena of a two-dimensional electron gas in the quantum Hall regime (theme 2).

• Arsiwalla, X.D. as of 1 November 2004 with E.P. Verlinde.
  project: development of non-perturbative methods in string-theory, in particular topological strings and black holes (theme 1).

• Hoogeveen, J. as of 1 September 2005 with R.H. Dijkgraaf and K. Skenderis.
  project: string theory, in particular the Berkovits formulation of superstrings (theme 1).

• Zozulya, O.S. as of 1 October 2005 with K. Schoutens.
  project: collective behavior vs. entanglement in atomic matter (theme 2).

• Mehmani, B. as of 1 December 2005 with B. Nienhuis and Th.M. Nieuwenhuizen.
  project: fundamental aspects of quantum physics (theme 2).

• Huijse, L. as of 1 June 2006 with K. Schoutens.
  project: study of supersymmetric lattice models (theme 2).

• van Rees, B.C. as of 1 September 2006 with K. Skenderis (E.P. Verlinde, formal advisor).
  project: understanding black holes and wormholes in 2+1 dimensions as well as global issues in AdS/CFT (theme 1).
• Atmaja, A.N. as of 1 November 2006 with K.E. Schalm (J. de Boer, formal advisor).
  project: studies of string theory/gauge theory duality aiming to make contact with QCD (theme 1).

• Oberreuter, J.M. as of 15 September 2007 with E.P. Verlinde.
  project: cosmological vacua in string theory (theme 1).

• Smolic, J. as of 18 January 2008 with K. Skenderis (E.P. Verlinde, formal advisor).
  project: non-equilibrium dynamics and black hole formation (theme 1).

• Smolic, M. as of 18 January 2008 with M.M. Taylor (E.P. Verlinde, formal advisor).
  project: the fuzzball proposal for black hole physics (theme 1).

• Mossel, J.J. as of 1 September 2008 with J.-S. Caux (K. Schoutens, formal advisor).
  project: cracking the quantum quench (theme 2).

• Romers, J.C. as of 1 September 2008 with K. Schoutens and F.A. Bais.
  project: topological quantum registers (theme 2).

• Baggio, M. as of 1 September 2009 with prof. dr. J. de Boer.
  project: to explore applications of the AdS/CFT correspondence to various systems (theme 1).

• Bzowski, A.W. as of 16 September 2009 with dr. K. Skenderis (E.P. Verlinde, formal advisor).
  project: holographic cosmology (theme 1).

• Haaker, S.M. as of 1 October 2009 with K. Schoutens.
  project: topological quantum computation - fractional quantum Hall effect devices (theme 2).

• Panfil, M. as of 1 October 2009 with J.-S. Caux (K. Schoutens, formal advisor).
  project: a new launch pad for renormalization (theme 2).

• Caldeira Costa, R.N. as of 24 November 2009 with M. Taylor (E.P. Verlinde, formal advisor).
  project: holography and black hole dynamics; use of gravity gauge duality to explore singularity resolutions (theme 1).

\textbf{Vrije Universiteit Amsterdam (VUA)}

• Boomsma, J.K. as of 1 September 2006 with P.J.G. Mulders and D. Boer.
  project: phase transitions in QCD (theme 1).

• van Dijk, T. as of 1 April 2007 with T.D. Visser.
  project: singular optics and plasmonics (theme 2)
• Broedersz, C.P. as of 1 May 2007 with F.C. MacKintosh.  
  project: theoretical development of models for cytoskeletal networks (theme 2).

• Mantz, C.L.M. as of 1 September 2008 with P.J.G. Mulders.  
  project: to investigate the ways in which the color flow affects the hard process by using recently developed theoretical tools, applicable in a large variety of scattering processes (theme 1).

• den Dunnen, W. as of 15 December 2008 with D. Boer (P.J.G. Mulders, formal advisor).  
  project: CP-violation at LHC from new gauge bosons (theme 1).

University of Groningen (RUG)

• Deuzeman, A. as of 1 January 2006 with E. Pallante.  
  project: understanding non-perturbative aspects of strong and weak interactions (theme 1).

• Ruszel, W.M. as of 1 March 2006 with A.C.D. van Enter.  
  project: non-Gibbsian aspects in lattice statistical mechanics (theme 2).

• Kadosh, A. as of 1 September 2006 with E. Pallante.  
  project: understanding and constraining extra-dimensional theories (brane worlds) derived as effective low-energy realizations of M-theory (theme 1).

• Nutma, T.A. as of 1 October 2006 with E.A. Bergshoeff.  
  project: string theory and quantum gravity, in particular the extended symmetry algebras of supergravity theories and their relation with gauged supergravity will be investigated (theme 1).

• Reker, S.F. as of 1 February 2008 with E. Pallante.  
  project: clarify properties of strong and weak interactions of baryonic matter from first principles, through a lattice formulation of the field theory for strong and weak forces (theme 1).

• Andringa, R. as of 1 September 2008 with E.A. Bergshoeff.  
  project: properties of gravitational theories in three-dimensional space-time, in particular with regard to contributions of higher order in the curvature, and to black holes (theme 1).

• Dibitetto, G. as of 1 November 2008 with E.A. Bergshoeff.  
  project: realistic compactifications of string M-theory that give rise to four-dimensional effective theories with moduli stabilisation (no massless scalar fields) and interesting cosmological aspects (inflation, late-time acceleration) (theme 1).

• Noordmans, J.P. as of 1 September 2009 with R.G.E. Timmermans.  
  project: theory of Lorentz and CPT violation in the weak interaction (theme 1).
• Yin, Y. as of 1 September 2009 with D. Roest (E.A. Bergshoeff and M. de Roo, formal advisors)
project: focus on the issue of stabilising parameters of the extra dimensions in string theory, which bridges the gap between theory and experiment (theme 1).

• Borghese, A. as of 15 November 2009 with D. Roest (E.A. Bergshoeff, formal advisor).
project: to investigate De Sitter vacua, corresponding to positive minima of the scalar potentials and hence a positive cosmological constant; special emphasis in this project will be placed on so-called N-2 theories (theme 1).

Leiden University (UL)

• Emanuel, M.O. as of 1 December 2005 with H. Schiessel.
project: theoretical biophysics of DNA and its complexation with proteins (theme 2).

• Beekman, A.J. as of 1 January 2006 with J. Zaanen.
project: topological phases in quantum liquid crystals (theme 2).

• Habraken, S.J.M. as of 1 February 2006 with G. Nienhuis.
project: quantum optics with complex light (theme 2).

• Ament, L.J.P. as of 1 September 2006 with J. van den Brink.
project: theory of decoherence and defect formation in many-body quantum systems (theme 2).

• Mesaroš, A. as of 1 September 2006 with J. Zaanen.
project: quantum liquid crystals and emerging Einsteinian gravity (theme 2).

• Žeravčić, Z. as of 1 September 2006 with W. van Saarloos.
project: the behavior of the granular media in the vicinity of the so-called ‘jamming point’ (theme 2).

• Huisman, E.M. as of 1 April 2007 with G.T. Barkema.
project: networks of semi-flexible polymers (theme 2).

• She, J.-H. as of 1 May 2007 with J. Zaanen.
project: fermionic quantum criticality and the constrained path integral (theme 2).

• Akhmerov, A.R. as of 1 July 2007 with C.W.J. Beenakker.
project: investigation of the potential of spin and valley qubits in graphene for quantum computation (theme 2).

• Hardeman, S.R. as of 1 November 2007 with A. Achúcarro and K.E. Schalm.
project: observational cosmology from strings, branes and quantum gravity (theme 1).

• Woldhuis, E.L. as of 4 June 2008 with M. van Hecke and W. van Saarloos.
project: statistical properties and rheology of foams near the jamming point (theme 2).
• Lanzani, G. as of 1 July 2008 with H. Schiessel.
  project: theoretical study of the organization and dynamics of chromatin (theme 2).

• van der Aalst, T.A.F. as of 6 October 2008 with K.E. Schalm (A. Achúcarro, formal advisor).
  project: experimental signatures of string theory in cosmology or collider experiments (theme 1).

• Rademaker, L. as of 1 January 2009 with J. van den Brink and J. Zaanen.
  project: electron correlation effects in coupled electron-hole doped Mott insulating interfaces (theme 2).

• Čubrović, M. as of 9 February 2009 with J. Zaanen.
  project: investigation of fermion sign structure through Ceperleg’s constrained path integral formalism for fermions (theme 2).

• van Ostaay, J. as of 1 September 2009 with C.W.J. Beenakker.
  project: majorana fermions in topological insulators and graphene (theme 2).

• Dahlhaus, J. as of 1 October 2009 with C.W.J. Beenakker.
  project: quantum transport in topological insulators and graphene; in particular transport along line defects in 3D topological insulators (theme 2).

Radboud University Nijmegen (RU)

• van den Oord, G.J.W.M. as of 1 February 2007 with R.H.P. Kleiss and S.C.M. Bentvelsen.
  project: to probe the nature of the Higgs sector, comparing observed data with model-independent, Monte Carlo generated events (theme 1).

• Malamos, I.E. as of 1 January 2008 with R.H.P. Kleiss.
  project: tools and precision calculations for physics discoveries at colliders (theme 1).

• Niessen, A.I.M. as of 1 September 2008 with W.J.P. Beenakker (formal advisor, R.H.P. Kleiss).
  project: precise Higgs and supersymmetry predictions for the LHC (theme 1).

• Akhukov, M.A. as of 1 January 2009 with A. Fasolino and M.I. Katsnelson.
  project: calculations of electronic and structural properties of finite graphene structures (theme 2).

• van den Broek, T.C.H. as of 1 November 2009 with W.J.P. Beenakker and W.D. van Suijlekom (formal advisor, R.H.P. Kleiss).
  project: deriving the minimal supersymmetric standard model from noncommutative geometry (theme 1).
Utrecht University (UU)

- Lim, L.-K. as of 15 January 2006 with C. Morais Smith.
  project: the application of theoretical methods to describe rotating Bose-Einstein condensates in the quantum Hall limit (theme 2).

- Gubbels, K.B. as of 1 February 2006 with H.T.C. Stoof.
  project: ultra cold atomic gases (theme 2).

- Eggen, E.J. as of 1 March 2006 with R.H.H.G. van Roij (H. van Beijeren, formal advisor).
  project: theoretical study of suspensions of colloidal molecules such as dumbbells and (semi-) flexible chains, both in bulk and in external fields (electric, shear, substrates) (theme 2).

- Reska, P.M. as of 1 Augustus 2006 with R. Loll.
  project: various aspects of non-perturbative quantum gravity and quantum cosmology, and in particular the question of the role of the conformal factor and big-bang scenarios (theme 1).

- Makogon, D. as of 15 August 2006 with C. Morais Smith.
  project: transport properties in one dimensional systems (theme 2).

- de Leeuw, M. as of 1 October 2006 with G.E. Arutyunov (B. de Wit, formal advisor).
  project: the development and application of new methods aimed to further understand the relationship between gauge and string theories (the AdS/CFT correspondence) (theme 1).

- Looyestijn, H.T. as of 1 October 2006 with S.J.G. Vandoren (B. de Wit, formal advisor).
  project: to study the perturbative and non-perturbative structure of type II superstrings compactified to four space-time dimensions, and its relation to heterotic string theory (theme 1).

- Machado, P.F. as of 1 July 2007 with R. Loll.
  project: renormalization group approach to quantum gravity (theme 1).

- Katmadas, S. as of 1 September 2007 with B. de Wit.
  project: study of black holes in the context of string theory (theme 1).

- Koksma, J.F. as of 15 September 2007 with T. Prokopec (G. ’t Hooft, formal advisor).
  project: study the nature of dark energy (theme 1).

- Diederix, J.M. as of 1 October 2007 with H.T.C. Stoof.
  project: research in the field of ultracold atomic gases (theme 2).

- van Zalk, M. as of 1 October 2007 with B. de Wit.
  project: study of N=2 and 4 supergravities and their consequences for flux compactifications and black holes (theme 1).
van de Meent, M. as of 1 November 2007 with G. ’t Hooft.
project: algebraical description of quantum effects of the Schwarzschild horizon and related aspects of quantum gravity (theme 1).

project: theoretically predicting and/or explaining properties of soft matter systems in bulk and in external fields (theme 2).

Swaving, A.C. as of 1 February 2008 with R.A. Duine (H.T.C. Stoof, formal advisor).
project: understanding of the interplay between ferro and antiferromagnetism, and electric current (theme 2).

Budd, T.G. as of 1 March 2008 with R. Loll.
project: gravity, quantum gravity and quantum geometry (theme 1).

Höhn, P.A. as of 1 May 2008 with R. Loll.
project: quantum gravity and quantum cosmology, and their nonperturbative aspects (theme 1).

Lucassen, M.E. as of 1 June 2008 with R.A. Duine (H.T.C. Stoof, formal advisor).
project: current-driven magnetization dynamics in ferro and antiferromagnets (theme 2).

Beugeling, W. as of 1 September 2008 with C. Morais Smith.
project: the study of multi-layer quantum Hall systems (theme 2).

Hristov, K.P. as of 1 September 2008 with S.J.G. Vandoren (B. de Wit, formal advisor).
project: string theory compactifications and implications for cosmology (theme 1).

Mink, M.P. as of 1 September 2008 with R.A. Duine (H.T.C. Stoof, formal advisor).
project: cold atoms, especially on the boundary between cold atoms and (un)conventional condensed-matter systems (theme 2).

van Driel, H.J. as of 1 December 2008 with R.A. Duine (H.T.C. Stoof, formal advisor).
project: theoretical investigation of pseudospin transport in electron-hole and graphene bilayers (theme 2).

van Heugten, J.J.R.M. as of 1 January 2009 with H.T.C. Stoof.
project: microscopic description of the thermodynamical and dynamical properties of quark-gluon plasma aimed at observing color superconductivity in neutron stars (theme 2).
• Wever, C.S.P. as of 1 January 2009 with G. ’t Hooft.
  project: effective multicomponent field theory for quantum chromodynamics (theme 1).

• Jordan, S. as of 1 March 2009 with R. Loll.
  project: nonperturbative quantum properties of gravitational interaction (theme 1).

• Franzen, A.T. as of 1 June 2009 with G. ’t Hooft.
  project: algebraical description of quantum effects of the horizon of black holes and related aspects of quantum field theories (theme 1).

• van Gelderen, R. as of 1 June 2009 with C. Morais Smith.
  project: analogies between cold atoms and condensed matter systems (theme 2).

• Tieleman, O. as of 1 July 2009 with C. Morais Smith.
  project: to study the exotic quantum phases in strong correlated systems (theme 2).

• Baarsma, J.E. as of 1 September 2009 with H.T.C. Stoof.
  project: microscopic description of degenerate atomic gases, directed to the possible observation of supersolidity in two species Fermi mixtures (theme 2).

• van Tongeren, S. as of 1 September 2009 with G.E. Arutyunov (B. de Wit, formal advisor).
  project: integrable quantum field theories in finite volume; development of the thermodynamic Bethe Ansatz for strings on semi-symmetric superspaces (theme 1).

• Belli, S. as of 1 October 2009 with R.H.H.G. van Roij (M. Dijkstra, formal advisor).
  project: investigation of nucleation and clustering phenomena in suspensions of anisotropic particles (e.g., rods or platelets), by (dynamic) density functional theory, integral equation theory, and by simulation (theme 2).

• Weenink, J.G. as of 1 November 2009 with T. Prokopec (E.L.M.P. Laenen, formal advisor).
  project: compatibility of baryogenesis with the standard model that will emerge as a result of the future LHC experiments (theme 1).

**Nikhef Theory Group (Nikhef)**

• Maio, M., as of 1 December 2007 with A.N.J.J. Schellekens.
  project: string theory from a conformal field theory point of view (theme 1).

• de Adelhart Toorop, R., as of 1 February 2008 with J.-W. van Holten.
  project: particle physics beyond the standard model, with focus on supersymmetry and family symmetries (theme 1).
• Hartgring, L., as of 1 January 2009 with E.L.M.P. Laenen.
  project: precise descriptions of single top production at the LHC (theme 1).

• Mooij, S.J.N., as of 1 April 2009 with M. Postma (E.L.M.P. Laenen, formal advisor).
  project: learning about particle physics from cosmology and inflation (theme 1).

3.6 Scientific and educational activities of PhD students (theme 1)

Andringa, R. (RUG)
  - Gravity in three dimensions, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
  - Supersymmetry and supergravity, PhD Day, Utrecht, 9 October 2009 (talk).
  - 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 3-5 December 2009 (attended).

Arsiwalla, X.D. (UvA)
  - Spring School Interdisciplinary College 2009 - Neuroscience, Cognitive Science and Artificial Intelligence, Mohnesee-Gunne, Germany, 6-13 March 2009 (attended).
  - Neuroinformatics Course, Faculty of Integrative Neurophysiology, Vrije Universiteit Amsterdam, the Netherlands, Spring 2009 (attended).
  - International Symposium on the Neural Basis of Decision Making, Groesbeek, the Netherlands, 20-22 April 2009 (attended).
  - Brain Connectivity Workshop, Maastricht University, the Netherlands, 1 May 2009 (attended).
  - Summer School on Consciousness and the Brain, Cognitive Science Center Amsterdam, the Netherlands, 15-24 June 2009 (attended).
  - Workshop on Consciousness, Cognitive Science Center Amsterdam, the Netherlands, 25 June 2009 (attended).
  - Animal in your brain?, International Symposium on The Neural Basis of Consciousness, Cognitive Science Center Amsterdam, the Netherlands, 26 June 2009 (poster).
  - Brain Development, Plasticity and Repair Course, Faculty of Neuroscience, University of Amsterdam, the Netherlands, Fall 2009 (attended).
  - MTEDxAmssterdam Conference, Amsterdam, the Netherlands, 20 November 2009 (attended).
Atmaja, A.N. (UL)

- *Photon production at strongly coupled quark gluon plasma in RHIC using AdS/CFT correspondence*, Physics@FOM, Veldhoven, the Netherlands, 19-21 January 2009 (talk).
- CERN Winter School on Supergravity, Strings and Gauge Theories, Geneva, Switzerland, 9-13 February 2009 (attended).
- Workshop Monodromy and Geometric Phases in Classical and Quantum Mechanics, Lorentz Center, Leiden, the Netherlands, 15-19 June 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Baggio, M. (UvA)

- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

Boomsma, J.K. (VUA)

- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Borghese, A. (RUG)

- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Third part of the Amsterdam/Brussel/Paris Doctoral School, 16 November-3 December 2009 (attended).
- 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, 3-5 December 2009 (attended).

