



UNIVERSITY OF AMSTERDAM

The background of the cover is a complex, abstract pattern. It consists of a dense field of small, dark blue and black dots, with larger, light blue and green circular shapes interspersed. Overlaid on this pattern are numerous small, yellow and green triangular shapes pointing upwards. The overall effect is a textured, almost crystalline appearance.

Institute for
Theoretical Physics
Amsterdam
Annual Report 2008

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1. Scientific Mission

The mission of the Institute of Theoretical Physics of the University of Amsterdam is to strengthen and maintain research and teaching in theoretical physics. It also aims to disseminate knowledge and enthusiasm for physics in society not only to attract students to physics, but also to communicate the importance of physics to the wider society.

While theoretical physics is strongly linked to experimental physics, its status as a separate discipline is well justified. New developments in physics come from new theoretical insights as well as from new experiments. As a result there are cases in which new observations from experiments challenge theorists to explain them, but it is just as likely that the new phenomena predicted by theory challenge experimentalists to design experiments to verify them. We stimulate collaboration with experimental groups to promote this kind of exchange.

The theoretical descriptions of phenomena in widely varying areas in physics often make use of the same techniques. As a result there is intensive cross fertilization between different branches of theoretical physics. For this reason we maintain the importance of a unified institute of theoretical physics, rather than a thematic division of physics, in which theorists are associated with experimental investigations.

As the analytic methods for problem solving in theoretical physics are applicable in many fields besides physics, the graduates of the Institute of Theoretical Physics find very diverse types of employment. We maintain that this is part of our role in society, besides the education of highly trained researchers for academic and industrial investigations.

Without detracting anything from this role in society, we strongly believe in the importance of fundamental research irrespective of the possibility of immediate applications. The essential technical progress of society requires new insights into the fundamental properties of matter as much as the development of existing theories into new technologies.

2. Annual Survey

In 2008, the Institute for Theoretical Physics Amsterdam (ITFA) has been active and successful in its pursuit of excellence in research and teaching. During the summer no less than four major scientific meetings were hosted. Teaching and outreach activities have been intensified, with increasing student numbers in both the Bachelor Natuur- en Sterrenkunde and in the Master Program Theoretical Physics. An unusually high number of research grants have been acquired by members of the institute and several members have been honored with important distinctions.

2.1 Mid-term review by Scientific Advisory Council

In June 2008 the newly appointed Scientific Advisory Council (SAC) of the institute paid a visit to the institute and conducted what is called a mid-term research evaluation. Professors John Cardy (Oxford), Eduardo Fradkin (Urbana, Illinois), Stephen Shenker (Stanford) visited the institute on June 5 and 6, and took ample time to learn about its activities and to talk to all senior researchers individually. Their conclusions were written in a report which was submitted to prof. Gaemers, dean of the FNWI. To quote from this report:

“The members of the council are unanimously of the opinion that this is a world-class institute, maintaining the strong traditions of Theoretical Physics in the Netherlands. This opinion is based on

- *the outstanding reputation of many of its members*
- *its excellent track record of former post-docs and PhD students*
- *its outstanding record of outreach activities, promoting public awareness of science far beyond the boundaries of the research interests of the institute.”*

2.2 Honors and distinctions

The 2008 FOM Minerva Prize was awarded to Marika Taylor for her article *Fuzzball solutions for black holes and D1-brane-D5-brane Microstates*. The Minerva Prize is awarded to the best scientific publication in physics by a woman during the past two years. The prize was presented on 21st January by dr Tini Colijn-Hooymans, member of the Board at TNO.

In May 2008, Robbert Dijkgraaf became the new president of the Royal Netherlands Academy of Arts and Sciences (KNAW). Erik Verlinde has taken over from him as leader of the research group on String Theory and Quantum Gravity, which is a joint effort of ITFA and the KdV institute for Mathematics. On the occasion of Robbert’s ‘farewell’ from the University of Amsterdam, his book ‘Blikwisselingen’ was presented to the public. In November 2008, Marika Taylor was invited to join the Young Academy (DJA) of the KNAW as one of ten new members.

The UvA thesis prize 2008 was awarded to Daan Meerburg for his Master thesis *Non-Gaussian Seeds of Inflation*, written under supervision of Jan Pieter van der Schaar and Ralph Wijers. The prize was awarded during the UvA Universiteitsdag on June 7. Three Master students, Pawel Caputa, Jorn Mossel and Jesper Romers, received a Shell Stipendium for their performance in the Master Theoretical Physics.

In November 2008 the “Genootschap ter bevordering van de Natuur-, Genees- en Heelkunde” awarded a “Andreas Bonn medaille” to Eddy Ardonne for the research presented in his PhD thesis *A conformal field theory description of fractional quantum Hall states*. Ardonne did his PhD work at the Institute for Theoretical Physics, guided by Kareljan

Schoutens. He obtained his PhD cum laude in April 2002 and is currently an assistant professor at NORDITA in Stockholm.

Finally, Sander Bais has been appointed as ‘external faculty member’ at the Santa Fe Institute. The Santa Fe Institute is a private, not-for-profit, independent research and education center founded in 1984, for multidisciplinary collaborations in the physical, biological, computational and social sciences. Understanding of complex adaptive systems is critical to addressing key environmental, technological, biological, economic, and political challenges.

2.3 Grants and research funding

The vitality of the research directions envisioned by members of the institute has been underlined by a high approval rate of research proposals submitted to NWO and FOM.

During 2008 the following research projects have been granted:

- NWO VENI project ‘The dynamics of ultra-cold atoms’, principal investigator M. Snoek
- NWO VENI project ‘Fingerprinting the cosmic fireball’, principal investigator P. MacFadden
- FOM projectruimte, ‘Topological quantum registers’, principal investigator K. Schoutens
- FOM projectruimte, ‘Cracking the quantum quench’, principal investigator J.S. Caux
- FOM program Sold State Quantum Information Processing, ‘Topological quantum computation in fractional quantum Hall effect devices’, principal investigator K. Schoutens
- FOM projectruimte, ‘A new launch pad for renormalization’, principal investigator J.S. Caux
- FOM projectruimte, ‘Topological computations for supersymmetric theories’, principal investigators J. de Boer and R.H. Dijkgraaf
- NWO VICI project ‘Unraveling the mysteries of black holes’, principal investigator K. Skenderis

Together these projects, which will stretch over the period 2009-2013, represent a financial injection of more than € 3M and they will cover more than 50 person-years of research effort.

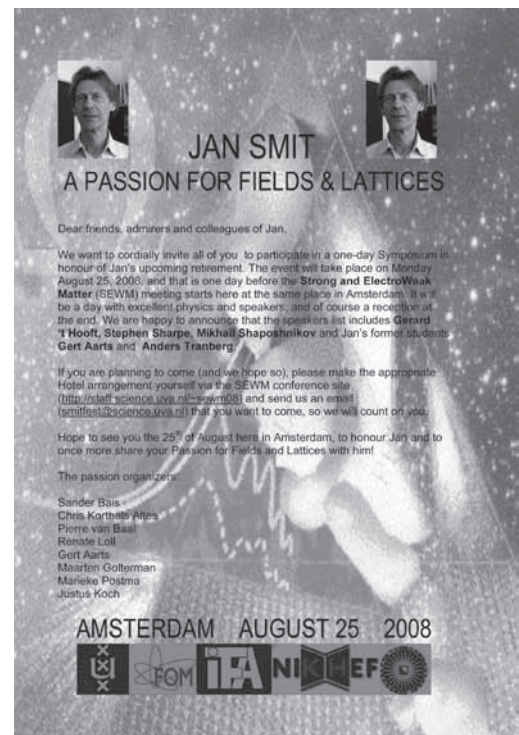
2.4 Workshops and Conferences

The Amsterdam String Theory group organized the research conference Eurostrings 2008, June 30-July 4, as well as the 2008 Amsterdam Summer Workshop on String Theory, July 7-11. This workshop followed in the tradition of yearly Amsterdam Summer Workshops organized by the ITFA, on the subjects of String Theory and Quantum Gravity and Low-D Quantum Condensed Matter.



Poster conference Eurostrings 2008

A second double header was the symposium ‘a Passion for Fields and Lattices’, honoring Jan Smit (August 25), followed by the research conference on Strong and Electroweak Matter (August 26-29). The focus of the latter conference was the Standard Model and beyond at finite temperature and density.



Poster ‘a Passion for Fields and Lattices’

On October 17 the coordinators of the FNWI spearhead ‘Astroparticle Physics’ organized a kick-off symposium ‘Astroparticle Physics - plans for a centre of excellence at the UvA’ in De Rode Hoed.



Poster kick-off symposium Astroparticle Physics

2.5 Teaching

Student numbers in both the Bachelor Natuur- en Sterrenkunde and in the Master Theoretical Physics are steadily on the rise. Judging from the leading position in some of the national rankings, the quality of the educational programs in Physics at the University of Amsterdam can be deemed as excellent. In 2008 members of the ITFA guided a total of 12 Master theses and 13 Bachelor theses. Extending our teaching profile, members of the institute designed and taught a new ‘UvA-breed’ course on *Relativiteit (ruimte en tijd volgens Einstein)*. Sander Bais, Erik Verlinde, and Jan Pieter van der Schaar offered a series of ten evening lectures, explaining special relativity, gravitation and general relativity, and cosmology to a broad audience. The course will be offered again in the fall of 2009. Jean-Sébastien Caux was nominated for best lecturer of the University of Amsterdam for his performance in the course Statistical Physics

and Condensed Matter Theory I in the Master program Theoretical Physics.

2.6 Research output

In 2008, a total of three PhD theses were completed. Members of the institute signed for about 50 research papers, including 1 in Physics Reports, 4 in Physical Review Letters, 17 in the Journal of High Energy Physics and 7 in the Physical Review (A, B, D and E).

This annual report includes a Highlight written by Eric Laenen on theoretical research associated with the upcoming experiments at the LHC at CERN in Geneva.

2.7 Lorentz letters

In *The Scientific Correspondence of H.A. Lorentz, volume 1*, (New York: Springer, 2008), Anne Kox presents a selection of 434 carefully annotated letters from and to the Dutch physicist and Nobel Prize winner Hendrik Antoon Lorentz (1853-1928), covering the period from 1883 until a few months before his death in February 1928. Most of these letters are of a scientific nature, with the exception of letters between Lorentz and Albert Einstein, Max Planck, Woldemar Voigt, and Wilhelm Wien during World War I, since these letters shed important light on the disruption of scientific relations during the war and on the political views of these correspondents as well as of Lorentz. A projected second volume (foreseen for 2011) will focus on Lorentz’s Dutch correspondents and will give unique insights in the dynamics of the Dutch physics community in the decades around 1900.

2.8 People at the institute

The year 2008 marked the retirement from the institute of Jan Smit, Willem van Leeuwen and, at the secretariat, Lotty Gillieron. We have welcomed Bianca de Regt as the new coordinator of the secretariat.

On February 15, 2008 Kareljan Schoutens took over from Bernard Nienhuis as director of the ITFA. Erik Verlinde and Bernard Nienhuis act as senior advisors to the director and as coordinators of the Bachelor Natuur- en Sterrenkunde (Verlinde) and the Master Theoretical Physics (Nienhuis).

3. Research

3.1 Research programs, themes and 2008 topics

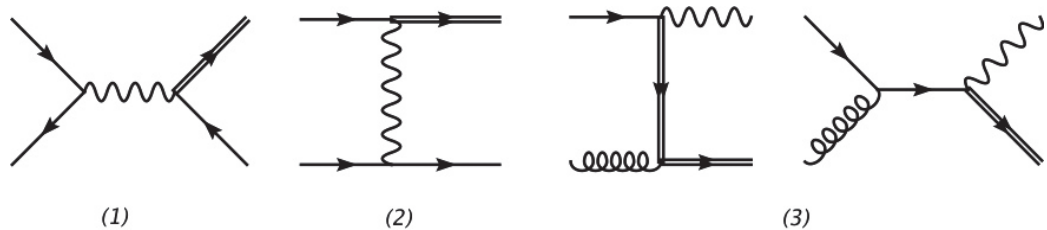
| Programs | Themes | 2008 Topics |
|--|--|--|
| Particle Physics, Cosmology, and Quantum Gravity | String Theory and Quantum Gravity | Quantum black holes Gravity/gauge theory duality Supersymmetric field theories |
| | Particle & Astroparticle Physics and Cosmology | LHC Physics Early universe Cold electroweak baryogenesis |
| Quantum Matter and Complex Systems | Low-D Quantum Condensed Matter and Quantum Information | 1D Bose gas Quantum Hall effects Topological quantum computation Entanglement entropy Quantum measurement Quantum symmetry breaking |
| | Complex/Collective phenomena | Force networks in granular matter Supersymmetric lattice models |
| History of Physics | | Biography H.A. Lorentz Physics in Amsterdam History of early quantum theory |

3.2 Highlight: Top quarks at the LHC [Eric Laenen]

The ephemeral top quark is among the strangest pieces of elementary matter ever made. It is bizarrely heavy, about 20,000 times more massive than its ubiquitous cousin, the up quark which is part of every proton and neutron. The top's heaviness alone has fascinating and potentially far-reaching implications for our understanding of elementary matter and force. Its large mass is thought to be a direct consequence of electroweak

A particularly interesting top production mechanism proceeds through the weak interaction and is called single-top production. In the simplest form, in lowest order perturbation theory, the Feynman diagrams in Fig. 1 describe the process. Although only a lowest order definition, the three channels have sufficiently unique characteristics that this nomenclature is maintained when radiative corrections are included. For each channel, the rate is proportional to the Cabibbo-Kobayashi-Maskawa element V_{tb} . If only the known three fermion families exist, the latter must be 0.9998.