Budd, T.G. (UU)

- *Geometric observables in 2 + 1D gravity*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Bzowski, A.W. (UvA)

- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

de Adelhart Toorop, R. (Nikhef)

- *Family physics*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).

Quark-lepton complementarity in an $S_4$ Pati Salam inspired scenario, International School of Nuclear Physics, 31st Course, Neutrinos in Cosmology, in Astro-, Particle- and Nuclear Physics, Erice, Italy, 16-24 September 2009 (talk).

DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).

de Leeuw, M. (UU)

RTN Winter School 09, CERN, Switzerland, 9-13 February 2009 (attended).


Conference Integrability in Gauge and String Theory, AEI, Golm, Germany, 29 June-3 July 2009 (attended).

DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

den Dunnen, W. (VUA)

Vacuum structure of the strong interaction with a Peccei-Quinn symmetry, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).

National Seminar Theoretical High Energy Physics, Nikhef, Amsterdam, the Netherlands, 27 March 2009 (attended).

Fysica 2009, Groningen, the Netherlands, 14 April 2009 (attended).


Fourth Graduate School in Physics at Colliders, Turijn, Italy, 29 June-3 July 2009 (attended).

DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

NNV Fall Meeting, Lunteren, the Netherlands, 6 November 2009 (attended).

National Seminar Theoretical High Energy Physics, Nikhef, Amsterdam, the Netherlands, 20 November 2009 (attended).

FOM Young Scientist Day, Amsterdam, the Netherlands, 4 December 2009 (attended).

Deuzeman, A. (RUG)

Tracking the conformal phase, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).


Traces of a fixed point: unravelling the phase diagram at large $N_f$, Lattice 2009, Beijing, China, July 2009 (talk).

El-Showk, S.N. (UvA)

Quantizing $N = 2$ multicenter solutions, Leuven, Belgium, 2 March 2009 (talk).

Multicentered solutions in AdS$_3$xS$^2$, Paris, France, 1 May 2009 (talk).
On the uses of multicentered solutions, Munich, Germany, 1 July 2009 (talk).
Workshop ENS Summer Institute, Paris, France, 17-20 August 2009 (attended).

Dibitetto, G. (RUG)
CERN Winter School on Strings and Supergravity, Genéve, Switzerland, 9-13 February 2009 (attended).
De Sitter solutions in IIA string theory compactifications, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
Trieste ICTP Spring School on String Theory, Trieste, Italy, 22-31 March 2009 (attended).
23rd Nordic Network Meeting on Strings and Related Topics, Copenhagen, Denmark, 16-18 April 2009 (attended).
15th European Workshop on String Theory, ETH, Zurich, Switzerland, 7-11 September 2009 (attended).
DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
Flux compactifications and $\mathcal{N}=4$ gauged supergravity, Milan, Italy, 29 October 2009 (talk).
National Seminar, Nikhef, Amsterdam, the Netherlands, 20 November 2009 (attended).
24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 3-5 December 2009 (attended).
The quantum universe, One Day Symposium, Groningen, the Netherlands, 9 December 2009 (attended).

Franzen, A.T. (UU)
DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Hardeman, S.R. (UL)
Physics@FOM, Veldhoven, the Netherlands, 19-21 January 2009 (attended).
Cosmological constraints on the stability of extra dimensions in $\mathcal{N}=1$ supergravity, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
APPNL Symposium, Leiden, the Netherlands, 20 March 2009 (co-organizer).
Consistent decoupling of moduli in $\mathcal{N}=1$ supergravity, DRSTP Symposium Trends in Theory 2009, Dalfsen, the Netherlands, 14-15 May 2009 (poster).
Workshop Varying Fundamental Constants, 18-20 May 2009, Leiden, the Netherlands (attended).
DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Amsterdam-Brussels-Paris Doctoral School Paris, France, 19 October-6 November 2009 (attended).
- Amsterdam-Brussels-Paris Doctoral School Amsterdam, the Netherlands, 16 November-4 December 2009 (attended).

Hartgring, L. (Nikhef)
- *Unitarity constraints in off-shell vector boson fusion*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- *LHC phenomenology*, DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (talk).

Herquet, M. (Nikhef)
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Höhn, P.A. (UU)
- *Measuring anisotropic degrees of freedom in gravity*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- Supergravity Workshop, Pennsylvania State University, USA, August 2009 (talk).
- *Diffeomorphism symmetry in discrete gravity I and II*, Nature of Time in the Natural Sciences Workshop, Penn State University, USA, 18 November 2009 (talk).
- *Diffeomorphism symmetry in discrete gravity I and II*, Penn State University, USA, 2 December 2009.
- Pennsylvania State University, USA, August-December 2009 (work visit).

Hollands, L. (UvA)
- Focus Week on New Invariants and Wall Crossing, Workshop, Tokyo, Japan, 18-22 May 2009 (attended).
- Workshop Chern-Simons Gauge Theory: 20 years after, Hausdorff Center for Mathematics, Bonn, Germany, 3-7 August 2009 (attended).

Hoogeveen, J. (UvA)
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
Hristov, K.P. (UU)
- RTN Winter School 09, CERN, Switzerland, 9-13 February 2009 (attended).
- DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
- 5th Aegean Summer School, Milos, Greece, 21-26 September 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Brussels-Paris-Amsterdam PhD School, October-November 2009 (attended).

Jordan, S. (UU)
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Kadosh, A. (RUG)
- $A_4$ flavor model for quarks and leptons in warped geometry, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 3-5 December 2009 (attended).
- Visit to Prof. Aharon Davidson from Ben-Gurion University. Project: Obtaining Thick FRW Branes and How Can We Really Describe 5D Cosmology, Israel, 2009 (work visit).

Katmadas, S. (UU)
- Almost BPS black holes, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- The IST String Fest, Perspectives from a Younger Generation, Instituto Superior Tecnico, Lisbon, Portugal, 29 June-1 July 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- 24th Nordic Network Meeting, Groningen, the Netherlands, 3-5 December 2009 (attended).

Koksma, J.F. (UU)
- Effect of the trace anomaly on the cosmological constant, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- Interactions in the Dark: Physics of DE-DM Interactions, Lorentz Center, Leiden University, the Netherlands, 6-9 April 2009 (attended).
- Beyond Part III, University of Cambridge, UK, 16 April 2009 (attended).
- Cosmo 09, CERN, Geneva, Switzerland, 7-11 September 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).

**Looyestijn, H.T. (UU)**
- CERN Winter School on Supergravity, Strings and Gauge Theories, Switzerland, 9-13 February 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Machado, P.F. (UU)**

**Maio, M. (Nikhef)**
- *Towards resolving fixed points in CFT extensions*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- *CFT: review and applications. Fixed point resolution in permutation orbifolds*, NNV Annual Meeting of the section Subatomic Physics, Lunteren, the Netherlands, 6 November 2009 (talk).

**Malamos, I.E. (RU)**
- HEPTOOLS Midterm Meeting, Second Annual Meeting, Lisbon, Portugal, 9-12 March 2009 (attended).
- *Feynman rules for the rational parts of the standard model 1-loop amplitudes*, THEP Colloquium, Radboud University Nijmegen, the Netherlands, 19 March 2009 (talk).
- MC4LHC Workshop: From Parton Showers to NNLO, CERN, Geneve, Switzerland, 4-8 May 2009 (attended).
- Mini-Workshop on Fixed Order Multi-Leg Automatic NLO Calculations, Wuppertal, Germany, 2-3 June 2009 (attended).
- Fourth Graduate School in Physics at Colliders: On the Eve of the LHC, Turin, Italy, 29 June-3 July 2009 (attended).
- Internal Meeting the Institute Demokritos, Athens, Greece, 27 September-4 October 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- *Feynman rules for the rational part of the electroweak 1-loop amplitudes*, 3rd HEP-TOOLS Annual Meeting, Vienna, Austria, 1 December 2009 (talk).

**Mantz, C.L.M. (VUA)**
- *Holomorphic gravity*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- *Holomorphic gravity*, Nikhef, Amsterdam, the Netherlands, 29 May 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).

**Messamah, I. (UvA)**

**Mooij, S.J.N. (Nikhef)**
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Niessen, A.I.M. (RU)**
- *Supersymmetric phenomenology in the mSUGRA parameter space*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- *Supersymmetric phenomenology in the mSUGRA parameter space*, Physics@FOM, Veldhoven, the Netherlands, 20-21 February 2009 (poster).
- *Supersymmetric phenomenology in the mSUGRA parameter space*, School on Particle Physics and Cosmology, Oran, Algeria, 2-10 May 2009 (poster).
- Fourth Graduate School in Physics at Colliders: On the Eve of the LHC, Turin, Italy, 29 June-3 July 2009 (attended).
- *Soft-gluon resummation for squark and gluino production*, THEP Colloquium, Radboud University Nijmegen, the Netherlands, 9 September 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).
- *Improving predictions for SUSY cross sections*, NNV Fall Meeting, Lunteren, the Netherlands, 6 November 2009 (talk).

**Noordmans, J.P. (RUG)**
- *The AdS/CFT correspondence - semiclassical string states and gauge theory operators*, DRSTP Symposium Trends in Theory 2009, Dalfsen, the Netherlands, 14-15
Nutma, T.A. (RUG)
- *The infinite symmetries of supergravity*, Fysica 2009, Groningen, the Netherlands, 24 April 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).
- 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 3-5 December 2009 (attended).

Oberreuter, J.M. (UvA)
- *Resolution of cosmic singularities via string theory*, Physics@FOM, Veldhoven, the Netherlands, 20 January 2009 (poster).
- *Resolution of cosmic singularities via string theory*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- Fifth Aegean Summer School: From Gravity to Thermal Gauge Theories: The AdS/CFT Correspondence, Adamas, Island of Milos, Greece, 21-26 September 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (co-organizer).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- 24th Nordic Network Meeting: Playing with Gravity, Groningen, the Netherlands, 3-5 December 2009 (attended).

Plauschinn, E. (UU)
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

Reker, S.F. (RUG)
- *Lattice QCD (introduction)*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- *First results of ETMC simulations with N_f = 2 + 1 + 1 maximally twisted mass fermions*, the XXVII International Symposium on Lattice Field Theory, LAT-2009, Beijing, China, 26 July 2009 (talk).
- *Status of N_f = 2 + 1 + 1 simulations*, ETMC Meeting Groningen, the Netherlands, 23 September 2009 (talk).
Reska, P.M. (UU)
- Quantum Gravity Meeting, Imperial College London, UK, 9-10 January 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Smolic, J. (UvA)
- DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
- Fifth Aegean Summer School: From Gravity to Thermal Gauge Theories: The AdS/CFT Correspondence, Adamas, Island of Milos, Greece, 21-26 September 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Smolic, M. (UvA)
- DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
- Fifth Aegean Summer School: From Gravity to Thermal Gauge Theories: The AdS/CFT Correspondence, Adamas, Island of Milos, Greece, 21-26 September 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Stavenga, G.C. (UU)

van de Meent, M. (UU)
- DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
- 2nd School and Workshop on Quantum Gravity and Quantum Geometry, Corfu, Greece, 13-20 September 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

van den Broek, T.C.H. (RU)
- Super-QCD from noncommutative geometry, THEP Colloquium, Radboud University Nijmegen, the Netherlands, 14 October 2009 (talk).
van den Oord, G.J.W.M. (RU)
- MC4LHC Workshop: From Parton Showers to NNLO, CERN, Geneve, Switzerland, 4-8 May 2009 (attended).
- Fourth Graduate School in Physics at Colliders: On the Eve of the LHC, Turin, Italy, 29 June-3 July 2009 (attended).
- Feynman rules with Majorana particles, THEP Colloquium Radboud University Nijmegen, the Netherlands, 23 September 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Computing LO matrix elements with Camorra, NNV Fall Meeting, Lunteren, the Netherlands, 6 November 2009 (talk).

van der Aalst, T.A.F. (UL)
- Physics@FOM, Veldhoven, the Netherlands, 19-21 January 2009 (attended).
- Time dependent string backgrounds & tachyon condensation, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (talk).
- 11th Dutch Astroparticle Symposium, Leiden University, the Netherlands, 20 March 2009.
- Casimir Symposium Nine Challenges in Interdisciplinary Physics, Leiden, the Netherlands, 26 June 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- 24th Nordic Network Meeting on Fields, Strings and Branes, University of Groningen, the Netherlands, 3-5 December 2009 (attended).
- The Quantum Universe, Symposium in Honour of Eric Bergshoeff, University of Groningen, the Netherlands, 9 December 2009.

van Rees, B.C. (UvA)
- Realtime gauge/gravity duality, USC, Santiago de Compostela, Spain, 4 June 2009 (talk).
- Topologically massive gravity and the $\text{AdS}/(L)\text{CFT}$ correspondence, 15th European Workshop on String, Zurich, Switzerland, 8 September 2009 (talk).
- Topologically massive gravity and $\text{AdS}/\text{CFT}$, Groningen, the Netherlands, 24 September 2009 (talk).
- Gauge/gravity duality, DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (talk).
- Realtime gauge/gravity duality, UPMC, Paris, France, 26 October 2009 (talk).
– DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
– *Real-time gauge/gravity duality*, MPI, Munich, Germany 18 November 2009 (talk).
– *Realtime gauge/gravity duality*, YITP, Stony Brook, USA, 2 December 2009 (talk).
– *Realtime gauge/gravity duality*, MIT, Boston, USA, 8 December 2009 (talk).

**van Tongeren, S. (UU)**
– *Integrable superstrings in $AdS_4 \times \mathbb{CP}^3$ geometry*, DRSTP Symposium Trends in Theory 2009, Dalfsen, the Netherlands, 14-15 May 2009 (poster).
– Physique Thorique et Mathmatique-ULB, Theoretical Particle Physics, VUB, Brussels, Belgium, 21 September-9 October 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
– Laboratoire de Physique Thorique, Ecole Normale Suprieure (various institutions in Paris led by Ecole Normale Suprieure), Paris, France, 19 October-6 November 2009 (attended).
– Institute for Theoretical Physics, University of Amsterdam, the Netherlands, 16 November-4 December 2009 (work visit).

**van Zalk, M. (UU)**
– Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (attended).
– DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
– Nordic Network Meeting, Groningen, the Netherlands, 3-5 December 2009 (attended).

**Wever, C.S.P. (UU)**
– DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Yin, Y. (RUG)**
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
– National Seminar on High Energy Physics of the DRSTP, Amsterdam, the Netherlands, 20 November 2009 (attended).
– 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 3-5 December 2009 (attended).
3.7 Scientific and educational activities of PhD students (theme 2)

Akhmerov, A.R. (UL)
- *How to send current through a neutral mode*, MIT, Boston, USA, 3 March 2009 (talk).
- *How to send current through a neutral mode*, Harvard University, Boston, USA, 6 March 2009 (talk).
- *How to send current through a neutral mode*, Kavli Institute for Theoretical Physics, Santa Barbara, USA, 25 March 2009 (talk).
- *How to send current through a charge-neutral mode*, SSQIP Work Discussion, TU Delft, the Netherlands, 23 April 2009 (talk).
- *Blocking current by supercurrent in graphene*, Graphene Conference, Benasque, Spain, 5 August 2009 (talk).
- *The second simplest quantum transport problem*, SSQIP Work Discussion, TU Delft, the Netherlands, 24 September 2009 (talk).
- *Tunable spin precession in inverted band gap semiconductors*, Mesoscopic Physics Seminar, Universität Würzburg, Germany, 17 November 2009 (talk).
- *Pseudodiffusive conductance via Dirac fermions in d-wave superconductors*, Institut de Ciencies Fotoniques (ICFO), Barcelona, Spain, 4 December 2009 (talk).
- *Tunable spin precession in inverted band gap semiconductors*, Atelier de Physique Théorique, Geneva University, Switzerland, 8 December 2009 (talk).
- *How to read out a Majorana qubit in a topological insulator*, Lyon Mini-School on Topological Insulators, ENS Lyon, France, 11 December 2009 (talk).

Akhukov, M.A. (RU)
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Graduate Course Theoretical Chemistry and Spectroscopy, Han-Sur-Lesse, Belgium, 7-11 December 2009 (attended).
- Tutorial Understanding Molecular Simulations (MolSimm2009), University of Amsterdam, the Netherlands, 5-16 January 2009 (attended).
- Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (attended).
- Graphene Meeting, Leiden University, the Netherlands, 2009 (attended).

Ament, L.J.P. (UL)
- *Theory of probing orbitons in YTiO3 with resonant inelastic x-ray scattering*, Physics@FOM, Veldhoven, the Netherlands, January 2009 (poster).
- Collaboration with Dr. Giniyat Khaliullin, MPI-FKF Stuttgart, Germany, February, May and December 2009 (work visit).
- Workshop Cambridge-Leiden EasyMeeting on Quantum Matter, Leiden, the Netherlands, 6-7 May 2009 (organizer).
- Casimir Science Day, Nine Challenges in Interdisciplinary Physics, Leiden, the Netherlands, June 2009 (attended).
- Theory of probing orbitons in $YTIO_3$ with resonant inelastic x-ray scattering, RIXS Workshop, ESRF, Grenoble, France, June 2009 (poster).
- Theory of probing orbitons with RIXS, Stanford University, USA, August 2009 (talk).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- Collaboration with Dr. Michel van Veenendaal, Argonne National Laboratory, Chicago, USA, November 2009 (work visit).

**Baarsma, J.E. (UU)**
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Beekman, A.J. (UL)**
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).

**Belli, S. (UU)**
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Beugeling, W. (UU)**
- Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (attended).
- National Seminar Condensed Matter, Groningen, the Netherlands, 17 April 2009 (attended).
- Chern-Simons theory of multi-component quantum Hall systems, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
- National Seminar Condensed Matter, Groningen, the Netherlands, 17 April 2009 (attended).
- Workshop Cambridge-Leiden easyMeeting on Quantum Matter, Leiden, the Netherlands, 6-7 May 2009 (attended).
- Workshop Low D Quantum Condensed Matter, Amsterdam, the Netherlands, 7-10 July 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Boon, N.J.H. (UU)**
- 20th Han-Sur-Lesse Winterschool, Han-Sur-Lesse, Belgium, 26-30 January 2009 (attended).
- *Charge renormalization for inhomogeneously charged colloids*, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

**Broedersz, C.P. (VUA)**
- *Dynamics of transiently crosslinked cytoskeletal networks*, FOM Annual Dutch Meeting on Molecular and Cellular Biophysics, Veldhoven, the Netherlands, 28-29 September 2009 (talk).
- Annual Meeting of the Biophysical Society, Boston, Massachusetts, USA, 28 February-4 March 2009 (attended).
- Harvard University, Cambridge, Massachusetts, USA, 2009 (work visit).

**Čubrović, M. (UL)**
- Theory of Condensed Matter, MSc Course by Prof. Jan Zaanen, University of Leiden, the Netherlands, Spring 2009 (attended).
- *Fermionic quantum criticality and high-Tc superconductivity*, Miniworkshop on Application of AdS/CFT to Condensed Matter Problems, University of Crete, Greece, 8-12 May 2009 (talk).
- *Fermionic quantum phase transitions and the emergence of Fermi liquid from

- Discovery of the week, from black holes to metals: gravitational description of quantum critical matter, University of Leiden, the Netherlands, 16 June 2009 (talk).
- Fermi liquids and fermionic quantum criticality from AdS/CFT correspondence, ICAM, Cargese, France, 6-18 July 2009 (talk).
- Fermi liquids and quantum criticality from AdS − CFT, ICAM, Cargese, France, 6-18 July 2009 (poster).
- Introduction to Dutch and the Dutch, FOM Course for OIOs/AIOs, James Boswell Institute, University of Utrecht, the Netherlands, October 2009 (attended).
- Taking Charge of your PhD Project, FOM Course for Graduate Students, FOM Office, Utrecht, the Netherlands, November 2009 (attended).

Diederix, J.M. (UU)
- DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Eggen, E.J. (UU)
- Screening of patchy colloids and Janus particles, Physics@FOM Veldhoven, the Netherlands, 20 January 2009 (poster).
- Physics@FOM Veldhoven, the Netherlands, 20-21 January 2009 (attended).
- Sixth Dutch Soft Matter Meeting, Delft, the Netherlands, 27 February 2009 (attended).
- Seventh Dutch Soft Matter Meeting, Amsterdam, the Netherlands, 6 October 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Emanuel, M.O. (UL)
- Large scale organization of chromatin as a polymer model, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

Gubbels, K.B. (UU)
- Physics@FOM Veldhoven, the Netherlands, 20-21 January 2009 (poster).
- **Quantum matter**, DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (talk).
- **Exotic superfluidity in imbalanced Fermi mixtures**, Meeting of the Amsterdam Quantum Collective, Amsterdam, the Netherlands, 25 November 2009 (talk).

**Haaker, S.M. (UvA)**
- Low-D Quantum Condensed Matter Workshop, Amsterdam, the Netherlands, 6-11 July 2009 (attended).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
- **Phase transitions induced by topological symmetry breaking**, Microsoft Station Q, Santa Barbara, USA, 24 October-14 November 2009 (talk and work visit).

**Habraken, S.J.M. (UL)**
- **Twisted and rotating light**, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).

**Huijse, L. (UvA)**
- **What can cohomology tell us about many-particle quantum systems?**, Group Seminar, Stockholm, Sweden, 14 January 2009 (talk).
- **Supersymmetric models for lattice fermions: critical in 1D, frustrated in 2D**, Summer Workshop on Low-D Quantum Condensed Matter, Amsterdam, the Netherlands, 9 July 2009 (talk).
- **Quantum phases of supersymmetric models for lattice fermions**, Workshop on Quantum Information and Condensed Matter Physics, Maynooth, Ireland, 16 September 2009 (talk).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (co-organizer).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (co-organizer).
- **Quantum phases of supersymmetric models for lattice fermions**, Seminar, Caltech, Pasadena, USA, 19 October 2009 (talk).
- **Quantum phases of supersymmetric models for lattice fermions**, Seminar, Boulder, Colorado, USA, 23 October 2009 (talk).

**Huisman, E.M. (UL)**

**Idema, T. (UL)**
- *The math of membranes - how differential geometry can be useful for biology*, UCLA Physics/Chemistry Theory Seminar, Los Angeles, California, USA, January 2009 (talk).
- *Membrane organization - from phase separation to the sorting of large domains*, Leiden General Physics Colloquium, Leiden University, the Netherlands, June 2009 (talk).
- *A new perspective on the rich phase behavior of ternary lipid systems*, Annual FOM Biophysics Meeting, Veldhoven, the Netherlands, September 2009 (poster).
- *A new model for contact inhibition and tumorigenesis. This weeks discoveries*, Leiden Faculty of Science Seminar, Leiden University, the Netherlands, November 2009 (talk).

**Koetsier, A.O. (UU)**

**Kuipers, J. (UU)**

**Lanzani, G. (UL)**
- Taking Charge of your PhD, FOM Course, Utrecht, the Netherlands, February 2009 (attended).
- The Art of Presenting Science, FOM Course, Utrecht, the Netherlands, November/December 2009 (attended)

**Lim, L.-K. (UU)**
- *Correlation effects in ultracold two-dimensional Bose gases*, Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (poster).
- *Strongly interacting two-dimensional Dirac fermions in a cold atomic system*, Utrecht, the Netherlands, 3 April 2009 (talk).
- Cambridge-Leiden: easyMeeting on Quantum Matter, Leiden, the Netherlands, 6-7 May 2009 (attended).
- *Strongly interacting two-dimensional Dirac fermions in a cold atomic system*, Workshop Low-D Quantum Condensed Matter, Amsterdam, the Netherlands, 6-11 July 2009 (poster).
Strongly interacting two-dimensional Dirac fermions, Recent Progress in Many Body Physics 2009, Ohio State University, Columbus, USA, 25 July-1 August 2009 (poster).

Strongly interacting two-dimensional Dirac fermions in a cold atomic system, Informal Condensed Matter Seminar, Massachusetts Institute of Technology, Boston, USA, 4 August 2009 (talk).

Strongly interacting two-dimensional Dirac fermions, ICREA Workshop on Quantum Gauge Theories and Ultracold Atoms, Barcelona, Spain, 1-4 September 2009 (poster).

Strongly interacting two-dimensional Dirac fermions in a cold atomic system, Group Seminar Bloch’s Group, Max Planck Institute for Quantum Optics, Munich-Garching, Germany, 3 November 2009 (talk).

Mini-School on Topological Insulators and Quantum Spin Hall Effect, Lyon, France, 9-11 December 2009 (attended).

Correlation effects in ultracold two-dimensional Bose gases, BEC Meeting, Utrecht University, the Netherlands, 22 December 2009 (talk).

Lucassen, M.E. (UU)
- Physics@FOM, Veldhoven, the Netherlands, 22-23 January 2009 (poster).
- Spincaloritronics, Lorentz-Center, Leiden, the Netherlands, 10-13 February 2009 (poster).
- Models for driven domain walls, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
- Nanoned/FOM Spintronics Meeting, Nijmegen, the Netherlands, 22-23 June 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Makogon, D. (UU)
- Coupled quantum wires: explaining the observed localized states at the crossing, Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (poster).
- National Seminar Condensed Matter, Groningen, the Netherlands, 17 April 2009 (attended).
- FYSICA 2009, Groningen, the Netherlands, 24 April 2009 (attended).
- Workshop Cambridge-Leiden easyMeeting on Quantum Matter, Leiden, the Netherlands, 6-7 May 2009 (attended).
- Coupled quantum wires: explaining the observed localized states at the crossing, DRSTP Symposium Trends in Theory 2009, Dalfsen, the Netherlands, 14-15 May 2009 (poster).
- Effects of disorder and interactions in the Quantum Hall ferromagnet, International Conference on Quantum Criticality and Novel Phases, Dresden, Germany, 2-5 August 2009 (poster).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
Mehmani, B. (UvA)
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

Mesaroš, A. (UL)
- Dislocations in graphene, Physics@FOM, Veldhoven, the Netherlands, 18-21 January 2009 (poster).
- Collaboration with the group of Prof. Eun-Ah Kim, Cornell University, Laboratory for Atomic and Solid State Physics, Ithaca, New York, USA, 20 August-20 November 2009 (work visit).

Mink, M.P. (UU)
- Exciton condensation in graphene bilayers, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Mossel, J.J. (UvA)
- The dynamical structure factor of the gapped AFM Heisenberg spin chain, Physics@FOM, Amsterdam and Leiden, the Netherlands, 14 May 2009 (poster).
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Palacios, G.L.E.G. (UvA)
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).

Panfil, M. (UvA)
- DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
- DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Rademaker, L. (UL)
- Physics@FOM, Veldhoven, the Netherlands, 21 January 2009 (attended).
- National Seminar Condensed Matter Physics, University of Groningen, the Netherlands, 17 April 2009 (attended).
- Workshop Cambridge-Leiden EasyMeeting on Quantum Matter, Leiden, the Netherlands, 6-7 May 2009 (attended).
- ICAM2 Summer School, Cargese, Italy, 18 July 2009 (attended).
– Visited the group of Prof. T. Devereaux, Stanford University, USA, 27 July-29 August 2009 (work visit).
– DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Romers, J.C. (UvA)
– DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (attended).
– DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (co-organizer).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Ruszel, W. (RUG)
– Gibbs-non-Gibbs properties for lattice and mean-field $xy$ models and beyond: the lattice case, Seminar Statistics, University of Groningen, the Netherlands, 30 January 2009 (talk).
– Gibbs-non-Gibbs properties for lattice and mean-field $xy$ models and beyond: the lattice case, Mark Kac Seminar, Utrecht, the Netherlands, 6 February 2009 (talk).

She, J.-H. (UL)
– DRSTP Conformal Field Theory Course 2009-2010, University of Amsterdam, the Netherlands, October-December 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Swaving, A.C. (UU)
– DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (attended).

Tieleman, O. (UU)
– Physics@FOM, Veldhoven, the Netherlands, 20-21 January 2009 (attended).
– National Seminar Condensed Matter, Groningen, the Netherlands, 17 April 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).
– Bilayer quantum Hall system at $\nu_t = 1$: pseudospin models and in-plane magnetic field, Arnold Sommerfeld Summer School, Ludwig-Maximilians-Universit at Munich, Germany, 11-16 October 2009 (poster).

van Dijk, T. (VUA)
– Evolution of singularities in a vortex beam, First Delft Optics Workshop, TU Delft, the Netherlands, 9 April 2009 (talk).
– *Evolution of singularities in a partially coherent beam*, Frontiers in Optics, Conference of the Optical Society of America, San Jose, California, USA, 14 October 2009 (talk).

van Driel, H.J. (UU)
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

van Gelderen, R. (UU)
– Workshop Low D Quantum Condensed Matter, Amsterdam, the Netherlands, 7-10 July 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

van Heugten, J.J.R.M. (UU)
– FOM@Veldhoven, Veldhoven, the Netherlands, 20-21 January 2009 (attended).
– j-ITP Meeting, Leiden, the Netherlands, 6 November 2009 (attended).
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

van Ostaay, J. (UL)
– DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (attended).

Woldhuis, E.L. (UU)
– *Foam rheology near the jamming transition*, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009 (talk).
– Dynamics of Patterns Day, Amsterdam, the Netherlands, 6 May 2009 (attended).
– *Foam rheology near the jamming transition*, Boulder Summer School: Nonequi-

- Foam rheology near the jamming transition, Workshop Flow of Foams, Lorentz Center, Leiden, the Netherlands, 17-21 August 2009 (talk).

- Granular matter, DRSTP PhD Day 2009, Utrecht University, the Netherlands, 9 October 2009 (talk).

Žeravčić, Z. (UL)

- Localization of vibrations in a bubble array, Burgersdag, Eindhoven, the Netherlands, 13 January 2009 (talk).

- Excitations of ellipsoid packings near jamming, Physics@FOM, Veldhoven, the Netherlands, 22-23 January 2009 (poster).

- From spheres to ellipsoids: the story of the density of states, University of Twente, Enschede, the Netherlands, 27 January 2009 (talk).

- From spheres to ellipsoids: the story of the density of states, 6th Soft Matter Meeting, Delft, the Netherlands, 27 February 2009 (talk).

- Excitations of ellipsoid packings near jamming, APS March Meeting, Pittsburgh, USA, 16-20 March 2009 (talk).


- Professor Nagel, Chicago, USA, August 2009 (work visit).


Zozulya, O.S. (UvA)

- Entanglement signatures of topological phase transitions in fractional quantum Hall systems, Physics@FOM, Veldhoven, the Netherlands, 20 January 2009 (talk).


Zwanikken, J.W. (UU)


- FOM-Days Physics@Veldhoven, Veldhoven, the Netherlands, 20-21 January 2009 (talk).

- Max Planck Institut, Seminar zur Physik der kondensierten Materie (SPKM), Stuttgart, Germany, 7 July 2009 (talk).
4  Scientific staff (31-12-2009)

Below an overview is given of the permanent and temporary staff of the DRSTP on 31 December 2009. Also the associate groups and members are listed. PhD students are given in chapter 3 (section 6).

Theme 1 refers to particle physics, cosmology, quantum gravity and string theory and theme 2 to quantum matter, quantum information, soft condensed matter and biophysics. The fte commitment of the permanent staff is given in the last column.

4.1 Permanent staff

**University of Amsterdam (UvA)**

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<tr>
<th>Name</th>
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<td>prof. dr. ir. F.A. Bais</td>
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<tr>
<td>prof. dr. J. de Boer</td>
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<tr>
<td>prof. dr. R.H. Dijkgraaf</td>
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<td>prof. dr. E.L.M.P. Laenen</td>
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<td>prof. dr. B. Nienhuis</td>
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<tr>
<td>dr. Th.M. Nieuwenhuizen</td>
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<tr>
<td>prof. dr. A.M.M. Pruisken</td>
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<tr>
<td>prof. dr. K. Schoutens</td>
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<tr>
<td>dr. M.M. Taylor</td>
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<tr>
<td>prof. dr. E.P. Verlinde</td>
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**Vrije Universiteit Amsterdam (VUA)**

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<td>prof. dr. T.D. Visser</td>
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<tr>
<td>prof. dr. P.R. ten Wolde</td>
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### University of Groningen (RUG)

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<td>prof. dr. M. de Roo</td>
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<td>prof. dr. R.G.E. Timmermans</td>
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<td>prof. dr. A.C.D. van Enter</td>
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### Leiden University (UL)

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### Radboud University Nijmegen (RU)

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<td>prof. dr. M.I. Katsnelson</td>
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### Utrecht University (UU)

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<tr>
<td>prof. dr. B. de Wit</td>
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<tr>
<td>dr. R.A. Duine</td>
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<td>prof. dr. E.L.M.P. Laenen</td>
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<td>dr. S.J.G. Vandoren</td>
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<tr>
<td>dr. R. Fleisicher</td>
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<tr>
<td>prof. dr. J.-W. van Holten</td>
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<tr>
<td>dr. J.A.M. Vermaseren</td>
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### 4.2 Temporary staff

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<td>dr. B.D. Chowdhury</td>
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<tr>
<td>dr. F.A.H. Dolan</td>
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<tr>
<td>dr. B.D.A. Estienne</td>
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<tr>
<td>dr. M. Kulaxizi</td>
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<tr>
<td>dr. P.L. McFadden</td>
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<tr>
<td>dr. G.L.E.G. Palacios</td>
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<td>dr. K. Papadodimas</td>
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<td>dr. B.S. Pozsgai</td>
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<td>dr. T. Quella</td>
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<td>dr. M. Shigemori</td>
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<td>dr. M. Snoek</td>
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<td>dr. J.P. van der Schaar</td>
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<tr>
<td>dr. M. Das</td>
<td>2</td>
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<tr>
<td>dr. M. Depken</td>
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<td>dr. T.C. Rogers</td>
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<tr>
<td>dr. B. Béri</td>
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<tr>
<td>dr. J.-O. Gong</td>
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<tr>
<td>dr. N. Hamedani Radja</td>
<td>2</td>
</tr>
<tr>
<td>dr. F. Hassler</td>
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<tr>
<td>dr. S.E. Henkes</td>
<td>2</td>
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<tr>
<td>dr. C.H. Hou</td>
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<tr>
<td>Theme</td>
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</table>
| **Radboud University Nijmegen (RU)** | dr. A.S. de Wijn (2)  
dr. J. Laamanen (1) |
| **Utrecht University (UU)** | dr. M. Arzano (1)  
dr. N. Banerjee (1)  
dr. U. Gürsoy (1)  
dr. I. Khavkine (1)  
dr. T.S. Koivisto (1)  
dr. A. Lazarides (2)  
dr. E. Plauschinn (1)  
dr. M.P. Seevinck (1)  
dr. A. Torrielli (1) |
| **Nikhef Theory Group (Nikhef)** | dr. N. Akerblom (1)  
dr. M. Aybat (1)  
dr. D.P. George (1)  
dr. M. Herquet (1)  
dr. J. Kuipers (1)  
dr. M. Postma (1)  
dr. T. Reiter (1)  
dr. J. Vollinga (1) |

**4.3 Associate members**

<table>
<thead>
<tr>
<th>Theme</th>
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| prof. dr. H.A. de Raedt (RUG) (2)  
prof. dr. L.-F. Feiner (Philips) (2)  
dr. B.J. Hoenders (RUG) (2)  
dr. ir. L.P.J. Kamp (TU/e) (2)  
prof. dr. J. Knoester (RUG) (2)  
prof. dr. D. Lohse (UT) (2)  
dr. M.V. Mostovoy (RUG) (2)  
Theoretical and Polymer Physics Group (TU/e) (2) |
### 4.4 Emeriti

<table>
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<tr>
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<tr>
<td>dr. K. Allaart</td>
<td>VUA</td>
<td>2</td>
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<tr>
<td>dr. B.L.G. Bakker</td>
<td>VUA</td>
<td>1</td>
</tr>
<tr>
<td>prof. dr. H.W.J. Blöte</td>
<td>UL</td>
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<td>prof. dr. H.W. Capel</td>
<td>UvA</td>
<td>2</td>
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<tr>
<td>prof. dr. ir. H. Dekker</td>
<td>UvA</td>
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<tr>
<td>prof. dr. M.H. Ernst</td>
<td>UU</td>
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<td>prof. dr. J.H. Koch (Nikhef/UvA)</td>
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<td>dr. T.A. Rijken</td>
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<td>dr. L.G. Suttorp</td>
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<td>dr. L.J. van den Horn</td>
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<td>prof. dr. N.G. van Kampen</td>
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<td>UvA</td>
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</table>
This chapter presents an overview of publications in refereed journals published in 2009. The publications belonging to theme 1 and theme 2 are given separately. Within each theme the publications are ordered according to university. Occasionally publications may be listed twice, when several universities are involved. Publications by associate members are not included. Professional publications are listed in chapter 7.