Figure 1
Leading order diagrams for single- t production in the (1) s -channel, (2) t -channel and (3) Wt -channel. The t -quark line is doubled.



symmetry breaking, so its behavior must be especially sensitive to this mechanism's details. It might even be its cause, as in some models beyond the Standard Model top quark couplings drive the symmetry breaking when evolving from high to low energies. Moreover, it is possible that thus far unknown symmetries exist with exotic, heavy particles as harbingers. Being about as heavy, the behavior of a top quark in high-energy collisions might well be measurably influenced by such particles, and thereby reveal their existence. The CDF and D0 experiments at Fermilab's Tevatron have discovered the top quark in 1995, have measured mass with great accuracy, as well as some other of its properties. Pen's Large Hadron Collider is a true top quark factory, and will produce millions of top quarks per year starting in 2009. Precise scrutiny of the top quark's interactions is therefore a key component of the research of the LHC experiments. Such an endeavour rests crucially on being able to distinguish the new from the known, which in turn requires the best possible description of the top quarks Standard Model behavior.

If a heavy fourth family exists, it can be much smaller. A direct measurement of this parameter, which is in fact only possible in single top production, is therefore very interesting. Moreover, the Standard Model weak interaction produces the top quark in a pure spin-state, and the top decays before mixing the other spin-state occurs. It actually imparts its spin information with 100% efficiency to the angular distribution of the final electron or muons in its decay chain. Many new-physics models produce top in a mixture of spin-states, so that also these angular corrections are an interesting discriminant.

To describe single top production most accurately, and flexibly, exact higher order radiative corrections must be included, and the result cast in a parton shower Monte Carlo framework. Until a few years ago, these two requirements were never merged in one description. The most severe among the obstacles were the problems of double counting of emissions between the parton shower and the next-to-leading order corrections, and the presence of negative probabilities due to virtual corrections. Such a combined framework was actually developed not long ago [1]. For the case of top quark pair production, Fig. 2 shows that this approach indeed combines the best of both descriptions.

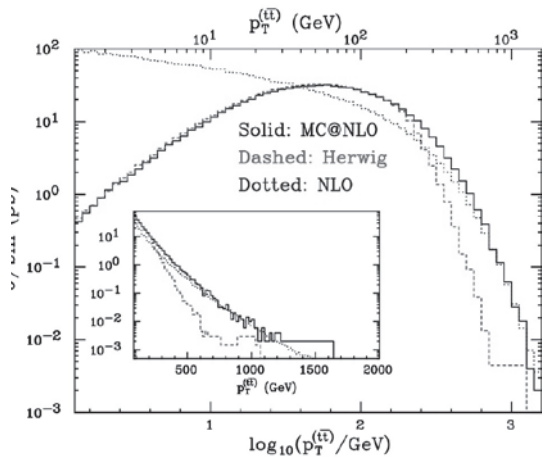


Figure 2

Transverse momentum distribution of top quark pair in combined MC@NLO approach, agreeing with parton shower (HERWIG) approach at small, and with fixed order (NLO) at large p_T .

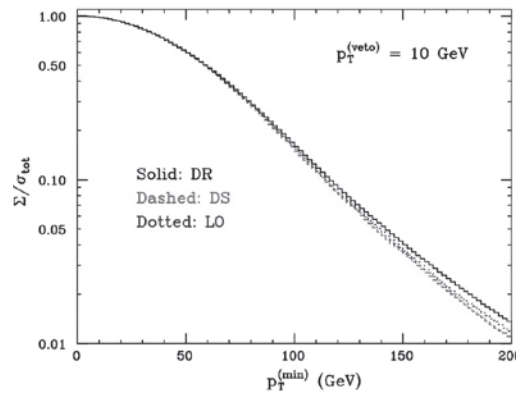


Figure 3

Cross section for Wt production, differential in p_T^H .

In Refs [2,3] we included the single-top process in this framework. For the s and t channel production models this involved extending the framework to allow for final state jets. These two channels are relevant for the Fermilab Tevatron. For the Wt channel, important for the LHC, we faced another fundamental obstruction: the quantum interference with the pair production process. Specifically, among the radiative corrections to the Wt channel is the production of a top pair with subsequent decay of the anti-top to a W^- and a b quark. Because the LHC pair production rate is about 20 times larger than the Wt rate, this is a serious problem indeed. In the literature a number of ad-hoc, theoretically idealistic solutions were proposed, but we had to solve this under the stringent requirements of a parton shower event generator. We solved this in two ways, the difference being in fact precisely the interference terms. In the first (diagram removal (DR)), we simply removed the diagrams from the amplitude. This drastic procedure required us to take a very critical look at gauge invariance. In the second (diagram subtraction (DS)) we constructed a counterterm that subtracts the resonant contributions point by point in the multidimensional phase space, and does not upset the delicate balance of cancelling infrared divergences. A very useful additional requirement we imposed to help separate Wt from pair production is to demand that the *second* most energetic b -quark does not have too high a transverse momentum, since b -quarks from anti-top decay do tend to have such high momentum.

In Fig. 3 I show the result for one particular observable: the combined transverse momentum p_T^H of the two leptons that result from top quark decay and W boson decay in Fig. 3. Clearly both methods agree quite well, with only a noticeable discrepancy at large p_T^H , implying that we have been successfully able to suppress the dangerously large interference terms.

Even though we have thus demonstrated that, like the s and t single-top production channels, the Wt channel can be consistently described using the best tools for radiative corrections, a selection strategy to separate it from the large background is still required. Having developed such an accurate and flexible description, we are in a prime position to define such a strategy. This is the subject of current, promising research.

Referenties

- [1] S. Frixione and B. R. Webber, *JHEP* 0206 (2002) 029 [arXiv:hep-ph/0204244].
- [2] S. Frixione, E. Laenen, P. Motylinski and B. R. Webber, *JHEP* 0603 (2006) 092 [arXiv:hep-ph/0512250].
- [3] S. Frixione, E. Laenen, P. Motylinski, B. R. Webber and C. D. White, *JHEP* 0807 (2008) 029 [arXiv:0805.3067 [hep-ph]].

3.3 Publications

Program 1: Particle Physics, Cosmology, and Quantum Gravity

PhD-theses

- Cheng, C.N., *The Spectra of Supersymmetric States in String Theory*, Thesis advisor: prof.dr. E.P. Verlinde, Universiteit van Amsterdam, 3 July 2008 (254 pages)

In this thesis we study the spectra of supersymmetric states in string theory compactifications with eight and sixteen supercharges, with special focus placed on the quantum states of black holes and the phenomenon of wall-crossing in these theories. A self-contained introduction to the relevant background material is included.

- Manschot, J., *Partition Functions for Supersymmetric Black Holes*, Thesis advisor: prof.dr. E.P. Verlinde, Universiteit van Amsterdam, 18 December 2008 (154 pages)

This thesis presents a number of results on partition functions for four-dimensional supersymmetric black holes. These partition functions are important tools to explain the entropy of black holes from a microscopic point of view. The black holes studied in this thesis are supersymmetric solutions of four-dimensional $N = 2$ supergravity carrying both electric and magnetic charges. If higher derivative contributions are included the entropy receives corrections that suggest that Z_{BH} is well approximated by the square of the topological string partition function $|Z_{top}|^2$. Here the electric charges are in a macrocanonical ensemble and the magnetic charges in a microcanonical ensemble. Another motivation is the correspondence between a theory including gravity in Anti-de Sitter (AdS) space and a conformal field theory (CFT) on the boundary of the AdS-space. Part of the near-horizon geometry of the black holes in eleven dimensions is AdS_3 , whose boundary is a two-dimensional torus. The correspondence suggests that the CFT_2 partition function equals the one of the theory in the bulk of AdS_3 , and therefore admits an expansion natural for an AdS_3 -(super)gravity partition function. Dijkgraaf *et al.* proposed that an SCFT partition function can be rewritten as a

Poincaré series, where each term corresponds to a semi-classical saddle point geometry. Chapter 2 explains these notions rather heuristically. Chapter 3 explains how the black holes arise as solutions of 11-dimensional M-theory reduced on a six-dimensional Calabi-Yau X times a circle S^1_M . The heavy objects, which source the black holes, are M5-branes. Their low energy degrees of freedom can be reduced to the T^2 formed by S^1_M and the Euclidean time circle S^1_t and combine to an $N=(4,0)$ superconformal field theory. The relevant partition function for this SCFT transforms covariantly under modular transformations. Hence it is possible to use the Cardy formula, which leads the correct black hole entropy.

An important property of the partition function is the decomposition into theta functions and a vector-valued modular form. Chapter 4 is devoted to an analysis of these forms. The principal part of the Laurent expansion of the vector-valued modular form defines the “polar spectrum” of the SCFT. In terms of these the non-polar degeneracies can be determined with arbitrary accuracy, improving on the leading order estimate by the Cardy formula.

With the results of Chapter 4, Chapter 5 revisits the motivations of Chapter 2. The regularized Poincaré series confirms the AdS_3/CFT_2 correspondence, since it is suggestive of a semi-classical sum over AdS_3 -geometries. The Poincaré series heuristically describes a sum over all particle states in the black hole background which themselves do not collapse into a black hole.

This is also how the connection between black holes and topological strings can be understood. The degeneracies of charged BPS-particles (M2-branes) in the near-horizon geometry are enumerated by $|Z_{top}|^2$, which appears for every saddle point geometry in Z_{BH} . This elucidates the conjecture for strong coupling.

- Meulen, M.P. van der, *Cold electroweak baryogenesis and quantum cosmological correlations*, Thesis advisor: prof.dr. J. Smit, Universiteit van Amsterdam, 7 May 2008 (171 pages)

This thesis describes two subjects from theoretical cosmology. The first concerns the creation of the matter-anti-matter asymmetry, which is generally assumed to be created in the early universe by a

process called baryogenesis. The details of this process are yet unknown and there exist many models of baryogenesis in the literature. I study a specific model: “Cold Electroweak Baryogenesis”. In particular I study the mechanism of the creation of particles in this model, and I estimate the size of the created asymmetry in this model. The result is that this specific model is unlikely to be able to produce a large enough asymmetry.

The second subject deals with cosmological density fluctuations, which are observed in the Cosmic Microwave Background (CMB) radiation.

According to the widely accepted inflationary paradigm, these density fluctuations are caused by quantum fluctuations during an early period in which the universe has expanded in an accelerated way. This period is called inflation and its underlying physics is still largely unclear. There is a plethora of models for inflation that predict characteristics of the fluctuations (“Quantum Cosmological Correlations”) that are in agreement with the current observations. However it is possible that more precise future observations will enable us to differentiate between different models of inflation. It is therefore important to calculate the characteristics of the fluctuations to high precision. In general these calculations are very complicated, and one often uses the simplifying assumption that the evolution of the fluctuations in a certain regime can be described by classical physics. In this thesis I check this assumption by applying a classical approximation to the calculation in quantum field theory. The result is that this assumption is valid, although it is a little bit less good than was expected.

Publications in refereed journals

- Appollonio, G. D’ & Quella, T., *The diagonal cosets of the Heisenberg group*, JHEP 05 (2008) 60 (42 pages)

In this paper we study the diagonal cosets of the non-compact H_4 WZW model. Generalising earlier work by Antoniadis and Obers, we provide an exact world-sheet description for several families of non-maximally symmetric gravitational plane waves with background NS fluxes. We show that the σ -models that correspond to an asymmetric action of the gauge group smoothly interpolate between singular and non-singular plane waves.

We also analyse the representations of the coset chiral algebra and derive the spectrum of all the models.

- Arsiwalla, X.D., More rings to rule them all: fragmentation, 4D \leftrightarrow 5D and split-spectral flows, JHEP 02 (2008) 066 (32 pages)

In this note we set-up an explicit 5D construction of AdS-fragmentation, whereby a single black ring splits-up into a multi-black ring configuration. Furthermore it is seen that these fragmented rings are equivalent to a direct 5D lift of 4D multi-center black holes. Along the way we also determine the 4D/5D transformations relevant for multi-center charges. It is seen that the physical charges involved in black ring fragmentation are Page charges arising due to 5D Chern-Simons terms. As an application of these methods, we reproduce the total angular momentum of concentric black rings, originally due to Gauntlett and Gutowski. Finally we provide a geometric interpretation of fragmented black rings using the idea of split-spectral flows, which seeks to study charge shifts of a given black ring due to fluxes generated in a multi-ring background.

- Balasubramanian, V., Boer, J. de, Showk, S. el & Messamah, I., *Black Holes as Effective Geometries*, Classical and Quantum Gravity 25 (2008) 214004 (68 pages)

Gravitational entropy arises in string theory via coarse graining over an underlying space of microstates. In cases with enough supersymmetry, it has been possible to explicitly construct such microstates in spacetime and understand how coarse graining of non-singular, horizon-free objects can lead to an effective description as an extremal black hole. We discuss how these results arise in type II string theory on $AdS_3 \times S^5$ and on $AdS_3 \times S^3 \times T^4$ that preserve 16 and eight supercharges, respectively. For such a picture of black holes as effective geometries to extend to cases with a finite horizon area, the scale of quantum effects in gravity would have to extend well beyond the vicinity of the singularities in the effective theory. By studying examples in M-theory on $AdS_3 \times S^2 \times CY$ that preserve four supersymmetries, we show how this can happen.