5.1 Theme 1: Particle physics, cosmology, quantum gravity and string theory

University of Amsterdam
- de Boer, J., Manschot, J., Papadodimas, K. and Verlinde, E.P., *The chiral ring of*


Vrije Universiteit Amsterdam

- Bakker, B.L.G., Veselov, A.I. and Zubkov, M.A., Nambu monopoles in lattice elec-


University of Groningen


- Nutma, T., Kac-Moody algebras & gauged supergravity, proceedings of the XIII International Conference on Selected Problems of Modern Physics, Dubna, Russia,

Leiden University

Radboud University Nijmegen
- Kiritsis, E., Lennek, M. and Schellekens, B., Free fermion orientifolds, JHEP 0902


Utrecht University


5. Academic publications


**Nikhef Theory Group**
5.2 Theme 2: Quantum matter, quantum information, soft condensed matter and biophysics

University of Amsterdam

5. Academic publications


**Vrije Universiteit Amsterdam**

- Gremaud, R., Broedersz, C.P., Borgschulte, A., van Setten, M.J., Schreuders, H.,


**University of Groningen**


**Leiden University**


Jiang, H.C., Kruger, F., Moore, J.E., Sheng, D.N., Zaanen, J. and Weng, Z.Y.,

Radboud University Nijmegen


ab initio lattice dynamical method, Comp. Mat. Sci. 44 (2009) 888-894.


**Utrecht University**


- Olschlager, M., Wirth, G., Morais Smith, C. and Hemmerich, A., *Kinetic Thomas-


Tieleman, O., Lazarides, A., Makogon, D. and Morais Smith, C., Bilayer quantum Hall system at \( n_{\nu T} = 1 \): pseudospin models and in-plane magnetic field, Phys. Rev. B 80 (2009) 205315 (arXiv: 0909.1729 [cond-mat.str-el]).


6 | Scientific activities

This chapter contains an overview of conference talks, seminars, lecture courses and poster presentations of staff members and postdoctoral fellows. An overview of the presentations of PhD students is given in chapter 3 (sections 6 and 7). A list of public lectures can be found in chapter 7 (section 3).

6.1 Theme 1: Particle physics, cosmology, quantum gravity and string theory

University of Amsterdam
- Bais, F.A., QI@ITFA, Quantum Information @ Amsterdam, the Netherlands, 11 May 2009.
- de Boer, J., Brownian motion in AdS/CFT, 5th (1st Iberian) Workshop on Gravitational Aspects of Strings and Branes, Gijon, Spain, 4 February 2009.
- de Boer, J., Brownian motion and AdS/CFT, Niels Bohr Institute, Copenhagen, Denmark, 17 February 2009.
- de Boer, J., Black holes as effective geometries, series of four one-hour lectures, Spring School on Superstring Theory and Related Topics, Trieste, Italy, 27 March 2009.
- de Boer, J., Macroscopic quantum effects near black holes, Institute for Theoretical Physics, Heidelberg, Germany, 23 April 2009.
- de Boer, J., Macroscopic quantum effects near black holes, Workshop on Cosmological Frontiers in Fundamental Physics, Brussels, Belgium, 14 May 2009.
- de Boer, J., Macroscopic quantum effects near black holes, 4th International Sakharov Conference on Physics, Lebedev Institute, Moskou, Russia, 18 May 2009.
- de Boer, J., A bound on the entropy of supergravity?, Spinoza Institute, Utrecht, the Netherlands, 12 June 2009.
- de Boer, J., Quantum aspects of black holes, 14th Itzykson Meeting on String
- Papadodimas, K., *The chiral ring of AdS3/CFT2 and the attractor mechanism*, Seminar, Groningen, the Netherlands, 5 February 2009.
- Papadodimas, K., *Holographic neutron stars*, Seminar, Utrecht, the Netherlands, 2 October 2009.
- Quella, T. *World-sheet dualities for superspace sigma-models*, Symposium on Mathematical and Theoretical Physics, St. Petersburg, Russia, 3 July 2009.
- Quella, *Conformal superspace sigma-models*, International Congress on Mathematical Physics, Young Researcher Symposium, Prague, Czech Republic, 30 July 2009.
- Quella, T., *Conformal superspace sigma-models*, Potsdam, Germany, 12 October 2009.
- Quella, T. *Conformal superspace sigma-models*, Munich, Germany, 19 November 2009.
- Quella, T., *Conformal superspace sigma-models*, Utrecht, the Netherlands, 25 November 2009.
- Skenderis, K., *Unraveling the mysteries of black holes using holography*, Colloquium, Utrecht, the Netherlands, 11 February 2009.
6. Scientific activities

- Taylor, M.M., *Are black holes really fuzzballs?*, Southampton University, Maths Department, Southampton, UK, 6 November 2009.
- van der Schaar, J.P. *Focus session: the early universe*, Physics@FOM meeting, Veldhoven, the Netherlands, 21 January 2009.
- van der Schaar, J.P., *At the right time, at the right place*, Symposium, University of Twente, Enschede, the Netherlands, 25 November 2009.

**Vrije Universiteit Amsterdam**

- Bazzocchi, F., *SO(10) versus flavor symmetries: possible strategies to describe fermion mixings and mass hierarchies*, University of Padova, Italy, April 2009.
- Boer, D., *Transverse Lambda polarization at high energy colliders*, Berkeley Summer Program on Nucleon Spin, Physics, LBL, Berkeley, USA, 11 June 2009.
- Mulders, P.J., *Universality of transverse momentum dependent distribution functions*, Workshop on Three-dimensional parton structure of the nucleon encoded in GPDs and TMDs, Institute for Nuclear Theory, Seattle, USA, 16 September 2009.

**University of Groningen**
- Bergshoeff, E.A., *New massive gravity in three dimensions*, 4th International
Sakharov Conference on Physics, Moscow, Russia, May 2009.
- Bergshoeff, E.A., (Super-)gravity in three dimensions, XXV Max Born Conference The Planck Scale, Wroclaw, Poland, June-July 2009.
- Roest, D., Gaugings at angles from orientifold reductions, String Seminar, ITFA, Utrecht University, the Netherlands, 6 February 2009.
- Roest, D., Moduli stabilisation and orientifold reductions, Theory Seminar, Nikhef, Amsterdam, the Netherlands, 2 April 2009.
- Roest, D., Moduli stabilisation and De Sitter vacua, PASCOS 2009, Hamburg, 6-10 July 2009.
- Roest, D., Moduli stabilisation and De Sitter in extended supergravity, 15-th European Workshop on String Theory, Zurich, Switzerland, 7-11 September 2009.
- Roest, D., String theory, supergravity and cosmology, Seminar at UAM, Mexico City, Mexico, 3 November 2009.
- Roest, D., Modern cosmology: a challenge for fundamental physics, Colloquium, UAM, Mexico-City, Mexico, 6 November 2009.
- Roest, D., De Sitter in string theory and supergravity, National Seminar Theoretical High Energy Physics, Amsterdam, the Netherlands, 20 November 2009.
- Roest, D., Picking up speed in string cosmology, 24th Nordic Network Meeting, Groningen, the Netherlands, 3-5 December 2009.
- Roest, D., Cosmic challenges for fundamental physics, Symposium The Quantum Universe, Groningen, the Netherlands, 9 December 2009.

Leiden University
- Achúcarro, A., Moduli stabilization and de Sitter vacua in supergravity and superstrings, Workshop New Horizons for Modern Cosmology, Galileo Galilei Institute, Florence, Italy, 2 February 2009.
- Achúcarro, A., Multiple reconnections of type II abelian Higgs strings, Challenges in Theoretical Cosmology, Talloires, France, 3 September 2009.
- Achúcarro, A., Cosmology in the era of Planck and the LHC, Colloquium, Radboud University Nijmegen, the Netherlands, 27 November 2009.
- Schalm, K.E., *Strings and strongly coupled gauge theory*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 16-27 February 2009.
- Schalm, K., *An emergent Fermi liquid from a strongly coupled quantum critical point*, String Seminar, Institute for Theoretical Physics, Utrecht University, the Netherlands, 11 November 2009.
- van Baal, P., *Calorons with non-trivial holonomy - an overview*, Symposium on Theoretical and Mathematical Physics, Euler International Mathematical Institute, St. Petersburg, Russia, 3 July 2009.
- van Baal, P., *Progress on calorons*, Workshop Universe in a Box: LHC, Cosmology and Lattice Field Theory, Lorentz Center, Leiden, the Netherlands, 28 August 2009.

**Radboud University Nijmegen**

- Kleiss, R.H.P., *Higgs, Genesis and the weight of wet light*, Physics@FOM Veldhoven, the Netherlands, 20 January 2009.
- Laamanen, J., *Relic density in SUSY GUT models with non-universal gaugino masses*, Theory Center Meeting, Nikhef, Amsterdam, the Netherlands, 23 October 2009.
- Laamanen, J., *Gaugino masses from SUSY SU(5), SO(10) and neutralino relic density*, THEP Colloquium, Radboud University Nijmegen, the Netherlands, 28 November 2009.
- Rijken, Th.A., *ESC08 NN/YN/YY-interactions for S = −1, −2, −3, −4 systems; Meson-exchange viewpoint*, Workshop Tokyo-Institute of Technology, Tokyo, Japan, 11 September 2009.
- Rijken, Th.A., *Status of understanding the YN/Yy-interactions; Meson-exchange viewpoint*, 10th International Conference on Hypernuclear and Strange Particle Physics (HYP-X), Tokai, Ibaraki, Japan, 16 September 2009.
- Rijken, Th.A., *ESC08 NN/YN/YY-interactions for S = −1, −2, −3, −4 systems; Meson-exchange viewpoint*, RIKEN, Strangeness Laboratory, Tokyo, Japan, 23 October 2009.
- Rijken, Th.A., *ESC08 NN/YN/YY-interactions for S = −1, −2, −3, −4 systems; Meson-exchange viewpoint*, Hosei University, Tokyo, Japan, 29 October 2009.
- Rijken, Th.A., *Recent Nijmegen extended-soft-core ESC08-models*, Workshop Hadrons and Nuclear Physics (HNP09), RCNP, Osaka University, Osaka, Japan,
19 November 2009.
- Rijken, Th.A., *ESC08 NN/YN/YY-interactions for S = −1, −2, −3, −4 systems; Meson-exchange viewpoint*, RCNP, Osaka University, Osaka, Japan, 20 November 2009.

**Utrecht University**
- Arutyunov, G., *On the exact spectrum of the AdS/CFT planar system*, Physics Institute of Bonn University, Bonn, Germany, 3 February 2009.
- Arutyunov, G., *Gauge theories from quantum strings*, 4th International Sakharov Conference on Physics, Moscow, Russia, 20 April 2009.
- Arutyunov, G., *Towards the exact spectrum of the AdS5xS5 superstring*, International Sakharov Conference on Physics, Moscow, Russia, 22 April 2009.
- Arutyunov, G., *Towards the exact spectrum of the AdS5xS5 superstring*, 24th Nordic Network Meeting on Fields, Strings and Branes, Groningen, the Netherlands, 4 December 2009.
- Cirafici, M., *On instanton effects in CalabiYau compactifications*, Utrecht University, the Netherlands, 19 June 2009.
- de Wit, B., *Supersymmetric black holes, the topological string, and all that*, Desy, Hamburg, Germany, 15 April 2009.
- de Wit, B., *Near-horizon analysis of D = 5 black holes and rings*, Fourth Sakharov International Conference on Theoretical Physics, Moscow, Russia, 21 May 2009.
- de Wit, B., *Extended gauged supergravities and fluxes*, Corfu Summer School on Cosmology and Strings, Corfu, Greece, 7 September 2009.
- de Wit, B., *BPS Horizons and higher derivative couplings in 4 and 5 dimensions*, Workshop Branes, Strings and Black Holes, Yukawa Institute, Kyoto, Japan, 13 October 2009.
- de Wit, B., *Supersymmetric deformations, gauged supergravities, and the embedding tensor*, IPMU, Tokyo, Japan, 27 October 2009.
- de Wit, B., *On the statistical interpretation of black hole entropy*, Shizuoka University, Ohya, Japan, 2 November 2009.
- de Wit, B., *On degrees of freedom*, Symposium on the occasion of Eric Bergshoeffs appointment to the Willem de Sitter Chair of Theoretical Physics, University of
Groningen, the Netherlands, 9 December 2009.


– Foster, B., *Dark matter and the binary pulsar*, Interactions In the Dark, Lorentz Center, Leiden, the Netherlands, 8 April 2009.


– Katmadas, S., *Five dimensional BPS attractors with higher derivatives*, Utrecht University, the Netherlands, 7 October 2009.

– Khavkine, I., *Time delay in quantum and fluctuating geometries*, Quist Seminar, Institute for Theoretical Physics, Utrecht University, the Netherlands, 29 January 2009.

– Koivisto, T.S., *Bouncing cosmologies in modified gravity*, Institute for Theoretical Physics, Utrecht University, the Netherlands, 23 November 2009.


Laenen, E.L.M.P. *Stress-testing the standard model at the LHC*, Symposium The Quantum Universe, Groningen, the Netherlands, 9 December 2009.


Loll, R., *CDT and the quest for observables*, School on Nonperturbative Gravity and QCD, Zakopane, Poland, 2 June 2009.


Loll, R., *Deriving spacetime from first principles*, GrassCosmoFun ’09 - Grassmannian Conference in Fundamental Cosmology, Szczecin, Poland, 14 September 2009.


Loll, R., *Quantum gravity from first principles*, Friedrich Schiller University, Jena, Germany, 17 November 2009.

Loll, R., *Causal dynamical triangulations and the quest for quantum gravity*, Friedrich Schiller University, Jena, Germany, 18 November 2009.

Loll, R., *Searching for the quantum origins of space and time*, Cologne University,
Germany, 1 December 2009.
- Maitra, R.L., *Can causal dynamical triangulations probe factor-ordering issues?*, Cracow School of Theoretical Physics, XLIX Course, Zakopane, Poland, 8 June 2009.
- Maitra, R., *Pain or gain: the factor-ordering problem and how CDT helps*, Grafiti Seminar, Institute for Theoretical Physics, Utrecht University, 26 October 2009.
- Prokopec, T., *Quantum gravitational backreaction in cosmology*, International Workshop on Cosmic Structure and Evolution (Cosmology), Bielefeld, Germany, 24 September 2009.
- Prokopec, T., *Quantum backreaction in cosmology*, McGill University, Montreal, Canada, 30 November 2009.
- Prokopec, T., *Quantum gravitational backreaction in cosmology*, Tufts University, Boston, USA, 3 December 2009.
- Seevinck, M., *Analyzing passion at a distance: progress in experimental metaphysics?*, Workshop Philosophical Perspectives on Understanding Quantum Mechanics, CLEA Institute, Free University Brussels (VUB), Belgium, 9 October 2009.
- Seevinck, M., *Analyzing passion at a distance: progress in experimental metaphysics?*, ESF Programme The Philosophy of Science in European Perspective, Zeist, the Netherlands, 19 October 2009.
- Seevinck, M., *Discerning elementary particles*, EPSA09, Amsterdam, the Netherlands, 22 October 2009.
- ’t Hooft, G., *The CKM matrix: a question of flavor*, Koninklijk Natuurkundig
Genootschap, Symposium Nobelprijzen, Groningen, the Netherlands, 10 January 2009.

‘t Hooft, G., *Crystalline gravity*, Université de Paris XI, Seminar, Centre d’Orsay, Laboratoire de Physique Théorique, Laboratoire associé au Centre National de la Recherche Scientifique, Orsay, France, 13 January 2009.


‘t Hooft, G., *The large hadron collider and its significance for elementary particle theory*, Special Seminar, Stanford Institute for Theoretical Physics (SITP), Physics Department, California, USA, 26 May 2009.


‘t Hooft, G., *Quantum gravity without space-time singularities or horizons*, Erice Summer School Subnuclear Physics, Sicily, Italy, 6 September 2009.

‘t Hooft, G., *Quantum gravity without space-time singularities or horizons*, Nikhef Theory Meeting, Amsterdam, the Netherlands, 8 September 2009.