- Balasubramanian, V., Boer, J. de, Jejjala, V. & Simon, J., *Entropy of near-extremal black holes in AdS₅*, JHEP 05 (2008) 67 (45 pages)

We construct the microstates of near-extremal black holes in $AdS_5 \times S^5$ as gases of defects distributed in heavy BPS operators in the dual $SU(N)$ Yang-Mills theory. These defects describe open strings on spherical D3-branes in the S^5 , and we show that they dominate the entropy by directly enumerating them and comparing the results with a partition sum calculation. We display new decoupling limits in which the field theory of the lightest open strings on the D-branes becomes dual to a near-horizon region of the black hole geometry. In the single-charge black hole we find evidence for an infrared duality between $SU(N)$ Yang-Mills theories that exchanges the rank of the gauge group with an R-charge. In the two-charge case (where pairs of branes intersect on a line), the decoupled geometry includes an AdS_3 factor with a two-dimensional CFT dual. The degeneracy in this CFT accounts for the black hole entropy. In the three-charge case (where triples of branes intersect at a point), the decoupled geometry contains an AdS_2 factor. Below a certain critical mass, the two-charge system displays solutions with naked timelike singularities even though they do not violate a BPS bound. We suggest a string theoretic resolution of these singularities.

- Boer, J. de, *Black hole bound states and their quantization*, International Journal of Modern Physics A 23 (2008) 2211-2219

We briefly review the construction of multi-centered black hole solutions in type IIA string theory. We then discuss a decoupling limit which embeds these solutions in M-theory on $AdS_3 \times S^2 \times CY_3$, and discuss some aspects of their dual CFT interpretation. Finally, we consider the quantization of these solutions and applications to the wall-crossing formula and the “fuzzball” proposal.

- Boer, J. de, Denef, J.F., Showk, S. el, Messamah, I. & Bleeken, D. van den, *Black hole bound states in AdS₃ × S²*, JHEP 11 (2008) 50 (72 pages)

We systematically construct the geometries dual to the 1+1 dimensional (0, 4) conformal field theories that arise in the low-energy description of wrapped M5-branes in $S^1 \times CY_3$ compactifications of M-theory. This includes a large number of multicentered black hole bound states asymptotic to $AdS_3 \times S^2$. In addition, we find many geometries that develop multiple, mutually decoupled $AdS_3 \times S^2$ throats. We argue there is a useful one to one correspondence between the connected components of the space of solutions and particular limits of type IIA attractor flow trees. We point out that there is a thermodynamic instability of small supersymmetric BTZ black holes to localization on the S^2 , a supersymmetric and exactly solvable analog of the well known AdS-Schwarzschild localization instability, and identify this with the “Entropy Enigma” in four dimensions. We discuss the phase transition this suggests, and initiate the CFT interpretation of these results.

- Boer, J. de, Medeiros, P. de, Showk, S. el & Sinkovics, A., *G₂ Hitchin functionals at one loop*, Classical and Quantum Gravity 25 (2008) 075006 (58 pages)

We consider the quantization of the effective target space description of topological M-theory in terms of the Hitchin functional whose critical points describe seven manifolds with a G_2 structure. The one-loop partition function for this theory is calculated and an extended version of it, that is related to the generalized G_2 geometry, is compared with the topological G_2 string. We relate the reduction of the effective action for the extended G_2 theory to the Hitchin functional description of the topological string in six dimensions. The dependence of the partition functions on the choice of background G_2 metric is also determined.

- Boer, J. de, Medeiros, P. de, Showk, S. el & Sinkovics, A., *Open G_2 strings*, JHEP 02 (2008) 12 (55 pages)

We consider an open string version of the topological twist previously proposed for sigma-models with G_2 target spaces. We determine the cohomology of open strings states and relate these to geometric deformations of calibrated submanifolds and to flat or anti-self-dual connections on such submanifolds. On associative three-cycles we show that the worldvolume theory is a gauge-fixed Chern-Simons theory coupled to normal deformations of the cycle. For coassociative four-cycles we find a functional that extremizes on anti-self-dual gauge fields. A brane wrapping the whole G_2 induces a seven-dimensional associative Chern-Simons theory on the manifold. This theory has already been proposed by Donaldson and Thomas as the higher-dimensional generalization of real Chern-Simons theory. When the G_2 manifold has the structure of a Calabi-Yau times a circle, these theories reduce to a combination of the open A-model on special Lagrangians and the open $B + \bar{B}$ -model on holomorphic submanifolds. We also comment on possible applications of our results.

- Boer, J. de, Naqvi, A.A. & Shomer, A., *The Topological G_2 String*, Advances in Theoretical and Mathematical Physics 12 (2008) 243-318

We construct new topological theories related to sigma models whose target space is a seven dimensional manifold of G_2 holonomy. We define a new type of topological twist and identify the BRST operator and the physical states. Unlike the more familiar six dimensional case, our topological model is defined in terms of conformal blocks and not in terms of local operators of the original theory. We also present evidence that one can extend this definition to all genera and construct a seven-dimensional topological string theory. We compute genus zero correlation functions and relate these to Hitchin's functional for three-forms in seven dimensions. Along the way we develop the analogue of special geometry for G_2 manifolds. When the seven dimensional topological twist is applied to the product of a Calabi-Yau manifold and a circle, the result is an interesting combination of the six dimensional A- and B-models.

- Britto, R.A.P., Feng, B. & Mastroia, P., *Closed-Form Decomposition of One-Loop Massive Amplitudes*, Physical Review D 78 (2008) 025031 (24 pages)

We present formulas for the coefficients of 2-, 3-, 4-, and 5-point master integrals for one-loop massive amplitudes. The coefficients are derived from unitarity cuts in D dimensions. The input parameters can be read off from any unitarity-cut integrand, as assembled from tree-level expressions, after simple algebraic manipulations. The formulas presented here are suitable for analytical as well as numerical evaluation. Their validity is confirmed in two known cases of helicity amplitudes contributing to $gg \rightarrow gg$ and $gg \rightarrow gH$, where the masses of the Higgs and the fermion circulating in the loop are kept as free parameters.

- Britto, R.A.P. & Feng, B., *Integral Coefficients for One-Loop Amplitudes*, JHEP 02 (2008) 095 (29 pages)

We present a set of algebraic functions for evaluating the coefficients of the scalar integral basis of a general one-loop amplitude. The functions are derived from unitarity cuts, but the complete cut-integral procedure has been carried out in generality so that it never needs to be repeated. Where the master integrals are known explicitly, the results here can be used as a black box with tree-level amplitudes as input and one-loop amplitudes as output

- Britto, R.A.P., Feng, B. & Yang, G., *Polynomial structures in one-loop amplitudes*, JHEP 09 (2008) 089 (45 pages)

A general one-loop scattering amplitude may be expanded in terms of master integrals. The coefficients of the master integrals can be obtained from tree-level input in a two-step process. First, use known formulas to write the coefficients of $(4-2\epsilon)$ -dimensional master integrals; these formulas depend on an additional variable, u , which encodes the dimensional shift. Second, convert the u -dependent coefficients of $(4-2\epsilon)$ -dimensional master integrals to explicit coefficients of dimensionally shifted master integrals. This procedure requires the initial formulas for coefficients to have polynomial dependence on u .

Here, we give a proof of this property in the case of massless propagators. The proof is constructive. Thus, as a byproduct, we produce different algebraic expressions for the scalar integral coefficients, in which the polynomial property is apparent. In these formulas, the box and pentagon contributions are separated explicitly.

- Cheng, C.N. & Verlinde, E.P., *Wall Crossing, Discrete Attractor Flow, and Borchers Algebra, Symmetry, Integrability and Geometry: Methods and Applications (SIGMA)*, 4, 068 (51 pages)

The appearance of a generalized (or Borchers-) Kac-Moody algebra in the spectrum of BPS dyons in $N=4$, $d=4$ string theory is elucidated. From the low-energy supergravity analysis, we identify its root lattice as the lattice of the T -duality invariants of the dyonic charges, the symmetry group of the root system as the extended S -duality group $PGL(2, Z)$ of the theory, and the walls of Weyl chambers as the walls of marginal stability for the relevant two-centered solutions. This leads to an interpretation for the Weyl group as the group of wall-crossing, or the group of discrete attractor flows. Furthermore we propose an equivalence between a “second-quantized multiplicity” of a charge- and moduli-dependent highest weight vector and the dyon degeneracy, and show that the wall-crossing formula following from our proposal agrees with the wall-crossing formula obtained from the supergravity analysis. This can be thought of as providing a microscopic derivation of the wall-crossing formula of this theory.

- Creutzig, T., Quella, T. & Schomerus, V., *Branes in the $GL(1|1)$ WZNW-Model*, Nuclear Physics B 792 (2008) 257-283

We initiate a systematic study of boundary conditions in conformal field theories with target space supersymmetry. The WZNW model on $GL(1|1)$ is used as a prototypical example for which we find the complete set of maximally symmetric branes. This includes a unique brane of maximal super-dimension $2|2$, a 2-parameter family of branes with super-dimension $0|2$ and an infinite set of fully localized branes possessing a single modulus. Members of the latter family can only exist along certain lines on the bosonic base, much like

fractional branes at orbifold singularities. Our results establish that all essential algebraic features of Cardy-type boundary theories carry over to the non-rational logarithmic WZNW model on $GL(1|1)$.

- Creutzig, T., Quella, T. & Schomerus, V., *New boundary conditions for the $c=-2$ ghost system*, Physical Review D 77 (2008) 026003 (4 pages)

We investigate a novel boundary condition for the bc system with central charge $c=-2$. Its boundary state is constructed and tested in detail. It appears to give rise to the first example of a local logarithmic boundary sector within a bulk theory whose Virasoro zero modes are diagonalizable.

- Dijkgraaf, R.H. & Sulkowski, P., *Instantons on ALE spaces and orbifold partitions*, JHEP 03 (2008) 013

We consider $N = 4$ theories on ALE spaces of A_{k-1} type. As is well known, their partition functions coincide with A_{k-1} affine characters. We show that these partition functions are equal to the generating functions of some peculiar classes of partitions which we introduce under the name ‘orbifold partitions’. These orbifold partitions turn out to be related to the generalized Frobenius partitions introduced by G.E. Andrews some years ago. We relate the orbifold partitions to the blended partitions and interpret explicitly in terms of a free fermion system.

- Dijkgraaf, R.H., Hollands, L., Sulkowski, P. & Vafa, C., *Supersymmetric Gauge Theories, Intersecting Branes and Free Fermions*, JHEP 02 (2008) 106 (67 pages)

We show that various holomorphic quantities in supersymmetric gauge theories can be conveniently computed by configurations of D4-branes and D6-branes. These D-branes intersect along a Riemann surface that is described by a holomorphic curve in a complex surface. The resulting I-brane carries two-dimensional chiral fermions on its world-volume. This system can be mapped directly to the topological string on a large class of non-compact Calabi-Yau manifolds. Inclusion of the string coupling constant corresponds to turning on a constant B -field on the complex surface, which makes this space non-commutative. Including all

string loop corrections the free fermion theory is elegantly formulated in terms of holonomic D -modules that replace the classical holomorphic curve in the quantum case.

- Frixione (et al.), S., Laenen, E.L.M.P., Motylinski, P., Webber, Bryan R. & White, C., *Single-top hadroproduction in association with a W boson*, JHEP 07 (2008) 029 (35 pages)

We present the calculation of the Wt single-top production channel to next-to-leading order in QCD, interfaced with parton showers within the MC@NLO formalism. This channel provides a complementary way of investigating the properties of the Wtb vertex, with respect to the s - and t -channels. We pay special attention to the separation of this process from top quark pair production.

- Hollands, L., Marsano, J., Papadodimas, K. & Shigemori, M., *Nonsupersymmetric flux vacua and perturbed $N = 2$ systems*, JHEP 10 (2008) 102 (70 pages)

We geometrically engineer $N = 2$ theories perturbed by a superpotential by adding 3-form flux with support at infinity to local Calabi-Yau geometries in type IIB. This allows us to apply the formalism of Ooguri, Ookouchi, and Park [arXiv:0704.3613] to demonstrate that, by tuning the flux at infinity, we can stabilize the dynamical complex structure moduli in a metastable, supersymmetry-breaking configuration. Moreover, we argue that this setup can arise naturally as a limit of a larger Calabi-Yau which separates into two weakly interacting regions; the flux in one region leaks into the other, where it appears to be supported at infinity and induces the desired superpotential. In our endeavor to confirm this picture in cases with many 3-cycles, we also compute the CIV-DV prepotential for arbitrary number of cuts up to fifth order in the glueball fields.

- Kanitscheider, I.R.G., Skenderis, K. & Taylor, M., *Precision holography for non-conformal branes*, JHEP 09 (2008) 094 (72 pages)

We set up precision holography for the non-conformal branes preserving 16 supersymmetries. The near-horizon limit of all such p -brane solutions with $p \leq 4$, including the case of fundamental string solutions, is conformal to $AdS_{p+2} \times S^{8-p}$ with a linear dilaton. We develop holographic renormalization for all these cases. In particular, we obtain the most general asymptotic solutions with appropriate Dirichlet boundary conditions, find the corresponding counterterms and compute the holographic 1-point functions, all in complete generality and at the full non-linear level. The result for the stress energy tensor properly defines the notion of mass for backgrounds with such asymptotics. The analysis is done both in the original formulation of the method and also using a radial Hamiltonian analysis. The latter formulation exhibits most clearly the existence of an underlying generalized conformal structure. In the cases of Dp -branes, the corresponding dual boundary theory, the maximally supersymmetric Yang-Mills theory SYM_{p+1} , indeed exhibits the generalized conformal structure found at strong coupling. We compute the holographic 2-point functions of the stress energy tensor and gluon operator and show they satisfy the expected Ward identities and the constraints of generalized conformal structure. The holographic results are also manifestly compatible with the M-theory uplift, with the asymptotic solutions, counterterms, one and two point functions etc. of the IIA F1 and D4 appropriately descending from those of M2 and M5 branes, respectively. We present a few applications including the computation of condensates in Witten's model of holographic YM_4 theory.

- Kashani-Poor, A.K., *Phase space polarization and the topological string: a case study*, Physics Letters A 23 (2008) 3199-3214 (15 pages)

We review and elaborate on our discussion in hep-th/0606112 on the interplay between the target space and the worldsheet description of the open topological string partition function, for the example of the conifold. We discuss the appropriate phase space and canonical form for the system. We find a map between choices of polarization and the

worldsheet description, based on which we study the behavior of the partition function under canonical transformations.

- Kulaxizi, M. & Parnachev, A., *Comments on Fermi Liquid from Holography*, Physical Review D 78 (2008) 086004 (11 pages)

We investigate the signatures of Fermi liquid formation in the $N = 4$ super Yang-Mills theory coupled to fundamental hypermultiplet at nonvanishing chemical potential for the global $U(1)$ vector symmetry. At strong 't Hooft coupling the system can be analyzed in terms of the D7-brane dynamics in the $AdS_3 \times S^5$ background. The phases with vanishing and finite charge density are separated at zero temperature by a quantum phase transition. In the case of vanishing hypermultiplet mass, Karch, Son, and Starinets discovered a gapless excitation whose speed equals the speed of sound. We find that this zero sound mode persists to all values of the hypermultiplet mass, and its speed vanishes at the point of phase transition. The value of critical exponent and the ratio of the velocities of zero and first sounds are consistent with the predictions of Landau Fermi liquid theory at strong coupling.

- Laenen, E.L.M.P., Magnea, L. & Stavenga, G., *On next-to-eikonal corrections to threshold resummation for the Drell-Yan and DIS cross sections*, Physics Letters B 669 (2008) 173-179

We study corrections suppressed by one power of the soft gluon energy to the resummation of threshold logarithms for the Drell-Yan cross section and for Deep Inelastic structure functions. While no general factorization theorem is known for these next-to-eikonal (NE) corrections, it is conjectured that at least a subset will exponentiate, along with the logarithms arising at leading power. Here we develop some general tools to study NE logarithms, and we construct an ansatz for threshold resummation that includes various sources of NE corrections, implementing in this context the improved collinear evolution recently proposed by Dokshitzer, Marchesini and Salam (DMS). We compare our ansatz to existing exact results at two and three loops, finding evidence for the exponentiation of leading NE logarithms and confirming the predictivity of DMS evolution.

- Marsano, J., Papadodimas, K. & Shigemori, M., *Off-shell M5 Brane, Perturbed Seiberg-Witten Theory, and Metastable Vacua*, Nuclear Physics B 804 (2008) 19-69

We demonstrate that, in an appropriate limit, the off-shell M5-brane worldvolume action effectively captures the scalar potential of Seiberg-Witten theory perturbed by a small superpotential and, consequently, any nonsupersymmetric vacua that it describes. This happens in a similar manner to the emergence from M5's of the scalar potential describing certain type IIB flux configurations [arXiv:0705.0983]. We then construct exact nonholomorphic M5 configurations in the special case of $SU(2)$ Seiberg-Witten theory deformed by a degree six superpotential which correspond to the recently discovered metastable vacua of Ooguri, Ookouchi, Park [arXiv:0704.3613], and Pastras [arXiv:0705.0505]. These solutions take the approximate form of a holomorphic Seiberg-Witten geometry with harmonic embedding along a transverse direction and allow us to obtain geometric intuition for local stability of the gauge theory vacua. As usual, dynamical processes in the gauge theory, such as decay of nonsupersymmetric vacua, take on a different character in the M5 description which, due to issues of boundary conditions, typically involves runaway behavior in MQCD.

- Mitev, V., Quella, T. & Schomerus, V., *Principal Chiral Model on Superspheres*, JHEP 11 (2008) 86 (45 pages)

We investigate the spectrum of the principal chiral model (PCM) on odd-dimensional superspheres as a function of the curvature radius R . For volume-filling branes on $S^{3|2}$, we compute the exact boundary spectrum as a function of R . The extension to higher dimensional superspheres is discussed, but not carried out in detail. Our results provide very convincing evidence in favor of the strong-weak coupling duality between supersphere PCMs and $OSP(2S + 2|2S)$ Gross-Neveu models that was recently conjectured by Candu and Saleur.

- Parikh, M.K. & Schaar, J.P. van der, *Not one bit of de Sitter information*, JHEP 09 (2008) 041 (8 pages)

We formulate the information paradox in de Sitter space in terms of the no-cloning principle of quantum mechanics. We show that energy conservation puts an upper bound on the maximum entropy available to any de Sitter observer. Combined with a general result on the average information in a quantum subsystem, this guarantees that an observer in de Sitter space cannot obtain even a single bit of information from the de Sitter horizon, thereby preventing any observable violations of the quantum no-cloning principle. The result supports the notion of observer complementarity.

- Queiroz Faria de Oliveira Baptista, J.M., *Twisting gauged non-linear sigma-models*, JHEP 02 (2008) 96 (33 pages)

We consider gauged sigma-models from a Riemann surface into a Kähler and hamiltonian G -manifold X . The supersymmetric $N = 2$ theory can always be twisted to produce a gauged A-model. This model localizes to the moduli space of solutions of the vortex equations and computes the Hamiltonian Gromov-Witten invariants. When the target is equivariantly Calabi-Yau, i.e. when its first G -equivariant Chern class vanishes, the supersymmetric theory can also be twisted into a gauged B-model. This model localizes to the Kähler quotient $X//G$.

- Skenderis, K. & Rees, B.C. van, *Real-time gauge/gravity duality*, Physical Review Letters 101 (2008) 081601 (83 pages)

We present a general prescription for the holographic computation of real-time n -point functions in nontrivial states. In quantum field theory such real-time computations involve a choice of a time contour in the complex time plane. The holographic prescription amounts to “filling in” this contour with bulk solutions: real segments of the contour are filled in with Lorentzian solutions while imaginary segments are filled in with Riemannian solutions and appropriate matching conditions are imposed at the corners of the contour. We illustrate the general discussion by

computing the 2-point function of a scalar operator using this prescription and by showing that this leads to an unambiguous answer with the correct $i\epsilon$ insertions.

- Quella, T., Schomerus, V. & Creutzig, T., *Boundary spectra in superspace σ -models*, JHEP 10 (2008) 24 (26 pages)

In this note we compute exact boundary spectra for D-instantons in σ -models on the supergroup $PSL(2|2)$. Our results are obtained through an explicit summation of the perturbative expansion for conformal dimensions to all orders in the curvature radius. The analysis exploits several remarkable properties of the perturbation series that arises from rescalings of the metric on $PSL(2|2)$ relative to a fixed Wess-Zumino term. According to Berkovits, Vafa and Witten, the models are relevant in the context of string theory on AdS_3 with non-vanishing RR-flux. The note concludes with a number of comments on various possible generalizations to other supergroups and higher dimensional supercoset theories.

- Skenderis, K. & Taylor, M., *The fuzzball proposal for black holes*, Physics Reports 467 (2008) 117 (107 pages)

The fuzzball proposal states that associated with a black hole of entropy S there are $\exp S$ horizon-free non-singular solutions that asymptotically look like the black hole but generically differ from the black hole up to the horizon scale. These solutions, the fuzzballs, are considered to be the black hole microstates while the original black hole represents the average description of the system. The purpose of this report is to review current evidence for the fuzzball proposal, emphasizing the use of AdS/CFT methods in developing and testing the proposal. In particular, we discuss the status of the proposal for 2 and 3 charge black holes in the D1-D5 system, presenting new derivations and streamlining the discussion of their properties. Results to date support the fuzzball proposal but further progress is likely to require going beyond the supergravity approximation and sharpening the definition of a “stringy fuzzball”. We outline how the fuzzball proposal could resolve longstanding issues in black hole physics, such as Hawking radiation and information loss. Our emphasis

throughout is on connecting different developments and identifying open problems and directions for future research.

- Taylor, M., *Matching of correlators in AdS_3/CFT_2* , JHEP 06 (2008) 10 (29 pages)

Recently exact agreement has been found between three-point correlators of (single particle) chiral operators computed in string theory on $AdS_3 \times S^3 \times T^4$ with NS-NS flux and those computed in the symmetric orbifold CFT. However, it has also been shown that these correlators disagree with those computed in supergravity, under any identification of single particle operators which respects the symmetries. In this note we resolve this disagreement: the key point is that mixings with multi-particle operators are not suppressed even at large N in extremal correlators. Allowing for such mixings, orbifold/string theory operators and supergravity operators can be matched such that both non-extremal and extremal three point functions agree, giving further evidence for the non-renormalization of the chiral ring.

Books

- Bais, F.A., *Very special relativity*, Seoul, South Korea: Eco-Livres, 2008
- Dijkgraaf, R.H., *Blikwisselingen*, Amsterdam: Bert Bakker, 2008

Book chapter

- Balasubramanian, V., Boer, J. de, Showk, S. el & Messamah, I., *Resolving Black Hole Microstates*, In Sharpe E. & Greenspoon A (Eds.), *Advances in String Theory: The First Sowers Workshop in Theoretical Physics*, 2008, article

Conference proceedings

- Bais, F.A. & Farmer, J.D., *The Physics of Information*, The Philosophy of Information, In Adriaans P. & van Benthem J. (Eds.), Amsterdam: North Holland, 2008
- Britto, R.A.P., *Unitarity Cuts for One-Loop Amplitudes*, Nuclear Physics B-Proceedings supplements, 183 (2008) 36, proceedings
- Laenen, E.L.M.P., *Top quark in theory*, Proceedings of the 19th Hadron Collider Physics Symposium 2008, proceedings
- Laenen, E.L.M.P., *Developments in QCD and generators*, Proceedings of XVI International Workshop on Deep-Inelastic Scattering and Related Topics, London, England, April 2008, proceedings

Program 2: Quantum Matter and Complex Systems

Publications in refereed journals

- Aquino, G., Allahverdyan, A. & Nieuwenhuizen, T.M., *Memory Effects in the Two-Level Model for Glasses*, Physical Review Letters 101 (2008) 015901 (4 pages)

We study an ensemble of two-level systems interacting with a thermal bath. This is a well-known model for glasses. The origin of memory effects in this model is a quasistationary but nonequilibrium state of a single two-level system, which is realized due to a finite-rate cooling and slow thermally activated relaxation. We show that single-particle memory effects, such as negativity of the specific heat under reheating, vanish for a sufficiently disordered ensemble. In contrast, a disordered ensemble displays a collective memory effect [similar to the Kovacs effect], where nonequilibrium features of the ensemble are monitored via a macroscopic observable. An experimental realization of the effect can be used to further assess the consistency of the model.

- Capel, H.W. & Pasmanter, R.A., *Mixing and Coherent structures in 2D viscous flows*, Physica D 237 (2008) 1993-1997

We introduce a dynamical description based on a probability density $\phi(\sigma, x, y, t)$ of the vorticity σ in two-dimensional viscous flows such that the average vorticity evolves according to the Navier-Stokes equations. A time-dependent mixing index is defined and the class of probability densities that maximizes this index is studied. The time dependence of the Lagrange multipliers can be chosen in such a way that the masses $m(\sigma, t) := \int dx dy \phi(\sigma, x, y, t)$ associated with each vorticity value σ are conserved. When the masses $m(\sigma, t)$ are conserved then (1) the mixing index satisfies an H-theorem and (2) the mixing index is the time-dependent analogue of the entropy employed in the statistical mechanical theory of inviscid 2D flows. In the context of our class of probability densities we also discuss the reconstruction of the probability density of the quasi-stationary coherent structures from the experimentally determined vorticity-stream function relations.

- Caux, J.S., Mossel, J.J. & Perez Castillo, I., *The two-spinon transverse structure factor of the gapped Heisenberg antiferromagnetic chain*, Journal of Statistical Mechanics, Theory and Experiment 08 (2008) 006 (20 pages)

We consider the transverse dynamical structure factor of the anisotropic Heisenberg spin-1/2 chain (XXZ model) in the gapped antiferromagnetic regime ($\Delta > 1$). Specializing to the case of zero field, we use two independent approaches based on integrability (one valid for finite size, the other for the infinite lattice) to obtain the exact two-spinon part of this correlator. We discuss in particular its asymmetry with respect to the $\pi/2$ -momentum line, its overall anisotropy dependence, and its contribution to sum rules.

- Faribault, D.P.A., Calabrese, P. & Caux, J.S., *Exact mesoscopic correlation functions of the pairing model*, Physical Review B 77 (2008) 064503 (13 pages)

We study the static correlation functions of the Richardson pairing model (also known as the reduced or discrete-state BCS model) in the

canonical ensemble. Making use of the Algebraic Bethe Ansatz formalism, we obtain exact expressions which are easily evaluated numerically for any value of the pairing strength up to large numbers of particles. We provide explicit results at half-filling and extensively discuss their finite-size scaling behavior.