‘t Hooft, G., *Quantum gravity without space-time singularities or horizons*, Seminar, Grafiti no. 183, Utrecht University, ITF, Utrecht, the Netherlands, 12 October 2009.


‘t Hooft, G., *The black hole correspondence principle*, Seminar, Niels Bohr Institute, Copenhagen, Denmark, 29 October 2009.

‘t Hooft, G., *Black hole complementarity and the cosmological constant*, Landessexzellenzinitiative, Symposium on Connecting Particles with the Cosmos, DESY, Hamburg, Germany, 4 November 2009.

‘t Hooft, G., *Quantum gravity without space-time singularities or horizons*, Seminar, MIT, Cambridge, Massachusetts, USA, 9 November 2009.


‘t Hooft, G., *Quantum gravity without space-time singularities or horizons*, Seminar, Chennai, India, 20 November 2009.

‘t Hooft, G., *Gravity and the quantum - the world may not be what it seems to be,*
10th International Symposium Frontiers Fundamental and Computational Physics, University Western Australia, Perth, 24 November 2009.


- ’t Hooft, G., *The unique beauty of the subatomic landscape*, Symposium From the Proton Synchrotron to the Large Hadron Collider, 50 Years of Nobel Memories in High-Energy Physics, CERN, Geneva, Switzerland, 4 December 2009.


- Torrielli, A., *Yangians in AdS/CFT integrability*, Institute for Theoretical Physics, University of Amsterdam, the Netherlands, 19 October 2009.


- Vandoren, S., *Instanton corrections from twistor geometry*, University of Amsterdam, the Netherlands, 3 February 2009.


- Vandoren, S., *Quaternion-Kähler geometry and string theory*, Mathematics Colloquium, Utrecht University, the Netherlands, 28 May 2009.

- Vandoren, S., *N = 2 gauged supergravity and compactifications of string theory*, Conference A New Year of String Theory, 100 years of Tel Aviv, Israel, 21-25 September 2009.


**Nikhef Theory Group**


- Gmeiner, F., *Threshold corrections in intersecting brane models*, University of Groningen, the Netherlands, 3 March 2009.

- Gmeiner, F., *The landscape of intersecting brane models*, Institute for the Physics
and Mathematics of the Universe, Tokyo, Japan, 21 April 2009.


- Postma, M., *Inflation on a torus*, Max Planck Institute, Munich, Germany, 4 June 2009.


Schellekens, A.N., *RCFT string model building*, University of Crete, Heraklion, Greece, 13 October 2009.

Schellekens, A.N., *The emperor’s last clothes?*, RWTH Aachen, Aachen, Germany, 17 November 2009.


### 6.2 Theme 2: Quantum matter, quantum information, soft condensed matter and biophysics

**University of Amsterdam**


Caux, J.-S., *Transmutation and fractionalization, or when 1 plus 1 isn’t simply 2*, DRSTP Postgraduate Course Theoretical High Energy Physics, Driebergen, the Netherlands, 25 February 2009.


- Caux, J.-S., *Correlations and quenches in integrable systems: from theory to experiment*, Theoretical Physics Colloquium, Utrecht, the Netherlands, 28 October 2009.
- Nieuwenhuizen, T.M., *Do non-relativistic neutrino’s constitute the dark matter?*, Groningen, the Netherlands, 8 July 2009.
- Nieuwenhuizen, T.M., *Do non-relativistic neutrino’s constitute the dark matter?*,
- Nieuwenhuizen, T.M., On the neutrino mass and neutrinos as the hot dark matter, Trieste, Italy, 9 September 2009.
- Nieuwenhuizen, T.M., Waaruit bestaat donkere materie?, Oostzaan, the Netherlands, 18 October 2009.
- Nieuwenhuizen, T.M., Do non-relativistic neutrinos constitute the dark matter?, Paul Scherrer Institute, Villigen, Switzerland, 22 October 2009.
- Nieuwenhuizen, T.M., Black holes with hair as a normal state of matter, Condensed Matter Group, ITFA, Amsterdam, the Netherlands, 2 December 2009.
- Panja, D., Memory effects in polymer dynamics: translocation, adsorption/desorption and melts, ITF and General Physics Colloquium, Amsterdam, the Netherlands, 4 June 2009.
- Pruisken, A.M.M., Can the theta-angle explain macroscopic quantization phenomena, 4th International Sakharov Conference on Physics, Moskou, Russia, 18 May 2009.
- Pruisken, A.M.M., Can the theta-angle explain macroscopic quantization phenomena, Theory Colloquium, Chernogolovka, Russia, 22 May 2009.
- Schoutens, K., Everything you always wanted to know about non-Abelian quantum Hall states but were afraid to ask, Colloquium, Nordita/Alba Nova, Stockholm, Sweden, 15 January 2009.
- Schoutens, K., Quantum phases for rotating bosons, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009.
- Schoutens, K., Paired and clustered quantum Hall states, EasyMeeting on Quantum Matter, Leiden, the Netherlands, 6 May 2009.
- Schoutens, K., Quantum phases of a supersymmetric model of lattice fermions, APCTP-MPIPKS Seminar and Workshop, Dresden, Germany, 29 June 2009.
- Schoutens, K., Exact results for supersymmetric lattice models, XVI International Congress in Mathematical Physics, Prague, Czech Republic, 7 August 2009.


Snoek, M., *Dynamical mean field analysis of the multi-species Bosonic Hubbard model*, CMT Group Meeting, Amsterdam, the Netherlands, 27 April 2009.


**Vrije Universiteit Amsterdam**


Depken, M., *Transcriptional proofreading and the competing demands of fidelity and velocity*, Physics goes DNA Workshop, Lorentz Center, Leiden, the Netherlands, 7 September 2009.


Depken, M., *The nature of transcriptional pauses and their role in proofreading*, Annual Dutch meeting on Molecular and Cellular Biophysics, Veldhoven, the Netherlands, 28-29 September 2009.


University of Groningen


van Enter, A.C.D. van, *Disorder and Gibbs formalism*, Minisymposium Interacting Random Systems, Groningen, the Netherlands, 4 September 2009.

van Enter, A.C.D. van, *Bootstrap percolation: questions, some answers and applications*, Seminar Dynamical Systems, Groningen, the Netherlands, 21 December 2009.

Leiden University


van den Brink, J., *Iron superconductors: breaking the high Tc rules*, Physics Colloquium, Utrecht University, the Netherlands, 14 January 2009.

van den Brink, J., *Exotic properties of graphene at interfaces: spin filtering and
mass generation, DPG March Meeting, Dresden, Germany, 25 March 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Physics Colloquium, Stanford University, USA, 7 May 2009.
- van den Brink, J., Magnons, bi-magnons and orbitons in RIXS, Resonant Inelastic X-Ray Scattering Workshop, ESRF Grenoble, France, 30 June 2009.
- van den Brink, J., Magnons, bi-magnons and orbitons in RIXS, Physics Seminar, Swiss Light Source, Paul Scherer Institute, Villingen, Switzerland, 2 July 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Seminar, Advanced Light Source, Berkeley, USA, 8 July 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Workshop on Resonant Inelastic X-Ray Scattering, Stanford Linear Accelerator Laboratory, USA, 3 August 2009.
- van den Brink, J., Iron superconductors: breaking the high Tc rules, Physics Colloquium, University of Technology Eindhoven, the Netherlands, 17 September 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Workshop on Soft X-Ray Scattering, NSRRC, Hsinchu, Taiwan, China, 12 October 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Physics Colloquium, University of Illinois Urbana Champaign, USA, 6 November 2009.
- van den Brink, J., CMSN activities of the cluster subgroup, RIXS Coordination Meeting, Stanford, USA, 12 November 2009.
- van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Physics Colloquium, Max Planck Research Department for Structural Dynamics, CFEL Hamburg, Germany, 1 December 2009.
- van Saarloos, W., From hard grains to soft bubbles - response and flow of materials near the jamming point, Fluids Seminar, University of Cambridge, UK, 13 February 2009.
- van Saarloos, W., Het onopgeloste mysterie van een glas, HOVO College, Teylers Museum, Haarlem, the Netherlands, 3 March 2009.
- van Saarloos, W., A general approach to front propagation into unstable states, Seminar, University of Pennsylvania, Philadelphia, USA, 24 September 2009.
- Schiessel, H., Structure of chromatin on larger scales, Biophysics of Chromatin Workshop, Heidelberg, Germany, February 2009.
- Schiessel, H., Stacking plates and wedges: the geometry of DNA compaction, ICTP Conference, Trieste, Italy, June 2009.
– Zaanen, J., *Orbital order and pnictide superconductivity*, Program on Pnictide Superconductivity, Kavli Institute of Theoretical Physics, Beijing, China, 23 May-5 June 2009.
– Zaanen, J., *Strings meet quantum matter*, Colloquium, Institute of Theoretical Physics, Chinese Academy of Sciences, Beijing, China, 3 June 2009.
– Zaanen, J., *Fermions signs and higher Tc superconductivity*, Program the Physics of Higher Temperature Superconductivity, KITP, Santa Barbara, USA, 12 August 2009.
– Zaanen, J., *Fermionic quantum criticality and the AdS/CFT correspondence*, International Conference Materials & Mechanisms of Superconductivity, Tokyo, Japan,
7-11 September 2009.

Radboud University Nijmegen
- de Wijn, A.S., *Periodic orbits and sliding friction on graphite*, Instituto de Física de Cantabria, Santander, Spain, 16 July 2009.
- de Wijn, A.S., *Regelmaat in chaos*, Marie-Curie Colloquium, Radboud University Nijmegen, the Netherlands, 2 October 2009.
- van den Brink, J., *Iron superconductors: breaking the high Tc rules*, Physics Colloquium, Utrecht University, the Netherlands, 14 January 2009.
- van den Brink, J., *The light that resonant inelastic x-ray scattering throws on high Tc cuprates*, Workshop on Resonant Inelastic X-ray Scattering, Stanford Linear Accelerator Laboratory, USA, 3 August 2009.
- van den Brink, J., *Iron superconductors: breaking the high Tc rules*, Physics Collo-
– van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Workshop on Soft X-Ray Scattering, NSRRC, Hsinchu, Taiwan, 12 October 2009.
– van den Brink, J., CMSN activities of the cluster subgroup, RIXS Coordination Meeting, Stanford, USA, 12 November 2009.
– van den Brink, J., The light that resonant inelastic x-ray scattering throws on high Tc cuprates, Physics Colloquium, Max Planck Research Department for Structural Dynamics, CFEL Hamburg, Germany, 1 December 2009.

Utrecht University
– Barkema, G.T., Simulation and theory of nucleation, IPAM Workshop, Los Angeles, USA, 23 February 2009.
– Barkema, G.T., Anomalous dynamics of polymer translocation, APS, Pittsburgh, USA, 16 March 2009.
– Barkema, G.T., Computational physics hands-on, DRSTP Postgraduate Course Statistical Physics and Theory of Condensed Matter, Driebergen, the Netherlands, 23 March-3 April 2009.
– Duine, R.A., Current-driven domain walls at nonzero temperature, Workshop Spin Caloritronics, Lorentz Center, Leiden University, the Netherlands, 12 February 2009.
– Duine, R.A., Generation of electric current by a moving domain wall, Spintronics II Symposium at SPIE Optics and Photonics, San Diego, California, USA, 4 August 2009.
– Duine, R.A., Generation of electric current by a moving domain wall, 16th International Summer School Nicolas Cabrera on Spin Transport and Dynamics in Nanostructures, Madrid, Spain, 15 September 2009.
– Duine, R.A., Antiferromagnetic metal spintronics, 16th International Summer School
Nicolas Cabrera on Spin Transport and Dynamics in Nanostructures, Madrid, Spain, 16 September 2009.


- Morais Smith, C., *Cold atoms as cond-mat simulators*, Program Low Dimensional Electron Systems, Kavli Institute, Santa Barbara, California, USA, 5 March 2009.


This chapter presents an overview of the science-related activities of DRSTP staff members and postdoctoral fellows. Here we list publications about or related to physics in a variety of printed media (section 7.1) and also public lectures (section 7.2) are given. All other outreach activities like forum discussions, television interviews, personal columns in newspapers etc. are listed in the paragraph ‘other contributions’ (section 7.3). Science-related activities of PhD students can be found in chapter 3 (sections 3.6 and 3.7).

### 7.1 Physics-related publications

- Kleiss, R., *Higgs speelt verstoppertje*, Trouw, the Netherlands, 30 October 2009, article.
- Nieuwenhuizen, T.M., *Neutrinos may indeed be the solution to the mystery surrounding dark matter*, UvA press release, 8 June 2009.
7.2 Public lectures

- de Boer, J., *Voorbij tijd en ruimte*, cosmologie volgens de snaartheorie, Science Cafe Nijmegen, the Netherlands, 6 November 2009.
- de Wit, B., *The LHC particle accelerator: why and how?*, Presentation for the 5th and 6th grade students, Christelijk Lyceum Zeist, the Netherlands, 29 January 2010.
- Kleiss, R., *Higgs; massa verklaard?*, Science Cafe, Nijmegen, the Netherlands, 21 April 2009.
- Loll, R., *The truth(?) about wormholes*, Utrecht University, the Netherlands, 11 June 2009.
- Mulders, P.J., *The standard model of particle physics and beyond*, Symposium ’At the right place at the right time’, University of Twente, Enschede, the Netherlands, 25 November 2009.
- ’t Hooft, G., *De large hadron collider*, Sociëteit De Vereeniging, Utrecht, the Netherlands, 19 January 2009.
- ’t Hooft, G., *Towards a more detailed understanding of the sub-atomic world*, Oc-
7. Science-related activities

-- occasion of an Honorary Doctorate, University of Tirana, Albania, 18 June 2009.
-- 't Hooft, G., *De large hadron collider*, Science Cafe Deventer, the Netherlands, 14 October 2009.
-- van der Schaar, J.P., *Voorbij tijd en ruimte - kosmologie volgens de snaartheorie*, Science Cafe Nijmegen, the Netherlands, 6 October 2009.
-- Vandoren, S., Radio-interview, VPRO, Radio 1 Programma Noorderlicht, the Netherlands, 17 March 2009.

7.3 Other contributions

-- Bais, F.A., *Einstein, the best physicist of all times*, the Netherlands, 19 June 2009, lecture on film.
- Bais, F.A., *De clou van de cosmos*, NRC, the Netherlands, 7 November 2009, interview.
- Bais, F.A., *Two people, two books two worlds*, Comenius alumni event together with Nelleke Noordervliet, Arnhem, the Netherlands, 17 November 2009, talk.
- Loll, R., TV appearance in De Nationale Wetenschapsquiz, Het Voorspel 3 - Exact, VPRO, the Netherlands, 13 December 2009.
materie, Amsterdam, the Netherlands, 2009, article.

- Schoutens, K., *Quantum ICT - over quantummechnica en computers*, Bachelordag Natuur- en Sterrenkunde, Amsterdam, the Netherlands, 7 March 2009, lecture.
- Schoutens, K., *Quantum mechanica*, Gastlessen op het Stedelijk Gymnasium Haarlem, the Netherlands, 10 March 2009, lectures.
- Schoutens, K., Voorlichting Bacheloropleiding Natuur- en Sterrenkunde, Haarlem, the Netherlands, 10 November 2009, lecture.
- Stoof, H.T.C., Techniek Tournooi Arnhem, the Netherlands, 4 June 2009.
- Stoof, H.T.C., Vragendag Klokkenhuis (NEMO) Amsterdam, the Netherlands, 22 November 2009.
- ’t Hooft, G., *De kleinste deeltjes, wat weten we en wat weten we niet?*, Jury beoordeling presentaties van scholieren over HiSparc, Scholierensymposium Vechtstede College, Weesp, the Netherlands, 24 March 2009.
- ’t Hooft, G., Column Vakidioot 40 Jaar, Jubileumeditie, the Netherlands, 2009.
- ’t Hooft, G., Column Natuurkunde in de Ruimte, gezamenlijke themanummer van Ruimtevaart en het Nederlands Tijdschrift voor Natuurkunde, Interview Science met Amir D. Aczel, the Netherlands, 2009.
- ’t Hooft, G., Interview with Margriet van der Heijden, NRC, over Zwarte Gaten, the Netherlands, 27 August 2009.
- ’t Hooft, G., *Tete a tete with a Nobel Laureate*, interactive session with school students, Chennai, India, 17 November 2009.
- ’t Hooft, G., Opening Tentoonstelling NewtonMania, Museum Boerhaave, Leiden, the Netherlands, 16 December 2009.
- Terhal, B., *De paradoxe wereld van quantum informatie*, Viva Fysica, Amsterdam, the Netherlands, 14 January 2009, talk.
- Vandoren, S., De Avond van Wetenschap en Maatschappij, 10e avond; thema-avond ter bevordering van de integratie van wetenschap in de maatschappij, Ridderzaal, Den Haag, the Netherlands, 2 November 2009.
- Vandoren, S., *Bilzenaar wint Descartes-Huygensprijs*, Radio interview, Radio 1,
Belgium, 31 March 2009.

- Verlinde, E.P., *Zwaartekracht is geen kracht*, Volkskrant interview, the Netherlands, 12 December 2009.
8 Research funding

Below an overview is presented of funding organizations that financially supported the research of the DRSTP in 2009. Regular university funding is not listed.