- Huijse, L., Halverson, J., Fendley, P. & Schoutens, K., *Charge Frustration and Quantum Criticality for Strongly Correlated Fermions*, Physical Review Letters 101 (2008) 146406 (4 pages)

We study a model of strongly correlated electrons on the square lattice which exhibits charge frustration and quantum critical behavior. The potential is tuned to make the interactions supersymmetric. We establish a rigorous mathematical result which relates quantum ground states to certain tiling configurations on the square lattice. For periodic boundary conditions this relation implies that the number of ground states grows exponentially with the linear dimensions of the system. We present substantial analytic and numerical evidence that for open boundary conditions the system has gapless edge modes.

- Huijse, L. & Schoutens, K., *Superfrustration of charge degrees of freedom*, European Physical Journal B 64 (2008) 543-550

We review recent results, obtained with P. Fendley, on frustration of quantum charges in lattice models for itinerant fermions with strong repulsive interactions. A judicious tuning of kinetic and interaction terms leads to models possessing supersymmetry. In such models frustration takes the form of what we call superfrustration: an extensive degeneracy of supersymmetric ground states. We present a gallery of examples of superfrustration on a variety of 2D lattices.

- Mehmani, B., Allahverdyan, A. & Nieuwenhuizen, T.M., *Quantum-state tomography using a single apparatus*, Physical Review A 77 (2008) 032122 (7 pages)

The density matrix of a two-level system (spin, atom) is usually determined by measuring the three non-commuting components of the Pauli vector.

This density matrix can also be obtained via the measurement data of two commuting variables, using a single apparatus. This is done by coupling the two-level system to a mode of radiation field, where the atom-field interaction is described with the Jaynes-Cummings model. The mode starts its evolution from a known coherent state.

The unknown initial state of the atom is found by measuring two commuting observables: the population difference of the atom and the photon number of the field. We discuss the advantages of this setup and its possible applications.

- Nienhuis, B., Guo, H. & Blöte, H.W.J., *Tricritical $O(n)$ models in two dimensions*, Physical Review E, 78 (2008) 061104 (10 pages)

We show that the exactly solved low-temperature branch of the two-dimensional $O(n)$ model is equivalent to an $O(n)$ model with vacancies and a different value of n . We present analytic results for several universal parameters of the latter model, which is identified as a tricritical point. These results apply to the range $n \leq 3/2$ and include the exact tricritical point, the conformal anomaly, and a number of scaling dimensions, among which are the thermal and magnetic exponents, and the exponent associated with the crossover to ordinary critical behavior and to tricritical behavior with cubic symmetry. We describe the translation of the tricritical model in a Coulomb gas. The results are verified numerically by means of transfer-matrix calculations. We use a generalized ADE model as an intermediary and present the expression of the one-point distribution function in that language. The analytic calculations are done both for the square and the honeycomb lattice.

- Nieuwenhuizen, T.M., *Exact solution for the interior of a black hole*, Fluctuation and Noise Letters 8 (2008) 2 (12 pages)

Within the Relativistic Theory of Gravitation it is shown that the equation of state $p = \rho$ holds near the center of a black hole. For the stiff equation of state $p = \rho - \rho_c$ the interior metric is solved exactly. It is matched with the Schwarzschild metric, which is deformed in a narrow range beyond the horizon. The solution is regular everywhere, with a specific shape at the origin. The gravitational redshift at the horizon remains finite but is large, $z \sim 10^{23} M_\odot/M$. Time keeps its standard role also in the interior. The

energy of the Schwarzschild metric, shown to be minus infinity in the General Theory of Relativity, is regularized in this setup, resulting in $E = Mc^2$.

- Nieuwenhuizen, T.M., *Supermassive black holes as giant Bose-Einstein condensates*, Europhysics Letters 83 (2008) 1 (6 pages)

The Schwarzschild metric has a divergent energy density at the horizon, which motivates a new approach to black holes. If matter is spread uniformly throughout the interior of a supermassive black hole, with mass $M \sim M_\star = 2.34 \cdot 10^8 M_\odot$, it may arise from a Bose-Einstein condensate of densely packed H atoms. Within the relativistic theory of gravitation with a positive cosmological constant, a bosonic quantum field is coupled to the curvature scalar. In the Bose-Einstein condensed ground state an exact, self-consistent solution for the metric is presented. It is regular with a specific shape at the origin. The redshift at the horizon is finite but large, $z \sim 10^{14} M_\star/M$. The binding energy remains as an additional parameter to characterize the BH; alternatively, the mass observed at infinity can be any fraction of the rest mass of its constituents.

- Panja, D., Barkema, G.T., Ball, R.C., *Pore-blockade times for field-driven polymer translocation*, J. Phys. Cond. Matt., 20, 095224 (2008)

We study pore-blockade times for a translocating polymer of length N , driven by a field E across the pore in three dimensions. The polymer performs Rouse dynamics, i.e., we consider polymer dynamics in the absence of hydrodynamical interactions. We find that the typical time for which the pore remains blocked during a translocation event scales as $\sim N^{(1+2\nu)/(1+\nu)}/E$, where $\nu \simeq 0.588$ is the Flory exponent for the polymer. We show, in line with our previous work, that this scaling behavior stems from polymer dynamics in the immediate vicinity of the pore—in particular, the memory effects in the polymer chain tension imbalance across the pore. This result, like numerical results from several other groups, violates the lower bound $\sim N^{1+\nu}/E$ suggested earlier in the literature. We discuss why this lower bound is incorrect and show, on the basis of the conservation of energy, that the correct lower bound for the pore-blockade time for field-driven translocation is given by $\eta N^{2\nu}/E$, where η is the viscosity of the medium surrounding the polymer.

- Panja D, Barkema GT, *Passage Times for Polymer Translocation Pulled through a Narrow Pore*, Biophys J, 94, 1630-1637 (2008)

We study the passage times of a translocating polymer of length N in three dimensions, while it is pulled through a narrow pore with a constant force F applied to one end of the polymer. At small to moderate forces, satisfying the condition $FN^\nu/k_B T \lesssim 1$, where $\nu \approx 0.588$ is the Flory exponent for the polymer, we find that τ_N , the mean time the polymer takes to leave the pore, scales as $N^{2+\nu}$ independent of F , in agreement with our earlier result for $F=0$. At strong forces, i.e., for, $FN^\nu/k_B T \gg 1$, the behavior of the passage time crosses over to $\tau_N \sim N^2/F$. We show here that these behaviors stem from the polymer dynamics at the immediate vicinity of the pore—in particular, the memory effects in the polymer chain tension imbalance across the pore.

- Panja D, Barkema GT, Ball RC, *Polymer translocation out of planar confinements*, J. Phys. Cond. Matt., 20, 075101 (2008)

Polymer translocation in three dimensions out of planar confinements is studied in this paper. Three membranes are located at $z = -b$, $z = 0$ and $z = b_1$. These membranes are impenetrable, except for the middle one at $z = 0$, which has a narrow pore. A polymer with length N is initially sandwiched between the membranes placed at $z = -b$ and $z = 0$ and translocates through this pore. We consider strong confinement (small b), where the polymer is essentially reduced to a two-dimensional polymer, with a radius of gyration scaling as $R_g^{(2D)} \sim N^{\nu_{2D}}$; here, $\nu_{2D} = 0.75$ is the Flory exponent in two dimensions. The polymer performs Rouse dynamics. On the basis of theoretical analysis and high-precision simulation data, we show that in the unbiased case $b = b_1$, the dwell time τ_d scales as $N^{2+\nu_{2D}}$, in perfect agreement with our previously published theoretical framework. For $b_1 = \infty$, the situation is equivalent to field-driven translocation in two dimensions. We show that in this case τ_d scales as $N^{2\nu_{2D}}$, in agreement with several existing numerical results in the literature. This result violates the earlier reported lower bound $N^{1+\nu}$ for τ_d for field-driven translocation. We argue, on the basis of energy conservation, that the actual lower bound for τ_d is $N^{2\nu}$ and not $N^{1+\nu}$. Polymer translocation in such theoretically motivated

geometries thus resolves some of the most fundamental issues that have been the subject of much heated debate in recent times.

- Pruisken, A.M.M. & Burmistrov, I.S., *Coulomb blockade and super universality of the θ angle*, Physical Review Letters 101 (2008) 056801

Based on the Ambegaokar-Eckern-Schön approach to the Coulomb blockade, we develop a complete quantum theory of the single electron transistor. We identify a previously unrecognized physical observable in the problem that, unlike the usual average charge on the island, is robustly quantized for any finite value of the tunneling conductance as the temperature goes to absolute zero. This novel quantity is fundamentally related to the nonsymmetrized current noise of the system. Our results display all of the superuniversal topological features of the θ angle concept that previously arose in the theory of the quantum Hall effect.

- Pruisken, A.M.M., Shankar, R. & Surendran, N., *Exact Haldane mapping for all S and super universality in spin chains*, Europhysics Letters 82 (2008) 47005

The low-energy dynamics of the anti-ferromagnetic Heisenberg spin S chain in the semiclassical limit $S \rightarrow \infty$ is known to map onto the $O(3)$ nonlinear σ -model with a θ term in 1+1 dimension. Guided by the underlying dual symmetry of the spin chain, as well as by the recently established topological significance of “dangling edge spins”, we report an exact mapping onto the $O(3)$ model that avoids the conventional large- S approximation altogether. Our new methodology demonstrates all the super universal features of the θ -angle concept that previously arose in the theory of the quantum Hall effect. It explains why Haldane’s original ideas remarkably yield the correct answer in spite of the fundamental complications that generally exist in the idea of semiclassical expansions.

- Pruisken, A.M.M. & Burmistrov, I.S., *Non-Fermi liquid criticality and super universality in the quantum Hall regime*, Pis'ma v ZhETF 87 (2008) 252-256

The results of a microscopic theory, based on the topological concept of a θ vacuum, which show that the Coulomb potential, unlike any finite-

ranged interaction potential, renders the long-standing problem of the plateau transitions in the quantum Hall regime like a non-Fermi liquid are reported. These results, which are important for quantum-phase transitions in general and composite fermion ideas in particular, provide a novel understanding of the critical exponent values that have recently been (re-)taken from a series of state-of-the-art quantum Hall samples.

- Suttorp, L.G., *Sum rules for correlation functions of ionic mixtures in arbitrary dimension $d \geq 2$* , Journal of Physics A-Mathematical and General 41 (2008) 495001 1-18

The correlations in classical multi-component ionic mixtures with a spatial dimension $d \geq 2$ are studied by using a restricted grand-canonical ensemble and the associated hierarchy equations for the correlation functions. Sum rules for the first few moments of the two-particle correlation function are derived and their dependence on d is established. By varying d continuously near $d = 2$ it is shown how the sum rules for the two-dimensional mixture are related to those for mixtures at higher d .

- Zozulya, O.S., Haque, M. & Schoutens, K., *Particle partitioning entanglement in itinerant many-particle systems*, Physical Review A 78 (25008) 042326 (5 pages)

For itinerant fermionic and bosonic systems, we study “particle entanglement,” defined as the entanglement between two subsets of particles making up the system. We formulate the general structure of particle entanglement in many-fermion ground states, analogous to the “area law” for the more usually studied entanglement between spatial regions. Basic properties of particle entanglement are uncovered by considering relatively simple itinerant models.

Book chapter

- Dekker, H., *Theory of hydrodynamic turbulence: external scales and irrotational fields*, In J.S Moreno (Ed.), Progress in Statistical Mechanics Research, New York: Nova Science Publishers, 2008, book chapter

- Huijse, L., *Standaardmodel - De samenhang der krachten*, In De Bètacanon. J.M. Meulenhoff, 2008 (book chapter)

Proceedings

- Burmistrov, I.S. & Pruisken, A.M.M., *The problem of macroscopic charge quantization in the Coulomb blockade*, Proceedings of Landau Days 2008
- Burmistrov, I.S. & Pruisken, A.M.M., *The problem of true macroscopic charge quantization in the Coulomb blockade*, In: Electron Transport in Nanosystems, Proceedings of the NATO Advanced Research Workshop Yalta, 2008

Program 3: History of Physics

Publications in refereed journals

- Janssen, M. & Kox, A.J., *Lorentz, Hendrik Antoon.*, New Dictionary of Scientific Biography 4 (2008) 487-500

Critical discussion of the life and work of H.A. Lorentz

- Kox, A.J., *Casimir, Hendrik Brugt Gerhard*, New Dictionary of Scientific Biography 2 (2008) 64-67

Critical discussion of the life and work of H.B.G. Casimir

- Kox, A.J., *Kasimier (Casimir), Hendrik Brugt Gerhard (1909-2000).*, Biografisch Woordenboek van Nederland 6 (2008) 242-244

Critical discussion of the life and work of H.B.G. Casimir

Book

- Kox, A.J., *The Scientific Correspondence of H.A. Lorentz*. New York: Springer (2008)

3.4 Scientific talks and lectures

Program 1: Particle physics, Cosmology, and Quantum Gravity

Arsiwalla, X.D., *Spectral flow invariance of 5D entropy functions*, Seminar University of Amsterdam, The Netherlands, 21 February 2008 (talk)

Bais, F.A., *Unity in diversity*, TNO-management course, Arnhem, The Netherlands, 9 May 2008 (invited lecture)

Bais, F.A., *Topological Quantum Computing*, Amsterdam, The Netherlands, 23 May 2008 (invited talk)

Bais, F.A., *Topological order*, Santa FE, USA, 23 August 2008 (invited colloquium)

Bais, F.A., *Turningpoints*, European Comenius Course, Cambridge, UK, 27-29 August 2008 (lectures)

Bais, F.A., *Topological Quantum Computation a status report*, Gordon Conference on Quantum information and processing, Montana, USA, 2 September 2008 (invited talk)

Boer, J. de, *Black Hole Microstates*, RTN Winter School on Strings, Supergravity and Gauge Theories Search, Geneva, Switzerland, 21-25 January 2008 (invited lectures)

Boer, J. de, *Introduction to the AdS/CFT Correspondence*, Workshop Integrability in the AdS/CFT correspondence, Utrecht, The Netherlands, 29-31 January 2008 (invited talk)

Boer, J. de, *Black Hole Microstates*, Spring School on Superstring Theory and Related Topics, Trieste, Italy, 27 March-4 April 2008 (invited lectures)

Boer, J. de, *Black hole boundstates in AdS₃*, Conference: String Theory, From Theory to Experiment, Jerusalem, Israel, 6-11 April 2008 (invited talk)

Boer, J. de, *Black hole boundstates in AdS₃*, Seminar DAMTP, Cambridge, UK, 23 April 2008 (invited talk)

Boer, J. de, *Quantization of gravitational solutions*, Conference Gravitational Thermodynamics and the Quantum Nature of Space Time, Edinburgh, UK, 16-20 June 2008 (invited talk)

Boer, J. de, *Black Hole Microstates*, Cargese Summer School Theory and Particle Physics: the LHC perspective and beyond, Cargese, France, 16-28 June 2008 (invited talk)

Boer, J. de, *Black Hole Quantization*, Workshop Emerging Directions in String Theory, Banff, Canada, 23-27 June 2008 (invited talk)

Boer, J. de, *Macroscopic quantum effects in supersymmetric black holes*, Black Holes: A Landscape of Theoretical Physics Problems, Geneva, Switzerland, 25 August-5 October 2008 (invited talk)

Boer, J. de, *Black Hole Berry phase*, Black Holes: A Landscape of Theoretical Physics, Geneva, Switzerland, 1 October 2008 (invited talk)

Boer, J. de, *Black Holes as Effective Geometries*, The 22nd Nordic Network Meeting on Strings, Fields and Branes, Stockholm, Sweden, 27-29 November 2008 (invited lectures)

Boer, J. de, *Brownian Motion in AdS/CFT*, London Triangle seminar on String Theory, London, UK, 10 December 2008 (invited lecture)

Britto, R.A.P., *Unitarity Cuts for One-Loop Amplitudes*, Loops and Legs in Quantum Field Theory, Sondershausen, Germany, 21 April 2008 (invited talk)

Britto, R.A.P., *Integral Coefficients for One-Loop Amplitudes*, Loopfest VII, Buffalo, USA, 16 May 2008 (invited talk)

Britto, R.A.P., *Spinor Integration for One-Loop Amplitudes*, Wonders of Gauge Theory and Supergravity, Paris, France, 26 June 2008 (invited talk)

Britto, R.A.P., *Analytic Expressions for One-Loop Amplitudes*, Workshop on Gauge Theory and String Theory, Zurich, Switzerland, 2 July 2008 (invited talk)

- Britto, R.A.P., *The Simplicity of Scattering Amplitudes*, 34th International Conference on High Energy Physics, Philadelphia, USA, 30 July 2008 (invited colloquium)
- Dijkgraaf, R.H., *D-modules and D-branes*, Colloquium Math Department, Utrecht, 17 January 2008 (talk)
- Dijkgraaf, R.H., *D-branes and D-modules*, Harvard University, USA, 11 February 2008 (seminar)
- Dijkgraaf, R.H., *Conformal Field Theory on Quantum Spectral Curves*, Yukawa Institute, Kyoto, Japan, 19 March 2008 (seminar)
- Dijkgraaf, R.H., *Quantum curves and random matrices*, Conference in honor of Yang & Simons, Stony Brook University, New York, USA, 28 March 2008 (talk)
- Dijkgraaf, R.H., *Quantum curves and random matrices*, UCSB Distinguished Lectures in the Mathematical Sciences University of California, Santa Barbara, USA, 31 March-4 April 2008 (talk)
- Dijkgraaf, R.H., *Gauge Theory and Quantum Curves*, Crawford Symposium, Stockholm, Sweden, 24 April 2008 (invited talk)
- Dijkgraaf, R.H., *String Theory*, Colloquium, Delft, 29 April 2008 (talk)
- Dijkgraaf, R.H., *D-branes and integrable systems*, IHES 50th anniversary conference, Paris, France, 19 June 2008 (invited talk)
- Dijkgraaf, R.H., *D-modules and D-branes*, Geometric Langlands Workshop, KITP, Santa Barbara, USA, 6 August 2008 (invited talk)
- Dijkgraaf, R.H., *The unreasonable effectiveness of quantum physics in modern mathematics*, UCL, Leuven, Belgium, 28 October 2008 (invited talk)
- Dijkgraaf, R.H., *Particles, strings, branes*, UCL, Leuven, Belgium, 6 November 2008 (invited talk)
- Dijkgraaf, R.H., *Random matrices and quantum curves*, UCL, Leuven, Belgium, 18 November 2008 (invited talk)
- Dijkgraaf, R.H., *D-branes and D-modules*, UCL, Leuven, Belgium, UCL, 25 November 2008 (invited talk)
- El-Showk, S., *Quantizing $N=2$ Multicenter Solutions*, Seminar CEA-Saclay Paris, France, October 2008 (talk)
- El-Showk, S., *Quantizing $N=2$ Multicenter Solutions*, Seminar Pennsylvania, USA, November 2008 (talk)
- El-Showk, S., *Quantizing $N=2$ Multicenter Solutions*, Seminar Stony Brook, New York, USA, November 2008 (talk)
- El-Showk, S., *Quantizing $N=2$ Multicenter Solutions*, Seminar Caltech, USA, November 2008 (talk)
- El-Showk, S., *Quantizing $N=2$ Multicenter Solutions*, Seminar University of Southern California, USA, November 2008 (talk)
- Hollands, L., *Supersymmetric gauge theories, intersecting branes and free fermions*, TH string theory seminar, Cern, Switzerland, 12 February 2008 (talk)
- Hollands, L., *Free fermions on a quantum curve*, DAMTP string theory seminar Cambridge University, UK, 27 November 2008 (talk)
- Hollands, L., *Free fermions on a quantum curve*, String theory seminar, Oxford, UK, 1 December 2008 (talk)
- Hoogeveen, J., RTN winterschool CERN, Geneva, Switzerland, 20-26 January 2008 (talk)
- Hoogeveen, J., *BRST quantization of pure spinor superstring*, Hamburg, Germany, 25 March 2008 (talk)
- Kox, A.J., *H. A. Lorentz's struggle with quantum theory and his discussion with Schrödinger on wave mechanics*, HQ2: Second International Conference on the History of Quantum Physics, 14-17 July 2008, Utrecht, 2008 (invited paper)

Laenen, E.L.M.P., *Developments in QCD and generators*, DIS2008 conference UCL, London, UK, 9 April 2008 (invited talk)

Laenen, E.L.M.P., *Top quark in theory*, Hadron Collider Physics Conference, Galena, USA, 27 May 2008 (invited talk)

Laenen, E.L.M.P., *Resummation*, Seminar at State University of New York, USA, 6 August 2008 (talk)

Laenen, E.L.M.P., *Broken symmetries*, Nobel prize Natuurkunde Colloquium, Utrecht, The Netherlands, 12 December 2008 (talk)

Laenen, E.L.M.P., *Top quark physics at the LHC*, RWTH Aachen Graduiertenkolleg, Aachen, Germany, 16 December 2008 (talk)

Manschot, J., *A modern farey tail*, Montreal, Canada, 16 February 2008 (talk)

Manschot, J., *Construction of partition functions for AdS_3/CFT_2* , Zurich, Switzerland, 9 April 2008 (talk)

McFadden, P.L., *Wald entropy and the Einstein equation of state*, Perimeter Institute for Theoretical Physics, Waterloo, Canada, 7 March 2008 (invited talk)

Meulen, M.P. van der, *Classical approximation to quantum cosmological correlations*, String Theory Group, Bielefeld, Germany, 15 April 2008 (talk)

Messamah, I., *Black hole bound states and AdS spaces*, Utrecht, The Netherlands, 29 February 2008 (talk)

Papadodimas, K., *Supersymmetry breaking in perturbed Seiberg-Witten theory and string theory*, Seminar, Utrecht, The Netherlands, February 2008 (invited talk)

Papadodimas, K., *Metastable supersymmetry breaking in $N=2$ gauge theories and string theory*, Seminar, Bonn, Germany, May 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, Monsoon workshop on string theory, Mumbai, India, July 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, Seminar Durham University, USA, October 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, DAMTP seminar, Cambridge, UK, November 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, Seminar Theory Group, Cern, Switzerland, November 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, Seminar, Paris, France, November 2008 (invited talk)

Papadodimas, K., *The chiral ring of AdS_3/CFT_2 and the attractor mechanism*, Seminar ETH, Zurich, Switzerland, December 2008 (invited talk)

Queiroz Faria de Oliveira Baptista, J.M., *The quantum equivariant cohomology of toric manifolds*, Aarhus Universitet, Denmark, 20 May 2008 (invited talk)

Queiroz Faria de Oliveira Baptista, J.M., *The quantum equivariant cohomology of toric manifolds*, Lisbon, Portugal, 22 July 2008 (talk)

Quella, T., *Low-dimensional Quantum Field Theories and Applications*, Galileo Galilei Institute Workshop, Florence, Italy, October 2008 (talk)

Quella, T., *World-sheet duality for supersphere σ -models*, Galileo Galilei Institute Workshop, Florence, Italy, October 2008 (talk)

Quella, T., *σ -models on supergroups*, Workshop on Applied 2d σ -models, Hamburg, Germany, November 2008 (talk)

Reffert, S., *Quantum Crystal and Topological Strings*, Ecole Normale Supérieure Paris, France, January 2008 (talk)

Schalm, K.E., *Effective actions for Gravity*, Seminar, Utrecht, The Netherlands, April 2008 (invited talk)

Shigemori, M., *Small Black Rings*, Black Holes: A Landscape of Theoretical Physics Problems, Cern, Switzerland, August 2008 (talk)

- Shigemori, M., *Brownian motion in AdS/CFT*, Seminar, Utrecht, The Netherlands, 14 November 2008 (invited talk)
- Shigemori, M., *Supersymmetric gauge theories*, Amsterdam-Brussels-Paris Doctoral School on Quantum Field Theory, Strings and Gravity, Amsterdam, The Netherlands, November 2008 (talk)
- Skenderis, K., *Holography and Fuzzball Proposal*, Rome, Italy, 1 February 2008 (invited talk)
- Skenderis, K., *The fuzzball proposal for black holes*, San Diego, USA, 4 March 2008 (invited talk)
- Skenderis, K., *The fuzzball proposal for black holes*, UCLA, USA, 10 March 2008 (invited talk)
- Skenderis, K., *The fuzzball proposal for black holes*, Santa Barbara, USA, 13 March 2008 (invited talk)
- Skenderis, K., *Precision holography and applications*, IPM String School and workshop, Isfahan, Iran, 9-17 April 2008 (series of lectures)
- Skenderis, K., *Real-time gauge/gravity duality*, Swansea, UK, 16 May 2008 (invited talk)
- Skenderis, K., *Issues in Gauge/gravity duality*, 32nd John Hopkins Workshop “Perspectives in String Theory”, Seoul, Korea, 28-31 May 2008 (invited talk)
- Skenderis, K., *Real-time gauge/gravity duality*, Workshop “Gravitational Thermodynamics and the Quantum Nature of Space Time”, Edinburgh, UK, 20 June 2008 (invited talk)
- Skenderis, K., *The fuzzball proposal for black holes*, CERN black hole institute, Cern, Switzerland, 25 August 2008 (invited lecture)
- Skenderis, K., *The fuzzball proposal for black holes*, Paris summer workshop at Ecole Normale Supérieure, Paris, France, 28 August 2008 (invited talk)
- Skenderis, K., *Non-conformal holography*, Perimeter, Canada, 18 November 2008 (invited talk)
- Skenderis, K., *Geometric flows and holography*, Workshop on Field Theory and Geometric Flows, Munich, Germany, 24 November 2008 (invited talk)
- Smit, J., *Lattice Simulations of Non-equilibrium Dynamics*, International Conference on Non-equilibrium Dynamics in Particle Physics and Cosmology, Santa Barbara, USA, 28 February 2008 (invited talk)
- Smit, J., *Classical Approximation to Quantum Cosmological Correlations*, KITP Program: Non-equilibrium Dynamics in Particle Physics and Cosmology, Santa Barbara, USA, 3 March 2008 (invited talk)
- Taylor, M., *Non-conformal holography*, Workshop: String theory - from theory to experiment, Jerusalem, Israel, 6-11 April 2008 (invited talk)
- Taylor, M., *Are black holes really fuzzballs?*, Fysica 2008 conference, Nijmegen, The Netherlands, 18 April 2008 (invited lecture)
- Taylor, M., *Precision holography for non-conformal branes*, Workshop “Gravitational Thermodynamics and the Quantum Nature of Space Time”, Edinburgh, UK, 16-20 June 2008 (invited talk)
- Taylor, M., *Precision holography for non-conformal branes*, Summer workshop at Ecole Normale Supérieure, Paris, France, 25-29 August 2008 (invited talk)
- Taylor, M., *Are black holes really fuzzballs?*, Colloquium at Astronomy Institute Anton Pannenkoek, Amsterdam, The Netherlands, 21 November 2008 (invited talk)
- Verlinde, E.P., *Hydrodynamics at the Horizon*, MIT seminar, Boston, USA, 8 April 2008 (talk)
- Verlinde, E.P., *Discussion on Black Holes*, Seminar, Cern, Switzerland, 18 April 2008 (talk)
- Verlinde, E.P., *Wall Crossing and Counting of BPS Dyons*, Seminar Harvard University, Cambridge, UK, 25 March 2008 (talk)
- Verlinde, E.P., *Counting Black Hole Dyons*, Seminar, Cern, Switzerland, 11 September 2008 (talk)