8.1 Personal grants

*University grants*
- High Potentials grant UU, R.H.H.G. van Roij (UU) (2005-2010)
- *The phases of gauge theories with many flavours*, NCF-grant for computing time (E. Pallante) (RUG)
- UU-Asia Fellowship grant [for R. Godbole, IISc, Bangalore, India], E.L.M.P. Laenen (UU/Nikhef)

*KNAW*
- Willem de Sitter professorship, E.A. Bergshoeff (RUG) (2009)
- Academy professorship, G. ’t Hooft (UU) (2005-2011)

*NWO*
- Spinoza grant (1999), C.W.J. Beenakker (UL) (2000-2009)
- VICI grant (2003), A. Achúcarro (UL) (2004-2009)
- VICI grant (2004), R. Loll (UU) (2005-2010)
- VICI grant (2007), C. Morais Smith (UU) (2008-2013)
- VICI grant (2008), K. Skenderis (UvA) (2009-2013)
- VIDI grant (2005), K. Peeters (UU) (2006-2011)
- VIDI grant (2007), M. Postma (Nikhef) (2008-2013)
- VIDI grant (2008), D. Roest (RUG) (2008-2013)
- VENI grant (2008), P.L. McFadden (UvA) (2008-2010)
- VENI grant (2008), M. Snoek (UvA) (2009-2011)

*ERC Starting grant*
ERC Advanced investigator grant
– C.W.J. Beenakker (UL), Search for mechanisms to control massless electrons in graphene, (2009-2014)

EU Marie Curie fellowships
– B. Dittrich (UU), Observables in quantum gravity, (1 September 2008 - 1 April 2009)
– M. Arzano (UU), Beyond local QFT, (15 September 2009 - 15 September 2011)
– T. Quella (UvA), Conformal field theories with Lie superalgebra symmetry and string backgrounds with fluxes, (1 September 2007 - 1 September 2009)
– C.D. White (Nikhef), Top@LHC, (1 October 2008 - 1 October 2009)
– P. Sulkowski (UvA), Black holes - BPS - black holes, BPS states and topological string theory, (1 October 2009 - 30 September 2012)

Other fellowships
– P. Höhn (UU), recipient of a German DAAD Doktorandenstipendium 2008
– K. Hristov (UU), KNAW Huygens Scholarship, (1 September 2008 - 1 September 2010)
– R.N. Caldeira Costa (UvA), Portuguese Foundation for Science and Technology PhD, research fellowship, (1 October 2008 - 1 October 2012)

8.2 FOM funding

– **FOM-A-01** (group leader F.A. Bais)
  *Fundamental interactions (FOM programme 31)*
  02FI10: Non-abelian electric-magnetic symmetry (F.A. Bais)

– **FOM-A-05** (group leader B. Nienhuis)
  *Collective and cooperative statistical physical phenomena (FOM programme 46)*
  04CCSPP26: Correlations in groundstates without finite size corrections (B. Nienhuis)

– **FOM-A-20** (group leader E.P. Verlinde)
  *String theory and quantum gravity (FOM programme 57)*
  01STQG01: Thermodynamics of strings, fluxes and branes (R.H. Dijkgraaf and J. de Boer)
  *A string theoretic approach to cosmology and quantum matter (FOM programme 121)*
  09CQ01: Dynamical aspects of black holes (J. de Boer, M.M. Taylor, E.P. Verlinde)
  09CQ02: Holography and cosmology (K. Skenderis, J.P. van der Schaar)
  09CQ09: Programmemanagement, workshops and guests (E.P. Verlinde)
  *Projectruimte*
03PR2266: Supersymmetric gauge theories and matrix models (R.H. Dijkgraaf and J. de Boer)
04PR2387: Connecting gauge interactions with gravity through string theory (R.H. Dijkgraaf and E.P. Verlinde)
06PR2510: Cosmological vacua in string theory (R.H. Dijkgraaf and E.P. Verlinde)
08PR2647: Topological computations for supersymmetric theories (J. de Boer)

- **FOM-A-25** (group leader K. Schoutens)
  *Collective and cooperative statistical physical phenomena (FOM programme 46)*
  04CCSPP23: The challenges of the chiral metal (J.-S. Caux)
  04CCSPP24: Collective behavior vs entanglement in atomic matter (K. Schoutens)
  *Solid state quantum information processing (FOM programme 73)*
  08QIP07: Topological quantum computation in fractional quantum Hall effect devices (K. Schoutens)

- **FOM-G-01** (group leader E.A. Bergshoeff)
  *String theory and quantum gravity (FOM programme 57)*
  01STQG03: String theory and quantum gravity (E.A. Bergshoeff/M. de Roo)
  02STQG06: Towards a formulation of coinciding M5-branes (E.A. Bergshoeff/M. de Roo)

- **FOM-L-05** (group leader C.W.J. Beenakker)
  *Photons in complex media (FOM Programme 45-2)*
  07WCM09: Photons in complex media: theory (C.W.J. Beenakker)
  *Graphene-based electronics (FOM Programme 101)*
  07GE02: Quantum transport in graphene (C.W.J. Beenakker)
  *Solid state quantum information processing (FOM Focusgroep)*
  08SSQIP: Nonlocally encoded qubits in topological insulators and graphene (C.W.J. Beenakker)

- **FOM-A-25** (group leader K. Schoutens)
  *Collective and cooperative statistical physical phenomena (FOM programme 46)*
  04CCSPP23: The challenges of the chiral metal (J.-S. Caux)
  04CCSPP24: Collective behavior vs entanglement in atomic matter (K. Schoutens)
  *Solid state quantum information processing (FOM programme 73)*
  08QIP07: Topological quantum computation in fractional quantum Hall effect devices (K. Schoutens)

- **FOM-G-01** (group leader E.A. Bergshoeff)
  *String theory and quantum gravity (FOM programme 57)*
  01STQG03: String theory and quantum gravity (E.A. Bergshoeff/M. de Roo)
  02STQG06: Towards a formulation of coinciding M5-branes (E.A. Bergshoeff/M. de Roo)

- **FOM-L-05** (group leader C.W.J. Beenakker)
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  *Solid state quantum information processing (FOM Focusgroep)*
  08SSQIP: Nonlocally encoded qubits in topological insulators and graphene (C.W.J. Beenakker)
06PR2504: Mesoscopic physics in graphene (C.W.J. Beenakker)
08PR2601: Electronic shot noise in fractal conductors (C.W.J. Beenakker)
09PR2659: Mesoscopic physics in topological insulators (C.W.J. Beenakker)

- **FOM-L-07** (group leader W. van Saarloos)

  *Collective and cooperative statistical physical phenomena (FOM programme 46)*

  04CCSPP15: Efficient statistical physical models for simulating macroscopic viscoelastic flow instabilities and turbulence (W. van Saarloos)
  04CCSPP18: Quantum phases of ultracold strongly interacting atoms
  (P.J.H. Denteneer)

  *Physics of granular matter (FOM Programme 63)*

  07PGM17: Response and scaling behavior of dense granular media near the jamming transition (W. van Saarloos)
  07CJR07: Competition of jamming and shear banding (W. van Saarloos)

  *Rheophysics: connecting jamming and rheology (FOM programme 102)*

  08iPOG02: Nonlinear waves and quasi-localized resonances in disordered granular media (W. van Saarloos & M. van Hecke)

- **FOM-L-15** (group leader J. Zaanen)

  *Collective and cooperative statistical physical phenomena (FOM programme 46)*

  04CCSPP13: Quantum phase transitions and fermion signs (J. Zaanen)

  *A string theoretic approach to cosmology and quantum matter (FOM Programme 121)* (A. Achúcarro & K.E. Schalm)

  *Projectruimte*

  04PR2295: Stripe fractionalization: the quest for emergent gauge principle (J. Zaanen)
  10ER2795: Fermionic quantum criticality and anti-de Sitter string theory: black-hole answers for condensed matter questions (K.E. Schalm/J. Zaanen)
  09PR2657-2: Strike while the iron is hot: uncovering the electronic structure of the new Fe-pnictide high temperature superconductors (J. van den Brink)

- **FOM-L-26** (group leader H. Schiessel)

  *Material properties of biological assemblies (FOM programme 90)*

  05MPBA09: Theory of the role and behavior of membranes in composite systems (H. Schiessel)
  06PR2465: Statistical mechanics of semiflexible biopolymers under tension and compression (H. Schiessel)
- **FOM-L-30** (group leader J. van den Brink)
  *Collective and cooperative statistical physical phenomena (FOM programme 46)*
  04CSSPP31: Orbital physics in oxides: novel types of quantum order (J. van den Brink)
  *Projectruimte*
  04PR2358: Does spontaneous symmetry breaking limit quantum coherence? (J. van den Brink)
  *FOM-Springplankplaatsen*
  02SP001: FOM-Springplankplaats (J. van den Brink)

- **FOM-N-01** (group leader R.H.P. Kleiss)
  *Fundamental interactions (FOM programme 31)*
  02FI15: Fundamental interactions (R.H.P. Kleiss)
  *Theoretical particle physics in the era of the LHC (FOM programme 104)*
  07TPP02: Higgs+SuSy (R.H.P. Kleiss)

- **FOM-N-09** (group leader M.I. Katsnelson)
  *Graphene-based electronics (FOM Programme 101)*
  07GE03: Graphene - based electronics (M.I. Katsnelson)
  *Projectruimte*
  05PR2427: Magnetic adatom clusters on metal surfaces as tunable many-body systems (M.I. Katsnelson)
  06PR2481: Graphene: the two dimensional crystal that should not exist (A. Fasolino)

- **FOM-U-01** (group leader G. ’t Hooft)
  *Theoretical particle physics in the era of the LHC (FOM programme 104)*
  07TPP03: Naturalness and fundamental vs composite scalars (G. ’t Hooft)
  *Projectruimte*
  07PR2522: What curves the space-time at large scales? The quest for the origin of dark energy of the universe (T. Prokopec)
  09PR2744: The 4D/5D connection for black holes and black rings (G. ’t Hooft)

- **FOM-U-05** (group leader H.T.C. Stoof)
  *Projectruimte*
  08PR2587: Ultracold Fermi gases and neutron stars (H.T.C. Stoof)

- **FOM-U-29** (group leader B. de Wit)
  *String theory and quantum gravity (FOM programme 57)*
  01STQG02: New approaches to hypermultiplets/local field theory couplings of BPS states (B. de Wit)
  *A string theoretic approach to cosmology and quantum matter (FOM programme 121)*
  09CQ03: Fixed point CFT’s for condensed matter systems (S.J.G. Vandoren)
  09CQ04: Moduli stabilization and cosmological vacua (S.J.G. Vandoren)
- **FOM-U-31** (group leader R.H.H.G. van Roij)
  *Innovative physics for oil and gas (FOM/SHELL programme 116)*
  08iPOG08: Electrokinetics and electroacoustics near oil-water interfaces in porous media (R.H.H.G. van Roij)
  *Projectruimte*
  07PR2592: Do smectic nuclei exist? (R.H.H.G. van Roij/ M. Dijkstra)

- **FOM-U-34** (group leader R.A. Duine)
  *Controlling spin dynamics in magnetic nanostructures: combining fast time and short length scales for tomorrow’s technology (FOM programme 109)*
  80SPIN03: Theory domain walls (R.A. Duine)

- **FOM-U-35** (group leader R. Loll)
  *Projectruimte*
  08PR2578: A reality check for quantum cosmology (R. Loll)

- **FOM-V-01** (group leader P.J.G. Mulders)
  *Fundamental interactions (FOM programme 31)*
  02FI18: Fundamental interactions (P.J.G. Mulders)
  *Theoretical particle physics in the era of the LHC (FOM programme 104)*
  07TPP04: Theoretical particle physics in the era of the LHC (D. Boer and P.J.G. Mulders)
  *Projectruimte*
  04PR2302: Exposing the color glass condensate (D. Boer)
  05PR2422: Time reversal odd phenomena in quantum chromodynamics (P.J.G. Mulders)
  07PR2547: Color flow in hard hadronic scattering processes (P.J.G. Mulders)

- **FOM-V-13** (group leader F.C. MacKintosh)
  *Biomolecular physics (FOM programme 60)*
  03BMP23: Micromechanics and active response of biopolymer networks (F.C. MacKintosh)
  *Material properties of biological assemblies (FOM programme 90)*
  05MPBA04: Cytoskeletal/filamentous protein networks and assemblies (F.C. MacKintosh)
  05MPBA06: Microrheology and non-equilibrium fluctuations of active cytoskeletal networks (F.C. MacKintosh/G. Koenderink)
  05MPBA10: Guest budget (F.C. MacKintosh)
  05MPBA11: Personal budget, program leader (F.C. MacKintosh)
  *Rheophysics: connecting jamming and rheology (FOM programme 102)*
  07CJR03: Modelling of non-affine deformations and flow (F.C. MacKintosh)
  *Projectruimte*
  07PR2680: Cell-inspired design of polymer networks with tailored mechanical properties (G.H. Koenderink/F.C. MacKintosh)
  *Mechanosensing and mechanotransduction by cells (FOM programme 117)*
  09MMC08: Force transmission in the extracellular matrix (F.C. MacKintosh)
8. Research funding

- **FOM-V-16** (group leader T.D. Visser)
  *Singular plasmonics*

### 8.3 FOM-Nikhef

- **FOM programme** (group leader E.L.M.P. Laenen)
  *Theoretical Particle physics in the era of the LHC (FOM programme 104)*
  07TPP06: Tools, methods and applications for new physics predictions for the LHC (J.-W. van Holten, E.L.M.P. Laenen, J.A.M. Vermaseren)

- **FOM programme** (group leader E. Verlinde)
  *String theory and quantum gravity (FOM programme 57)*
  01STGQG04: Conformal field theory (A.N.J.J. Schellekens)

- **FOM-Nikhef** (group leader J.A.M. Vermaseren)
  *Projectruimte*
  07PR2556: Precision phenomenology at the LHC (J.A.M. Vermaseren)

- **FOM-Nikhef** (group leader A.N.J.J. Schellekens)
  *Projectruimte*
  05PR2435: Standard model interactions from open string theory (A.N.J.J. Schellekens)

### 8.4 EU-networks

- Soft matter composites-an approach to nanoscale functional materials (6th framework programme, network of excellence 502235-2)
  Duration: from 01-06-2004 until 01-06-2009
  Network coordinator: D. Richter (Jülich, Germany)
  Scientists in charge: A. van Blaaderen/H. Lekkerkerker
  Participating theorist: R.H.H.G. van Roij (UU)

- Superstring theory (MRTN-CT-2004-512194)
  Duration: from 01-01-2005 until 31-12-2009
  Network coordinator: L. Brink (Göteborg, Sweden)
  Scientist in charge for UvA: R.H. Dijkgraaf
  Scientist in charge for UU (associated with UvA): G. ’t Hooft

- European network on random geometry ENRAGE (MRTN-CT-2004-005616)
  Duration: from 01-09-2005 until 31-08-2009
  Network coordinator: R. Loll (UU)
- HEPTOOLS (MRTN-CT-2006-035505)
  Duration: from 01-12-2006 until 30-11-2010
  Network coordinator: Dr. C.G. Papadopoulos (NRCS Dimokritos, Greece)
  Scientist in charge for RU: R.H.P. Kleiss

- Flavour Physics Training network FLAVIAnet
  Duration: 2006-2010
  Network coordinator: A. Pich (Valencia U., Spain)
  Scientist in charge for RUG (associated with Valencia): E. Pallante

- Study of Strongly Interacting Matter (HadronPhysics2)
  Duration: 2009-2012
  Network coordinator: C. Guaraldo (Frascati)
  Scientist in charge for VUA: P.J.G. Mulders

8.5 ESF

- Interdisciplinary statistical and field theory approaches to nanophysics
  and low dimensional systems (INSTANS)
  Duration: 2005-2010
  Network coordinator: G. Mussardo (SISSA, Trieste).
  Scientist in charge for UvA: K. Schoutens

8.6 Other

NWO
- Top-talent: (T. van Dijk) (VUA)
- NWO ECHO grant: Charged colloidal rods in suspension: screening, twisting,
  demixing, and ordering, R.H.H.G. van Roij (UU) (2008-2012)
- NWO Mozaikbeurs C. Wever (UU)

STW
- VTF 7803 (T. Visser) (VUA): Using light better (T. Stegeman and S. Raghu-
  nathan)

Fulbright Center
- Fulbright Scholar: duration 1 January 2009 - 1 June 2009, P.S. Carney (Beckman
  Institute, University of Illinois at Urbana-Champaign, USA)
  Host: T.D. Visser
Organisation (31-12-2009)

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Appendix A
Mission statement

Objectives
The Dutch Research School of Theoretical Physics (DRSTP) is a cooperation between the theoretical physics groups of six Dutch universities and of the National Institute for Subatomic Physics (Nikhef) with the following purpose:

- to implement a joint programme of graduate education in theoretical physics that draws upon a dynamic research environment;
- to maintain and strengthen research in theoretical physics from a broad unifying perspective that exploits the interrelationships between different fields of theory;
- to strengthen, both in research and graduate education, connections with experimental physics, and other disciplines such as mathematics, computational science, astrophysics, earth science, physical chemistry and the life sciences.

The DRSTP is based on the conviction that a joint venture of all the moderately sized local theory groups, each with its own profile, offers added value for the achievement of these objectives. The DRSTP represents a sizable part of the national activity in theoretical physics, a field that has a strong tradition in the Netherlands. At present there exists no other organization that represents this field of research at the national level. The DRSTP welcomes further growth, for instance, by cooperation with institutions in neighbouring countries that share these goals. Often its educational activities already attract students from neighbouring countries and occasionally some of these activities are based on a close collaboration with partners abroad.

Mandate
The governing board of the DRSTP, which consists of representatives of the partners, is responsible for undertaking any suitable initiative to further its goals. The scientific director of the DRSTP is responsible for implementing the overall policy on behalf of the board and for coordinating the DRSTP activities. The mandate to carry out these tasks is based on an official agreement between the boards of the participating partners, as a result of which the DRSTP has been accredited by the Royal Netherlands Academy of Arts and Sciences (KNAW) in June of 1994 and re-accredited in 1999 and 2004. The agreement guarantees means for a six year period in terms of explicit staff commitments as well as graduate student positions. The DRSTP is assisted in
its endeavor by an international advisory committee of distinguished scientists.