Verlinde, E.P., *Black holes, Holography and Emergent Gravity*, Ehrenfest Colloquium, Leiden, The Netherlands, 22 November 2008 (talk)

Verlinde, E.P., *Wall Crossing and Counting of BPS Dyons*, MIT Seminar, Boston, USA (talk)

Verlinde, E.P., *Wall Crossing and Counting of BPS Dyons*, Ihes seminar, France (talk)

Program 2: Quantum Matter and Complex Systems

Caux, J.S., *Correlation dynamics, noise and quenches in integrable systems*, Workshop on Quantum noise in strongly correlated systems, Rehovot, Israel, 11 January 2008 (invited talk)

Caux, J.S., *Integrability and the Bethe Ansatz: the challenge of correlation functions*, Workshop on Integrability in AdS/CFT, Utrecht, The Netherlands, 30 January 2008 (invited talk)

Caux, J.S., *Correlation dynamics in quantum spin chains and 1D Bose gases: from theory to experiment*, Wuppertal, Germany, 7 February 2008 (invited talk)

Caux, J.S., *Dynamics of Heisenberg spin chains: from the Bethe Ansatz to inelastic neutron scattering*, Workshop on Integrable Quantum Systems, Montreal, Canada, 30 June 2008 (invited talk)

Caux, J.S., *Correlation dynamics and quantum quenches in integrable systems*, Conference on Strong Fluctuations in Low Dimensional Systems, Montauk, USA, 3 September 2008 (invited talk)

Caux, J.S., *Correlations and quenches in integrable systems*, INSTANS Workshop on Correlations and Coherence in Quantum Matter, Evora, Portugal, 13 November 2008 (invited talk)

Faribault, D.P.A., *Algebraic Bethe Ansatz and the Richardson model*, Seminar presented to the Strongly Correlated Quantum Materials group, Palaiseau, France, 18 January 2008 (invited talk)

Faribault, D.P.A., *Correlation functions in superconducting metallic nanograins*, Physics@FOM, Veldhoven, The Netherlands, 22 January 2008 (talk)

Faribault, D.P.A., *Interaction quenches in the Richardson model: A Bethe Ansatz approach*, Solid State Theory Seminar, München, Germany, 17 March 2008 (invited talk)

Faribault, D.P.A., *Bethe Ansatz approach to quench dynamics in the Richardson model*, Workshop on integrable quantum systems and solvable statistical mechanical models, Montreal, Canada, 3 July 2008 (talk)

Huijse, L., *Supersymmetric lattice models*, Summerschool Les Houches, France, July 2008 (talk)

Huijse, L., *What can cohomology tell us about a many-particle quantum system?*, DIAMANT meets GQT workshop, Leiden, The Netherlands, 27-31 October 2008 (invited talk)

Mehmani, B., *Systems under the influence of a vrying environment*, Nancy, France, 9-11 July 2008, (talk)

Mehmani, B., *Work as tracer of the force that generates the geometric phase*, Prague, Czech, 28 July-2 August 2008 (talk)

Mehmani, B., *Non-Adiabatic cyclic evolution of a quantum system*, Leeds, UK, 12 November 2008 (talk)

Nienhuis, B., *Life in transitions*, Symposium in honor of Henk Blöte, Leiden, The Netherlands, 11 April 2008 (invited talk)

Nienhuis, B., *Entanglement in the XXZ chain*, Statistical-Mechanics and Quantum-Field-theory methods in Combinatoric Enumeration, Cambridge, England, 23 April 2008 (invited talk)

Nienhuis, B., *Scaling, Universality and integrability in force distributions in granular solids*, Colloquium, Groningen, The Netherlands, 16 June 2008 (invited talk)

Nienhuis, B., *Correlations in percolation models on arbitrary rhombus tilings*, Recent progress in two-dimensional Statistical Mechanics, Banff International Research Station, Banff, Canada, 30 June 2008 (invited talk)

- Nienhuis, B., *Correlations in percolation models on arbitrary rhombus tilings Kac*, Seminar, Utrecht, The Netherlands, 3 October 2008 (invited talk)
- Nienhuis, B., *qKZ equations and critical percolation*, Low-dimensional quantum field theory and applications, Firenze, Italy, 27 October 2008 (invited talk)
- Nieuwenhuizen, T.M., *Physical model for simultaneous measuring of non-commuting variables*, Young Academy, Berlin, Germany, 29 April 2008 (invited talk)
- Nieuwenhuizen, T.M., *Supermassive Black Holes as Giant Bose Einstein Condensates*, Como, Italy, 4 June 2008 (invited talk)
- Nieuwenhuizen, T.M., *Supermassive Black Holes as Giant Bose Einstein Condensates*, Conference: Problems of Practical Cosmology, St. Petersburg, Russia, 24 June 2008 (invited talk)
- Nieuwenhuizen, T.M., *Quantum Thermodynamics*, Doctoral College University of Nancy, France, 9-11 July 2008 (3 invited lectures)
- Nieuwenhuizen, T.M., *Supermassive Black Holes as Giant Bose Einstein Condensates*, Dresden, Germany, 25 July 2008 (invited talk)
- Nieuwenhuizen, T.M., *Supermassive Black Holes as Giant Bose Einstein Condensates*, Conference FQMT08, Prague, Czech, 2 August 2008 (invited talk)
- Nieuwenhuizen, T.M., *Supermassive Black Holes as Giant Bose Einstein Condensates*, Conference Foundations of Växjö, Växjö, Sweden, 24 August 2008 (invited talk)
- Nieuwenhuizen, T.M., *Exactly Solvable Model for the Dynamics of a Quantum Measurement*, Workshop: Dynamics and Manipulation of Quantum Systems, Tokyo, Japan, 21 October 2008 (invited talk)
- Nieuwenhuizen, T.M., *Bright light on dark matters*, Condensed matter group, Amsterdam, The Netherlands, 12 November 2008 (talk)
- Nieuwenhuizen, T.M., *Do non-relativistic neutrinos constitute the dark matter?*, Saclay, France, 18 December 2008 (invited talk)
- Pruisken, A.M.M., *Multi fractality and electron-electron interactions in the quantum Hall regime*, Seminar, Paris, France, 31 January 2008 (talk)
- Pruisken, A.M.M., *Multi fractality and electron-electron interactions in the quantum Hall regime*, Condensed Matter Colloquium, Rehovot, Israel, 14 February 2008 (talk)
- Pruisken, A.M.M., *Multi fractality and electron-electron interactions in the quantum Hall regime*, Condensed Matter Seminar, Princeton, USA, 29 May 2008 (talk)
- Pruisken, A.M.M., *Coulomb blockade and super universality of the θ angle*, Condensed Matter Seminar, Providence, USA, 23 October 2008 (talk)
- Pruisken, A.M.M., *Coulomb blockade and super universality of the θ angle*, Condensed Matter Seminar, Amsterdam, The Netherlands, 3 December 2008 (talk)
- Schoutens, K., *Paired and clustered quantum Hall states*, Seminar at the Weizmann Institute, Rehovot, Israel, 31 January 2008 (talk)
- Schoutens, K., *Superfrustration of lattice fermions*, Seminar, Firenze, Italy, 4 May 2008 (talk)
- Schoutens, K., *Superfrustration of lattice fermions*, Seminar at SISSA, Trieste, Italy, 7 May 2008 (talk)
- Schoutens, K., *Supersymmetry in fermionic lattice models*, Seminar at Albert-Einstein-Institut, Potsdam, Germany, 22 May 2008 (talk)
- Schoutens, K., *Hard squares, supersymmetry and combinatorics*, Mathematics Colloquium at the KdV Institute of the University of Amsterdam, The Netherlands, 28 May 2008 (talk)
- Schoutens, K., *Paired quantum Hall states at the edge*, International workshop Quantum Phases and Excitations in Quantum Hall Systems, Max Planck Institut, Dresden, Germany, 16 June 2008 (invited lecture)

Schoutens, K., *Supersymmetry in fermionic lattice models*, International workshop on Integrability in Gauge and String Theory, Utrecht, The Netherlands, 11 August 2008 (invited lecture)

Schoutens, K., *Topological Quantum Registers*, Workshop on Low-dimensional Quantum Field Theories and Applications, Galileo Galilei Institute, Florence, Italy, 5 September 2008 (invited lecture)

Schoutens, K., *Non-Abelian Anyons - when Ising meets Fibonacci*, The Sixth Symposium on Topological Quantum Computation, Dublin Institute for Advanced Studies, Dublin, Ireland, 17 September 2008 (invited lecture)

Schoutens, K., *Cohomology of the independence complex on 2-dimensional grids*, Presentation of challenge and results at the Lorentz Center Workshop 'DIAMANT meets GQT', Leiden, The Netherlands, 27 October 2008 (talk)

3.5 Conference posters

Program 2: Quantum Matter and Complex Systems

Huijse, L., *Superfrustration, tilings and quantum criticality*, Physics@FOM, Veldhoven, The Netherlands, 22-23 January 2008 (poster)

Zozulya, O.S., *Entanglement entropy in quantum Hall states*, Physics@FOM, Veldhoven, The Netherlands, 22-23 January 2008 (poster)

Zozulya, O.S., *Entanglement entropy in quantum Hall states*, Workshop Quantum phases and excitations in quantum Hall systems, Dresden, Germany, 16-20 June 2008 (poster)

3.6 Other research activities

Organization of conferences and workshops

Bais, F.A., et al., *A Passion for Fields and Lattices*, Symposium, Amsterdam, 25 August 2008

Bais, F.A., coordinator and discussion leader of a session on "Topological quantum computing" at the *Gordon Conference on Quantum Information*, Big Sky, Montana, USA, 30 August-6 September

Boer, J. de, Schaar, J.P. van der, Skenderis, K., Taylor, M.M., Verlinde E.P. *Amsterdam String Theory Workshop*, 07-11 July 2008

Boer, J. de, Schaar, J.P. van der, Skenderis, K., Taylor, M.M., Verlinde, E.P., *Eurostrings 2008*, conference, Amsterdam, 30 June-4 July 2008

Kox, A.J., *HQ2: Second International Conference on the History of Quantum Physics*, Utrecht, 14-17 July 2008

Laenen, E.L.M., Schalm, K.E., Smit, J., *Strong and Electroweak Matter*, conference, 26-29 August 2008

Schoutens, C.J.M., *Exact Results in Low-Dimensional Quantum Systems: 2nd INSTANS Summer Conference*, Florence, Italy, 08-12 September 2008

Smit, J., member of the International Advisory Committee of the conference series *Strong and Electroweak Matter*

Editorships

- Bais, F.A., *Amsterdam Academic Archive Series*
- Kox, A.J., *Moritz Schlick Collected Papers Edition*
- Kox, A.J., *Perspectives in Physics*
- Kox, A.J., *Studies in History and Philosophy of Modern Physics*
- Nienhuis, B., *Annales Henri Poincaré*
- Nienhuis, B., *Journal of Statistical Physics: theory and experiment*
- Verlinde, E.P., *Journal for Fundamental Physics*
- Verlinde, E.P., *Journal of Geometry and Physics*

Boards and committees

Laenen, E.L.M.P., member Nikhef internal scientific advisory board

Laenen, E.L.M.P., chairman FOM network Theoretical High Energy Physics

Schoutens, K., chairman of the board of the Dutch Research School for Theoretical Physics (since January 2005)

Schoutens, K., representative for the Netherlands in the Steering Committee of the ESF program INSTANS (since October 2005)

Schoutens, K., representative for the University of Amsterdam in the Kamer Natuurkunde of the VSNU (since February 2008)

Schoutens, K., member of evaluation committee on behalf of the SFI (Science Foundation Ireland), Dublin, June 12-13

Verlinde, E.P., member of the Raad voor Technische Wetenschappen, Wiskunde en Informatica, Natuur- en Sterrenkunde en Scheikunde van de KNAW

4. Education and Society

4.1 Education

Master theses

C.G. Battle, *DNA Toroids under Tension*, 31 August 2008, Supervisor: F. MacKintosh (VU)

P.P. Caputa, *Gluon scattering amplitudes from weak to strong coupling and back*, 12 June 2008, Supervisor: J. de Boer

J.A. Escobedo Solorzano, *Greybody Factors Hawking Radiation in Disguise*, 3 August 2008, Supervisor: J. de Boer