Research
Theoretical physics is based on universal principles. New concepts often have a much wider validity than in the field in which they are discovered, and methods developed in one field are sometimes very useful in another. Hence theoretical physics is characterized by unity in diversity.

The research fields of the DRSTP are highly diverse, ranging from the physics at the very smallest length scales to the large scale structure of space and time, and from the study of building blocks of matter to the intricacies of the many-body physics of condensed matter, be it quantum matter, soft matter or bio-matter.

The methods employed in these various fields make up the universal language of theoretical physics: formalisms such as the renormalization group and quantum field theory, and various concepts of statistical, computational and mathematical physics are universally applied and establish cross-talk among the research fields.

The research areas covered by the DRSTP can be grouped into the following broad and overlapping themes:

- Theme 1: Particle physics, cosmology, quantum gravity and string theory
- Theme 2: Quantum matter, quantum information, soft condensed matter and biophysics

The specific content of the research programme depends on the responsible project leaders, on their creativity as well as their initiative to obtain research funding from their home universities, the Dutch research councils of NWO, or from international sources such as European Union programmes.

The research programme is carried out under the responsibility of the governing board and the scientific director in accordance with the agreement. The governing board of the DRSTP safeguards the objectives of the research school. It monitors the overall coherence and quality of the research programme. The board discusses periodically whether the programme remains on the forefront of international developments. The scientific advisory committee plays an essential part in these matters.

The DRSTP is also accountable to the faculties of the participating partners. Therefore it reports regularly on past and planned activities, both in research and graduate education, on the basis of information presented in its yearly reports.

Graduate programme
The partners in the DRSTP offer a joint programme of graduate education leading to a PhD. As part of the research training, under the supervision of a member scientist of the corresponding node, the Research School guarantees a wide range of educational opportunities for its PhD students. They consist of advanced courses, seminars and topical courses in the Netherlands, and international experience in the form of workshops, summer schools or extended research visits abroad.

The governing board of the DRSTP decides on admission and monitors the evaluation of progress with a prognosis of ultimate success after the first year. This takes place on the basis of an “agreement of education and guidance” between each individual
PhD student and its supervisor(s), to be submitted to and approved by the board upon admittance.

A board of education advises the governing board. It also assembles the content of the yearly programme of regular activities. Standard advanced courses are published in a nationwide survey. Special PhD courses are offered within the DRSTP, in quantum field theory, statistical physics and in theoretical condensed matter physics, or result from joint efforts with other research schools.

The input of graduate students in the school takes place in the form of a graduate student council that meets regularly with the director and the chairman of the governing board and board of education (which also has one student member).

Individual members of the DRSTP play a pivotal role in helping to organize many summer schools and workshops, in the Netherlands as well as abroad, and in serving as teachers in all the activities that the DRSTP undertakes by itself or in cooperation with others.

**Other responsibilities**

The responsibilities of the DRSTP include:

- the promotion of a stimulating research environment in theoretical physics
- setting uniform standards of quality
- making educational supplements available tailored to individual research needs.

The board also develops a wide range of activities in order to support an exciting research climate from fund-raising, e.g. for postdoctoral fellows, guest teachers or international mobility of DRSTP students, to the selection of visiting professors, for example on the Kramers (UU), Lorentz (UL) or Van der Waals (UvA) Chairs.
Appendix B  
Selection and supervision procedure of PhD students

Selection and supervision of PhD students
When a PhD research position opens up at one of the participating universities, there is usually an open round of applications. Important criteria in the selection procedure are the potential of the student for doing independent scientific research and the level and skills demonstrated in the master programme. Admission to the DRSTP requires to submit a ‘plan for training and supervision’ [opleidings- en begeleidingsplan], containing a global description of educational activities with details provided for the first year. The plan also specifies how individual guidance will be provided under responsibility of the thesis advisor. The Research School safeguards a consistent implementation of the agreement, with uniform standards. The plan has to be submitted to the DRSTP bureau. Formal admission is subject to approval by the governing board.

After one year the progress is evaluated, based on an interview with the thesis advisor and an independent second referee. The school safeguards this procedure without interfering with the responsibilities of the employer. Participation in the educational programme is an explicit element of the evaluation: students are expected to attend at least two DRSTP postgraduate schools and the DRSTP symposium Trends in Theory. The outcome of the evaluation will reflect on whether the student will be able to complete the research programme within the amount of time allotted. If the prognosis is negative, the student will be asked to leave the DRSTP. Such outcomes should be, and are, extremely rare provided proper care is given to the initial selection.

A student can appeal a negative evaluation with the governing board of the school; a decision will be reached within one month. If the student does leave the school before completing the PhD, a diploma, specifying the student’s accomplishments in the educational programme, will be provided.

After the first year, throughout the duration of the PhD project, the progress will be closely monitored, for example by additional yearly evaluation interviews.
Appendix C
Postgraduate courses (AIO/OIO schools)

Theoretical High Energy Physics

Date:
16 - 27 February 2009

Location:
Hotel Bergse Bossen, Driebergen, the Netherlands

Scientific organizers:
E. Pallante (RUG); J.P. van der Schaar (UvA)

Lecturers:
E. Bergshoeff (RUG): Introduction to supersymmetry
M. Postma (Nikhef): Inflationary cosmology
V. Rychkov (SNS, University of Pisa): Beyond the standard model at the LHC
K. Schalm (UL): Strings and strongly coupled gauge theory

Guest lecturers:
G. ’t Hooft (UU): The CKM matrix: a question of flavor
J.-S. Caux (UvA): Transmutation and fractionalization, or when 1 plus 1 isn’t simply 2

Participants (30):
Andringa, Roel (RUG) Hartgring, Lisa (Nikhef)
Budd, Timothy (UU) Höhn, Philipp (UU)
Butt, Sharaz (NBI, Denmark) Hristov, Kiril (UU)
de Adelhart Toorop, Reinier (Nikhef) Kadosh, Avihay (RUG)
de Baetselier, Iwein (KU Leuven) Katmadas, Stefanos (UU)
de Vries, Jordy (KVI Groningen) Koksma, Jurjen (UU)
den Dunnen, Wilco (VUA) Maio, Michele (Nikhef)
Deuzeman, Albert (RUG) Mantz, Christiaan (VUA)
Dibitetto, Giuseppe (RUG) Niessen, Irene (RU)
Fischer, Oliver (Freiburg) Oberreuter, Johannes (UvA)
Hardeman, Sjoerd (UL) Pulice, Beyhan (Freiburg)
Student presentations:
Roel Andringa (RUG): *Gravity in three dimensions*
Timothy Budd (UU): *Geometric observables in 2+1D gravity*
Reinier de Adelhart Toorop (Nikhef): *Family physics*
Iwein De Baetselier (KU Leuven): *D = 4N = 2 SUGRA and the embedding tensor*
Wilco den Dunnen (VUA): *Vacuum structure of the strong interaction with a Peccei-Quinn symmetry*
Albert Deuzeman (RUG): *Tracking the conformal phase*
Giuseppe Dibitetto (RUG): *De Sitter solutions in IIA string theory compactifications*
Oliver Fischer (Freiburg): *High dimensional Z’ fields*
Sjoerd Hardeman (UL): *Cosmological constraints on the stability of extra dimensions in N = 1 supergravity*
Lisa Hartgring (Nikhef): *Unitarity constraints in off-shell vector boson fusion*
Philipp Höhn (UU): *Measuring anisotropic degrees of freedom in gravity*
Avihay Kadosh (RUG): *A4 flavor model for quarks and leptons in warped geometry*
Stefanos Katmadas (UU): *Almost BPS black holes*
Jurjen Koksma (UU): *Effect of the trace anomaly on the cosmological constant*
Michele Maio (Nikhef): *Towards resolving fixed points in CFT extensions*
Christiaan Mantz (VUA): *Holomorphic gravity*
Irene Niessen (RU): *Supersymmetric phenomenology in the mSUGRA parameter space*
Johannes Oberreuter (UvA): *Resolution of cosmic singularities via string theory*
Beyhan Pulice (Freiburg): *Källén-Lehmann spectral densities in phenomenology*
Siebren Reker (RUG): *Lattice QCD (introduction)*
Ted van der Aalst (UL): *Time dependent string backgrounds & tachyon condensation*
Statistical Physics and Theory of Condensed Matter

Date:
23 March - 3 April 2009

Location:
Hotel Bergse Bossen, Driebergen, the Netherlands

Scientific organizers:
J.-S. Caux (UvA); C. Storm (TU/e)

Lecturers:
G. Barkema (UU/UL): Computational physics hands-on
J.-S. Caux (UvA): Refresher course: Quantum many-body theory
R. Duine (UU): Theory of spin transfer
B. Nienhuis (UvA): Refresher course: Statistical physics
K. Schoutens (UvA): Quantum phases for rotating bosons
J. Snoeijer (Twente): Statics and dynamics of dense granular matter

Guest lecturers:
D. DiVincenzo (IBM Watson Research Center, NY): Pioneers of quantum computing
E. Laenen (Nikhef/UvA/UU): Theory@LHC
B. Meijer (TU/e): Why we cannot make life

Participants (20):
Amuasi, Henry (TU/e) Artyukhin, Sergey (RUG) Beugeling, Wouter (UU) Boon, Niels (UU) Cottaar, Jeroen (TU/e) Diederix, Jeroen (UU) Marc Emanuel (UL) Habraken, Steven (UL) Kersten, Sander (TU/e) Klauser, Antoine (UL) Lucassen, Mathies (UU) Mink, Martijn (UU) Mossel, Jorn (UvA) Muntean, Andrea (TU/e) Romers, Jesper (UvA) Sharma, Abhinav (TU/e) Swaving, Aron (UU) van Driel, Hedwig (UU) van Heugten, Jasper (UU) Wolthuis, Erik (UL)
Student presentations:
Henry Amuasi (TU/e): Multiscale structure and mechanics of collagen-based materials
Sergey Artyukhin (RUG): Ferromagnetic insulator state in FeTi03
Wouter Beugeling (UU): Chern-Simons theory of multi-component quantum Hall systems
Niels Boon (UU): Charge renormalization for inhomogeneously charged colloids
Jeroen Cottaar (TU/e): Describing laminar mixing in two-dimensional flows
Marc Emanuel (UL): Large scale organization of chromatin as a polymer model
Steven Habraken (UL): Twisted and rotating light
Antoine Klauser (UL): Thermodynamics of 1D2 component Bose gas: a statistical effect
Ties Lucassen (UU): Models for driven domain walls
Martijn Mink (UU): Exciton condensation in graphene bilayers
Jorn Mossel (UvA): Integrability: the Heisenberg spin chain
Andrea Muntean (TU/e): Molecular dynamics simulation of polymer surfaces for biosensors applications
Hedwig van Driel (UU): Models for driven domain walls
Jasper van Heugten (UU): Color superconductivity in low temperature quark-gluon plasmas
Erik Woldhuis (UL): Foam rheology near the jamming transition
Appendix D
Symposium Trends in Theory 2009

Date:
14 and 15 May 2009

Location:
Mooirivier Congreshotel, Dalfsen, the Netherlands

Lecturers:
Thursday, 14 May
R. Duine (UU): Gauge fields in spintronics
F. MacKintosh (VUA): Non-equilibrium behavior of active gels and living cells
D. Roest (RUG): Cosmic acceleration in string theory
B. Schellekens (Nikhef/RU): The standard model, string theory and the anthropic principle

An evening lecture was given (14 May) by the performers of Theater Adhoc.

Friday, 15 May
G. Barkema (UU/UL): Memories of string-like objects
D. Bouwmeester (UL): Macroscopic quantum superpositions and knots of light
Y. Levin (UL): Stellar and gas dynamics near supermassive black holes
D. Lohse (UT): Turbulent thermal convection: a unifying view
M. Taylor (UvA): Holography and its applications
B. Terhal (IBM Watson Research Center, NY/UvA): How to make a stable quantum memory
Participants (136):

P. Adamopoulou BSc (UvA)  L. Hartgring MSc (Nikhef)
M. Agathos BSc (UU)  dr. S. Henkes (UL)
drs. L. Ament (UL)  dr. M. Herquet (Nikhef)
R. Andringa MSc (RUG)  P. Höhn MSc (UU)
drs. S. Artyukhin (RUG)  drs. J. Hoogeveen (UvA)
dr. G. Arutyunov (UU)  K. Hristov MSc (UU)
drs. A. Nata Atmajja (UL)  drs. L. Huijse (UvA)
J. Baarsma BSc (UU)  drs. L. Huisman (UL)
prof. dr. S. Bais (UvA)  S. Jordan MSc (UU)
prof. dr. G. Barkema (UU/UL)  drs. A. Kadosh (RUG)
dr. F. Bazzocchi (VUA)  S. Katmadas MSc (UU)
drs. A. Beekman (UL)  drs. A. Klauser (UL)
dr. W. Beenakker (RU)  prof. dr. R. Kleiss (RU)
prof. dr. E. Bergshoeff (RUG)  R. Knegjens BSc (Nikhef)
dr. P. Bobbert (TU/e)  M. Koch-Janusz BSc (Nikhef)
dr. D. Boer (VUA)  drs. A. Koetsier (UU)
dr. P. Bongaarts (UL)  J. Koksmann MSc (UU)
drs. J. Boomsma (VUA)  D. Korres BSc (UvA)
N. Boon MSc (UU)  drs. J. Kuipers (UU)
prof. dr. D. Bouwmeester (UL)  prof. dr. E. Laenen (Nikhef/UvA/UL)
drs. C. Broedersz (VUA)  prof. dr. A. Lande (RUG)
T. Budd MSc (UU)  G. Lanzani MSc (UL)
drs. M. Čubrovič (UL)  dr. Y. Levin (UL)
A. Daniel BSc (UL)  drs. L.-K. Lim (UU)
drs. R. de Adelhart Toorop (Nikhef)  I. Lodato BSc (UU)
drs. M. de Leeuw (UU)  prof. dr. D. Lohe (UT)
prof. dr. M. de Roo (RUG)  prof. dr. R. Loll (UU)
J. de Vries MSc (RUG)  drs. H. Looyestijn (UU)
prof. dr. B. de Wit (UU)  M. Lucassen MSc (UU)
drs. W. den Dunnen (VUA)  drs. P. Machado (UU)
dr. P. Dentener (UL)  prof. dr. F. MacKintosh (VUA)
dr. M. Depken (VUA)  drs. M. Maio (Nikhef)
drs. A. Deuzeman (RUG)  drs. D. Makogon (UU)
drs. G. Dibitetto (RUG)  I. Malamos MSc (RU)
J. Diederix MSc (UU)  drs. C. Mantz (VUA)
dr. R. Duine (UU)  drs. A. Mesaroš (UL)
drs. E. Eggen (UU)  drs. I. Messamah (UvA)
drs. M. Emmanuel (UL)  M. Mink MSc (UU)
T. Fokkema BSc (UU)  A.J. Mizher MSc (VUA)
dr. F. Gmeiner (Nikhef)  S. Mooij MSc (Nikhef)
F. Godschalk BSc (UL)  prof. dr. C. Morais Smith (UU)
drs. K. Gubbels (UU)  prof. dr. P. Mulders (VUA)
S. Haaker BSc (UvA)  prof. dr. B. Nienhuis (UvA)
drs. S. Habraken (UL)  I. Niessen MSc (RU)
drs. S. Hardeman (UL)  J. Noordmans BSc (RUG)
Appendix D

T. Nutma MSc (RUG) prof. dr. R. Timmermans (RUG)
drs. J. Oberreuter (UvA) prof. dr. P. van Baal (UL)
dr. B. Overbosch (UL) drs. M. van de Meent (UU)
prof. dr. E. Pallante (RUG) G. van den Oord MSc (Nikhef/RU)
dr. M. Postma (Nikhef) T. van der Aalst MSc (UL)
dr. T. Prokopec (UU) H. van Driel MSc (UU)
L. Rademaker MSc (UL) J. van Heugten MSc (UU)
drs. S. Reker (RUG) prof. dr. J.-W. van Holten (Nikhef/VUA)
P. Reska MSc (UU) ir. B. van Rees (UvA)
dr. D. Roest (RUG) dr. R. van Roij (UU)
J. Romers MSc (UvA) S. van Tongeren BSc (UU)

drs. A. Scaramucci (RUG) M. van Zalk MSc (UU)
prof. dr. B. Schellekens (Nikhef/RU) dr. S. Vandoren (UU)
prof. dr. K. Schoutens (UvA) J. Venderbos BSc (UL)

dr. K. Shigechi (UvA) drs. L. Wansbeek (RUG)
J. Smolic MSc (UvA) C. Wever MSc (UU)
M. Smolic MSc (UvA) E. Woldhuis MSc (UL)
drs. G. Stavenga (UU) drs. T. Wyder (KU Leuven)
prof. dr. H. Stoof (UU) O. Yudilevich BSc (Nikhef)
drs. A. Swaving (UU) prof. dr. J. Zaanen (UL)
prof. dr. G. ’t Hooft (UU) drs. Z. Žeravčić (UL)

dr. M. Taylor (UvA) O. Zozulya MSc (UvA)
dr. B. Terhal (IBM, WRC/UvA) drs. J. Zwanikken (UU)

Poster presentations PhD students (72):

Michael Agathos (UU): Gravity from the ground down

Luuk Ament (UL): Theory of probing orbitons in YTiO₃ with resonant inelastic x-ray scattering

Sergey Artyukhin (RUG): Ferromagnetic insulator state in Fe-doped FeTiO₃

Ardian Nata Atmaja (UL) Anisotropic drag force from Kerr-AdS black holes

Aron Beekman (UL): Supersymmetry as a loophole for the MerminWagner theorem

Jorn Boomsma (VUA): Phases of quark matter with induced CP violation

Niels Boon (UU): Inhomogeneously charged colloids

Chase Broedersz (VUA): Viscoelasticity of transiently cross-linked cytoskeletal networks

Timothy Budd (UU): Gravity and scale-dependent geometry

Mihailo Ćubrović (UL): Fermionic quantum phase transitions and the emergence of Fermi liquid from AdS/CFT correspondence

Reinier de Adelhart Toorop (Nikhef): Family physics

Marius de Leeuw (UU): Bethe Ansatz in AdS/CFT

Jordy de Vries (RUG): CP-violation and the electric dipole moment

Wilco den Dunnen (VUA): Vacuum structure of the strong interaction with a Peccei-Quinn symmetry

Albert Deuzeman (RUG): Conformal physics in SU(3) gauge theories
Jeroen Diederix (UU): Confinement-induced Sarma phase in resonantly interacting Fermi mixtures
Eelco Eggen (UU): Inhomogeneously charged colloids
Thessa Fokkema (UU): How Feynman’s ghost propagated through history
Koos Gubbels (UU): Renormalization group theory for the imbalanced Fermi gas
Shanna Haaker (UvA): Edges and domain walls in topologically ordered phases
Steven Habraken (UL): Twisted and rotating light
Sjoerd Hardeman (UL): Consistent decoupling of moduli in N = 1 supergravity
Lisa Hartgring (Nikhef): Single top quark production
Philipp Hohm (UU): Aspects of (broken) gauge symmetries in Regge calculus
Joost Hoogeveen (UvA): (Non) decoupling of unphysical states in the minimal pure spinor formalism
Kirill Hristov (UU): Axion stabilization in type IIB flux compactifications
Liza Huijse (UvA): Superfrustration, tilings and quantum criticality
Liesbeth Huisman (UL): Modeling composite biopolymer networks
Samo Jordan (UU): Quantum gravity on the lattice
Avihay Kadosh (RUG): An A4 model in warped geometry
Stefanos Katmadas (UU): BPS attractors and the 4D/5D connection
Antoine Klauser (UL): Thermodynamics of 1D2 component Bose gas: a statistical effect
Jurjen Koksma (UU): Decoherence in quantum field theory
Jan Kuipers (UU): Non-Markovian dynamics of clusters during nucleation
Lih-King Lim (UU): Strongly interacting two-dimensional Dirac fermions in a cold atomic system
Ivano Lodato (UU): How Feynman’s ghost propagated through history
Hugo Looyestijn (UU): Moduli stabilization in supergravity
Mathies Lucassen (UU): Depinning a domain wall with current-induced fluctuations
Pedro Machado (UU): On the asymptotic safety of gravity
Michele Maio (Nikhef): Fixed-point resolution in permutation orbifolds
Dmytro Makogon (UU): Coupled quantum wires: explaining the observed localized states at the crossing
Ioannis Malamos (RU): Feynman rules for the rational part of the full standard model 1-loop amplitudes
Christiaan Mantz (VUA): Color flow in hard hadronic processes
Andrej Mesaros (UL): Dislocations in graphene
Martijn Mink (UU): Exciton condensation in graphene bilayers
Ana Julia Mizher (VUA): CP violation in the QCD chiral transition
Sander Mooij (Nikhef): Inflation
Irene Niessen (RU): Supersymmetric phenomenology in the mSUGRA parameter space
Jacob Noordmans (RUG): The AdS/CFT correspondence - semiclassical string states and gauge theory operators
Teake Nutma (RUG): The infinite symmetries of supergravity
Johannes Oberreuter (UvA): Resolution of cosmic singularities via string theory
Siebren Reker (RUG): Predictions from 2 + 1 + 1 flavour twisted mass lattice QCD
Paul Reska (UU): A point mass in Euclidean de Sitter space
Jesper Romers (UvA): Topological phase transitions on the lattice
Andrea Scaramucci (RUG): *Multiferroic and magnetoelectric behavior of conical spirals*

Jelena Smolic (UvA): *Nonequilibrium field theory and holography*

Milena Smolic (UvA): *Giant gravitons - with strings attached*

Aaron Swaving (UU): *Current-induced torques in antiferromagnets*

Maarten van de Meent (UU): *Collisions in straight string gravity*

Gijs van den Oord (Nikhef/RU): *Calculating matrix elements recursively with Camorra*

Ted van der Aalst (UL): *A geometric interpretation of the c-map*

Hedwig van Driel (UU): *Current-driven domain wall motion at nonzero temperature*

Jasper van Heugten (UU): *Color superconductivity in neutron stars*

Balt van Rees (UvA): *Real-time gauge/gravity duality*

Stijn van Tongeren (UU): *Integrable superstrings in AdS$_4$ x CP$^3$ geometry*

Maaike van Zalk (UU): *Stable de Sitter vacua in supergravity*

Chris Wever (UU): *Effective multicomponent field theory for QCD*

Erik Woldhuis (UL): *Bubble dynamics near the jamming transition*

Thomas Wyder (KU Leuven): *Split attractor flow trees and black hole entropy in string theory*

Zorana Žeravčić (UL): *Excitations of ellipsoid packings near jamming*

Oleksandr Zozulya (UvA): *Entanglement signatures of quantum Hall phase transitions*

Joost Zwanikken (UU): *Spontaneous emulsification of oil in water*

**Poster prize 2009**

Irene Niessen (RU) won this year’s poster prize with a poster entitled: *Supersymmetric phenomenology in the mSUGRA parameter space*. The jury members G. ’t Hooft (UU, chairman), M. Taylor (UvA) and P. Denteneer (UL) were given the difficult task of having to choose from 68 different posters. Jury’s comments: “The importance of this research subject at the interface of experiment and theory was evident from the way that simple as well as technically complicated issues were displayed. LHC experiments are a hot issue, and being able to point out where existing procedures can be further improved in such a clear way requires first class.”
Introduction

Supersymmetry is a theory that assumes a symmetry between fermions and bosons. Supersymmetric particles must have a higher mass than their Standard Model partners; supersymmetry is broken.

Minimal Supergravity (mSUGRA): supersymmetry is broken by gravity.

The Large Hadron Collider (LHC) will look for signs of supersymmetry.

Task: find a systematic method to predict what we will see at the LHC (phenomenology).

Approach

The phenomenology at the LHC is determined by:
- The total production cross section for supersymmetric particles
- The particles produced in the primary interaction
- Possible particle decays

Decays have to conserve energy!

Results

Phenomenological regions based on possible (kinematically allowed) decays of supersymmetric particles:
- Dark blue: only three-body decays possible.
- Light blue: \( \tilde{q} \tilde{q} \rightarrow Z\tilde{W} \) is the dominant decay.
- Light green: we also have the decay to the light stau, so more staus are produced.
- Yellow and light-green: decays to sneutrinos are possible, so we expect more sneutrinos.
- Red: all decays are kinematically allowed, so we expect to see more heavy sleptons.

Production of particles along the black line through the phenomenological regions coincides with the expectations.

Conclusion

The standard analysis of the ATLAS experiment at the LHC does not include all phenomenological regions. It would be useful to run full detector simulations of these different phenomenologies.

Special thanks to my supervisors Wim Beenakker and Nicolo de Groot.
Appendix E
PhD Day

Date:
9 October 2009

Location:
Blauwe Zaal, Marinus Ruppert Building, Utrecht University, the Netherlands

Organizers:
PhD student council

Lecturers:
R. Andringa (RUG): *Supersymmetry and supergravity*
K. Gubbels (UU): *Quantum matter*
L. Hartgring (Nikhef): *LHC phenomenology*
J. van der Horst (Shell): *From high energy physics to petrophysics, how can a physicist help searching for and extracting oil and gas?*
B. van Rees (UvA): *Gauge/gravity duality*
E. Woldhuis (UL): *Granular matter*

An experiment was presented by Tom Hijmans (UvA).

Participants (110):
Abel, Daniel (UL) Boon, Niels (UU)
Akhukov, Mikhail (RU) Boot, Tom (RUG)
Ament, Luuk (UL) Borghese, Andrea (RUG)
Andringa, Roel (RUG) Bosman, Sal (UvA)
Arredondo Ruiz, Manuel Jesus (UvA) Brill, Jelle (UL)
Atmaja, Ardian (UL) Budd, Timothy (UU)
Baarsma, Jildou (UU) Bzowski, Adam (UvA)
Beekman, Aron (UL) Catana, Catalin (UU/Nikhef)
Beenakker, Wim (RU) de Adelhart Toorop, Reinier (Nikhef)
Belli, Simone (UU) de Leeuw, Marius (UU)
Besjes, Geert-Jan (RU) de Vries, Jordy (RUG)
Beugeling, Wouter (UU) de Wit, Bernard (UU)
Boomsma, Jorn (VUA) de With, Meike (UvA/Nikhef)
den Dunnen, Wilco (VUA) Piebinga, Stefanie (UU)
Dibitetto, Giuseppe (RUG) Plauschinn, Erik (UU)
Diederix, Jeroen (UU) Rademaker, Louk (UL)
Eggen, Elco (UU) Reijnders, Koen (RU)
Eliens, Sebas (UvA) Reska, Paul (UU)
Fokkema, Thessa (UU) Romers, Jesper (UvA)
Franzen, Anne (UU) Santanu, Roy (RUG)
Groenewegen, Leon (RU) Schooneveldt, Gerben (UvA)
Gubbels, Koos (UU) She, Jian-Huang (UL)
Haaker, Shanna (UvA) Shi, Bo (UvA)
Hardeman, Sjoerd (UL) Smolic, Jelena (UvA)
Hartgring, Lisa (Nikhef) Smolic, Milena (UvA)
Herquet, Michel (Nikhef) Tielemans, Olivier (UU)
Hofman, Peter (UvA) van de Meent, Maarten (UU)
Hoogeveen, Joost (UvA) van den Aarssen, Laura (UL)
Hoogeveen, Marianne (UvA) van den Broek, Thjis (RU)
Hristov, Kiril (UU) van den Dungen, Koen (RU)
Huijse, Liza (UvA) van den Oord, Gijs (Nikhef/RU)
Jordan, Samo (UU) van der Aalst, Ted (UL)
Katmadas, Stefanos (UU) van der Bijl, Erik (UU)
Klauser, Antoine (UL) van der Horst, Juun (Shell)
Koksma, Jurjen (UU) van der Schee, Wilke (UU)
Koning, Vinzenz (UL) van der Vegte, Michiel (RUG)
Koster, Rik (VUA) van der Wel, Ruben (UU)
Lenz, Lucia (UL) van Driel, Hedwig (UU)
Lodato, Ivano (UU) van Gelderen, Ralph (UU)
Looyestijn, Hugo (UU) van Gerven Oei, Willem-Victor (UvA)
Lucassen, Mathies (UU) van Heugten, Jasper (UU)
Maio, Michele (Nikhef) van Ostaay, Jan (UL)
Makogon, Dmytro (UU) van Rees, Balt (UvA)
Malamos, Ioannis (RU) van Tongeren, Stijn (UU)
Mantz, Christiaan (VUA) van Zalk, Maaike (UU)
Mink, Martijn (UU) Verouden, Bart (Nikhef)
Mizher, Ana Julia (VUA) Wansbeek, Lotje (RUG)
Mooij, Sander (Nikhef) Weymiens, Wolf (UvA)
Mossel, Jorn (UvA) Wever, Chris (UU)
Netjes, Mark (RU) Woldhuis, Erik (UL)
Niessen, Irene (RU) Yang, Lu (UU)
Noordmans, Jacob (RUG) Yin, Yihao (RUG)
Nutma, Teake (RUG) Zhao, Arthur (UvA)
Oberreuter, Johannes (UvA) Zheng, Stephan (UU)
Panfil, Milosz (UvA) Zhou, Daren (RUG)
Poster PhD Day 2009
Appendix F
National seminars

Condensed Matter Physics

- Date: 17 April 2009
- Location: Senaatskamer Academiegebouw, Broerstraat 5, Groningen, the Netherlands
- Scientific organizer: M. Mostovoy (RUG)
- Program:
  B. Büchner (IFW Dresden): *The iron age of high-temperature superconductors*
  M. Katsnelson (RU): *Graphene: a new bridge between condensed matter and QED*
  B. van Wees (Zernike Institute, Groningen): *Two-dimensional electronics and spintronics in graphene*
  M. Zhitomirsky (CEA Grenoble): *Multipole phases in geometrically frustrated magnets*

Theoretical High Energy Physics

- Date: 27 March 2009
- Location: Nikhef-WCW, Turingzaal, Amsterdam, the Netherlands
- Scientific organizers: A. Achúcarro (UL); D. Boer (VUA); J. de Boer (UvA)
- Program:
  M. Postma (Nikhef): *Inflation on a torus*
  F. Sannino (University of Southern Denmark, Odense): *Conformal dynamics for electroweak symmetry breaking*
  K. Skenderis (UvA): *Holographic dualities and applications*
  D. Zeppenfeld (University of Karlsruhe): *Higgs physics and gauge boson fusion*
at the LHC

- **Date:**
  20 November 2009

- **Location:**
  Nikhef-WCW, Room Z009, Amsterdam, the Netherlands

- **Scientific organisers:**
  A. Achúcarro (UL); D. Boer (VUA); J. de Boer (UvA)

- **Program:**
  A. Buras (Technical University Munich): *FCNC processes waiting for the next decade*
  R. Emparan (University of Barcelona): *Blackfolds: fluid dynamics for higher-dimensional black holes*
  D. Roest (RUG): *De Sitter vacua in string theory and supergravity*
  J.-W. van Holten (Nikhef): *Conformal symmetry in non-relativistic field theories*
Appendix G
Shell stipends theoretical physics

Date:
28 September 2009

Location:
Rijswijk, the Netherlands

In 2008 Shell, together with the Dutch Research School of Theoretical Physics (DRSTP), launched a new stipend scheme to support young talented theoretical physicists in the Netherlands. The scheme was laid out for a period of three years and incorporates about ten stipends per year which are granted to the best master students in theoretical physics in the Netherlands.

Shell used to hire in the range of five to ten physicists in the Netherlands per year and is concerned about the decline in number of students in basic and applied science in the Netherlands and Europe over the last few years. With these stipends Shell wishes to emphasize the importance of science education in the Netherlands and in particular the role played by the Dutch Research School of Theoretical Physics.

On Monday, 28 September 2009 ten master students in theoretical physics were awarded a stipend from Shell. In the award ceremony held at Shell EPiCentre in Rijswijk, the Netherlands, dr. Dirk Smit, Shell R&D Manager for Exploration & Novel Technology, handed over cheques of Euro 2,000 to the master students who had obtained their MSc degree at one of the universities involved in the DRSTP.
The following students received a stipend:
Sjoerd de Haan (RUG)
Wilco den Dunnen (VUA)
Marcin Dukalski (UU)
Shanna Haaker (UvA)
Irene Niessen (RU)
Jorrit Rijnbeek (UL)
Olaf Smits (UvA)
Stijn van Tongeren (UU)
Jörn Venderbos (UL)
Chris Wever (UU)
Appendix G
Statistics

On 31 December 2009 ninety-one (91) PhD students were affiliated to the DRSTP. In 2009 twenty-four (24) PhD students joined the DRSTP.

Fifteen (15) PhD degrees were granted in 2009. The average duration of their PhD research (from start of contract to PhD exam date) was 51.2 months (50.0 in 2008).

Statistics 2004-2009
PhDs (AIO/OIO) granted
1 January 2004 - 31 December 2009

<table>
<thead>
<tr>
<th>Theme</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
<td>2006</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
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<tr>
<td>Theme 1</td>
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<td>9</td>
<td>7</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>48</td>
</tr>
<tr>
<td>Theme 2</td>
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<td>10</td>
<td>12</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>19</td>
<td>19</td>
<td>12</td>
<td>15</td>
<td>15</td>
<td>93</td>
</tr>
</tbody>
</table>
PhD efficiency

In the period 1 January 2004 - 31 December 2009, 93 PhD degrees were granted. Of these students 75% finished their PhD research within four years and six months. The full distribution is as follows:

- within 4 years: 26 (28%)
- within 4 years and 6 months: 44 (47%)
- within 5 years: 17 (18%)
- more than 5 years: 6 (6%)

The fraction of PhD degrees granted to women in the period 1 January 2004 - 31 December 2009 is 8%.

To monitor the PhD efficiency at a slightly longer time scale, we also present some data for the period 1 January 2001 - 31 December 2009. In this period 171 PhD students started their research work. At the end of this period (31 December 2009) 76 of them graduated and 3 prematurely discontinued their contract, and one unfortunately died. Of the remaining 91, 86 started their PhD research after 1 January 2006.
Employment following the PhD (2004-2009)

<table>
<thead>
<tr>
<th>Postdoctoral positions in theoretical physics:</th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>the Netherlands</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>EU</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Abroad elsewhere</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>subtotal</td>
<td>54</td>
<td>55%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positions in academia and in public (research) institutions not related to theoretical physics:</th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research scientist education foundation abroad</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PhD position mathematics (abroad)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>EURANDOM, Eindhoven</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ESN, Petten</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Nikhef</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Dutch Cancer Inst.</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Leiden Univ. Medical Center</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Utrecht Univ. Medical Center</td>
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<tr>
<td>subtotal</td>
<td>9</td>
<td>10%</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Positions in the government and in government related organizations:</th>
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<th>%</th>
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<tbody>
<tr>
<td>Ministry of Justice</td>
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</tr>
<tr>
<td>subtotal</td>
<td>1</td>
<td>1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Positions in commercial companies:</th>
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<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philips research</td>
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<td></td>
</tr>
<tr>
<td>Shell</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Corus</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>NXP semiconductors</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ASML</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Utility company</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Mesodyn</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Computational Tribology</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Banking</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Actuary assistant</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>(Pension) insurance</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Various software companies</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Consultancy (Ernst&amp;Young/McKinsey etc.)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>subtotal</td>
<td>25</td>
<td>27%</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Teaching positions:</th>
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<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school teacher</td>
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<tr>
<td>subtotal</td>
<td>3</td>
<td>3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other:</th>
<th>number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
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<td></td>
</tr>
<tr>
<td>subtotal</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

Total                                                                                       | 93     |    |