K.J. Fernhout, *Cosmological Billiards*, 9 December 2008, Supervisor: K. Skenderis

P. Gratia, *AdS/CFT, Holography and Hydrodynamics*, 25 August 2008, Supervisor: E.P. Verlinde

D. de Jonge, *Knot Theory And Categorification*, 14 September 2008, Supervisor: R. Dijkgraaf

F. Joucken, *Dynamics of Quantum measurement*, 31 August 2008, Supervisor: Th. M. Nieuwenhuizen

H. Kamei, *Holographic Renormalization*, 27 October 2008, Supervisor: E.P. Verlinde

A. Khatami, *String Corrections to Gravitational Instantons*, 26 August 2008, Supervisor: J.P. van der Schaar

S.J.N. Mooij, *Supersymmetric Grand Unification*, 18 August 2008, Supervisor: J. Smit

J.J. Mossel, *Dynamics of the antiferromagnetic Heisenberg spin -1/2 chain*, 4 August 2008, Supervisor: J.S. Caux

B.A. van der Plas, *Scalar field models for dark energy*, 9 June 2008, Supervisor: K. Skenderis

J.C. Romers, *Discrete gauge theories in two dimensions: a lattice approach*, 24 January 2008, Supervisor: F.A. Bais

O. Smits, *Clustered states in the fractional quantum Hall effect*, 29 September 2008, Supervisor: K. Schoutens

S. Walg, *Noncritical String Theory*, 26 August 2008, Supervisor: J. de Boer

P. Zevenbergen, *Gravitational ways*, August 2008, Supervisor: J.W. van Holten

Bachelor theses

R. Aben, 8 August 2008, *Topologisch quantum rekenen met Fibonacci-reeksen*, Supervisor: F.A. Bais

R. Danko, 14 August 2008, *Lie groepen in de deeltjesfysica*, Supervisor: E.P. Verlinde

H.T. van Deurzen, 25 August 2008, *Graphene and tabletop quantum electrodynamics*, Supervisor: J.S. Caux

B. Elsinga, 24 July 2008, *Versnelde waarnemers en de Unruh temperatuur*, Supervisor: J.P. van der Schaar

R.J.G. Jonker, 15 September 2008, *Niet-commutatieve meetkunde*, Supervisor: J. de Boer

H. Kurniawan, 7 August 2008, *Quantumeleportatie*, Supervisor: W.A. van Leeuwen

A.J. van der Leden, 29 July 2008, *De energie van het vacuum*, Supervisor: J.P. van der Schaar

W. Merbis, 27 June 2008, *On EPR arguments and Bell's inequality. Is there still hope for local realism in Quantum mechanics?*, Supervisor: T.M. Nieuwenhuizen & B. Mehmani

P.A. Moser, 11 January 2008, *Quantum Cryptography / Quantum Repeaters*, Supervisor: K. Schoutens

S.F. van der Niet, 7 August 2008, *Kritisch punt*, Supervisor: A.J. Kox

I.A. Niesen, 10 August 2008, *Supersymmetrische Kwantummechanica*, Supervisor: E.P. Verlinde

T.T. Nguyen, *Quark Confinement and the Abelian Higgs Model*, 22 August 2008, Supervisor: J. Smit

P.J. Rozing, 6 July 2008, *Relativistische snaren*, Supervisor: E.P. Verlinde

H. J. Teunissen, 22 October 2008, *Synchrotronstraling*, Supervisor: L.J. van den Horn,

J.C. de Valença, 4 September 2008, *Gravitiiegolven*, Supervisor: J. de Boer

Regular courses, supervision and coordination

Bachelor N&S: Bachelor programma Natuur- en Sterrenkunde

Master TP: Master program Theoretical Physics

F.A. Bais, *Quantumfysica 1*, eerste jaar Bachelor N&S

J. de Boer and K. Schoutens, *Statistical Physics and Condensed Matter Theory II*, Master TP

J. de Boer, *General relativity*, Master TP

J. de Boer, Coordinator of the Master program Theoretical Physics

J.S. Caux, *Statistical Physics and Condensed Matter Theory 1*, Master TP

J.S. Caux, supervisie tweedejaarsproject *On the Occurrence of Solitons in the Fermi-Pasta-Ulam*

Chain: a Theoretical Treatise, L. Blom, E.J. Goeree, P. de Lange en L. Nauta, Bachelor N&S

L.J. van den Horn, *Elektrodynamica & relativiteitstheorie 1*, derde jaar Bachelor N&S

L.J. van den Horn, *Elektrodynamica & relativiteitstheorie 2*, derde jaar Bachelor N&S

L.J. van den Horn, *Hydrodynamics of fluids & plasmas*, Master TP

L.J. van den Horn, Coördinatie Bachelor programma Natuur- en Sterrenkunde

L.J. van den Horn, Coördinatie Bachelor projecten Theoretische Fysica

L.J. van den Horn, Secretaris Examencommissie Natuur- en Sterrenkunde

L. Huijse, B. Nienhuis, supervisie tweedejaarsproject *Quantumketens met supersymmetrie*, M. Hogervorst en B. Wulms, Bachelor N&S

A.J. Kox, *Einstein*, with J. van Dongen (UU), Master program

A.J. Kox, *De wetenschappelijke revolutie van de 17e eeuw in historische context*, (Faculteit Gw)

A.J. Kox, *History of Modern Physics*, Master program

E.L.M.P. Laenen, *Particles and Fields*, Master program TP

W.A. van Leeuwen, met F.A.Bais, *Quantumfysica 2*, tweede jaar Bachelor N&S

B. Nienhuis, Coordinator of the Master Program Theoretical Physics

B. Nienhuis, *Statistische Fysica*, tweede jaar Bachelor N&S

T.M. Nieuwenhuizen, supervisie tweedejaarsproject *The Berry Phase*, K. Brink, P. Bult en P. de Kuijper, Bachelor N&S

T.M. Nieuwenhuizen, *Quantum mysteries*, derde jaar Bachelor N&S

A.M.M. Pruisken, *Quantumfysica 3*, derde jaar Bachelor N&S

A.M.M. Pruisken, supervisie tweedejaarsproject *Multifractality in metals*, A. Latour, Y. Mudde en M. van Duijn, Bachelor N&S

T. Quella, *Wiskunde N3*, derde jaar Bachelor N&S

K. Skenderis, *String Theory*, with K. Papadodimas & M. Taylor, Master TP

E.P. Verlinde, *Workshop Theoretische Fysica*, derde jaar Bachelor N&S

E.P. Verlinde, *Klassieke Mechanica*, tweede jaar Bachelor N&S

Special courses

F.A. Bais, *Keerpunten in de natuurwetenschappen*, 6 colleges en coördinatie, Beta gamma bachelor

F.A. Bais, *Keerpunten in de natuurwetenschappen*, 5 colleges en coördinatie, Open UvA college

F.A. Bais, *Relativiteit, ruimte en tijd volgens Einstein*, 4 colleges, Open UvA college

J. de Boer, *Advanced String Theory I*, Series of lectures for PhD students for the Brussels-Paris-Amsterdam PhD school

E.L.M.P. Laenen, *QCD at colliders*, BND school, Texel, 22 September 2008 (8 lectures)

B. Nienhuis, *Loop models, and the Coulomb Gas*, lecture Les Houches summerschool, July 2008

B. Nienhuis, *Bethe Ansatz for Random Tiling models*, lecture Les Houches summerschool, July 2008

K. Papadodimas, *Advanced String Theory*, Series of lectures for PhD students for the Brussels-Paris-Amsterdam PhD school

K. Schoutens, *Quantum ICT*, Mastercourse with R. Spreeuw

K. Skenderis, *Gauge/gravity duality*, Series of lectures for PhD students for the Brussels-Paris-Amsterdam PhD school

M. Taylor, *Black holes in string theory*, DRSTP school Driebergen, Series of lectures

M. Taylor, *Black holes in string theory*, Series of lectures for PhD students for the Brussels-Paris-Amsterdam PhD school

Tutoring and problem sessions

X.D. Arsiwalla
Statistische Fysica (Nienhuis)

J. Hoogeveen
Elektrodynamica 1 (v.d. Horn)

L. Huijse
Elektrodynamica 2 (v.d. Horn)

B. Mehmani
Quantum mysteries (Nieuwenhuizen)

B. Mehmani
Klassieke Mechanica (Verlinde)

I. Messamah
Quantumfysica 2 (v. Leeuwen)

J.J. Mossel
Van Klassiek naar Quantum (Verlinde)

J.M. Oberreuter
Statistische Fysica (Nienhuis)

B.C. van Rees
Klassieke Mechanica (Verlinde)
Van Klassiek naar Quantum (Verlinde)
Brussels-Paris-Amsterdam PhD school (teaching assistant)

O.S. Zozulya
Quantumfysica 3 (Pruisken)

4.2 Outreach

Program 1: Particle physics, Cosmology, and Quantum gravity

Bais, F.A., *The natural Sciences in Amsterdam*, Comenius Leergang Amsterdam, 31 January 2008 (talk)

Bais, F.A., *Highlights lecture*, Amsterdam, 8 February 2008 (lecture)

Bais, F.A., *Het krijtje*, NRC, 16 February 2008 (article)

Bais, F.A., *Speciale relativiteit*, UvA betamaand, Amsterdam, 17 February 2008 (lecture)

Bais, F.A., *Windowdressing*, LRPLN, March 2008 (column)

Bais, F.A., *Intro beta gamma*, Open dag UvA, Amsterdam, 7 March 2008 (talk)

Bais, F.A., *Introductie natuurwetenschappen*, Beta Gamma Bachelor voorlichting, Amsterdam, 8 March 2008 (talk)

Bais, F.A., *Keerpunten*, Comenius leergang, Arnhem, 20 March 2008, (2 lectures)

Bais, F.A., *De Natuurwetten*, Lustrum seminarium serie van de Leidsche Flesch, Leiden, 2008, 21 April 2008 (lecture)

Bais, F.A., *Van Kepler tot supersnaren*, VESTA, Zaandam, 25 September 2008 (lecture)

Bais, F.A., *Einstein in de klas*, KNAW onderwijs, Symposium, Amsterdam, 12 November 2008 (talk)

Bais, F.A., *Natuurwetten*, Comenius leergang, Arnhem, 13 November 2008 (lecture)

Bais, F.A., *Keerpunten in de natuurwetenschappen*, Diligentia jongerenlezing, Den Haag, 17 November 2008 (lecture)

Bais, F.A., *Noodzakelijke vaagheden*, Symposium over cognitie, wetenschap en kunst, Groningen, 28 November 2008 (lecture)

Bais, F.A., *Sublieme eenvoud*, Bonaventura college, Leiden, 4 December 2008 (lecture)

Bais, F.A., *Relativita; Guida illustrata molto speciale*, Editiono Dedalo, Rome, Italy, 2008 (book)

F.A. Bais, Supervision *profielwerkstuk over golf deeltjes dualiteit* by Jitse van der Wal, Rudolf Steiner School, Haarlem

Boer, J. de, *Snaartheorie*, Highlights, Amsterdam, 29 February 2008 (lecture)

Boer, J. de, *De toekomst van de theoretische fysica*, Studenten conferentie Fysica Voorspeld, Nijmegen, 4 June 2008 (lecture)

Boer, J. de, *Space - the final frontier*, Online magazine Blind, 28 November 2008 (article)

Dijkgraaf, R.H., *De ochtend*, Radio Noord Holland, 17 January 2008 (interview)

Dijkgraaf, R.H., *Tot hoever kun je tellen?*, Nemo, Amsterdam, 20 January 2008 (kinderlezing)

Dijkgraaf, R.H., *Tekort aan technisch talent*, Radio 1, 26 February 2008 (interview)

Dijkgraaf, R.H., *De onredelijke effectiviteit van de fysica in de moderne wiskunde*, Leidsche Flesch, Leiden, 9 april 2008 (lezing)

Dijkgraaf, R.H., *Leve de Wiskunde: Flatland II: de vierde dimensie*, UvA, Amsterdam, 25 April 2008 (lezing)

Dijkgraaf, R.H., *De wereld draait door*, Nederland 3, 28 April 2008 (interview)

Dijkgraaf, R.H., *Fundamental research, creativity and innovation*, Universiteit Maastricht, Maastricht, 14 May 2008 (lezing)

Dijkgraaf, R.H., *Wetenschap, technogoe en ruimtelijke ordening*, Forum stedelijke vernieuwing, Amsterdam, 20 May 2008 (talk)

Dijkgraaf, R.H., *Wetenschap en Verbeelding*, Nederlands gesprekscentrum, Leusden, 5 June 2008 (lezing)

- Dijkgraaf, R.H., *Leermeesters*, Noorderlicht radio, 23 June 2008 (interview)
- Dijkgraaf, R.H., *Het gesprek*, Televisie, 3 July 2008 (interview)
- Dijkgraaf, R.H., *De zwoele stad*, AT5 Televisie, 15 July 2008 (interview)
- Dijkgraaf, R.H., *Kennis en innovatie*, Saint Paul de Vence, France, 25 August 2008 (talk)
- Dijkgraaf, R.H., *Energie*, Future Planet Studies, Amsterdam, 2 September 2008 (lezing)
- Dijkgraaf, R.H., *Nova*, Televisie, 10 September 2008 (interview)
- Dijkgraaf, R.H., *De wereld draait door*, Televisie, 12 September 2008 (interview)
- Dijkgraaf, R.H., *De kennisbegroting*, NWO, Den Haag, 17 September 2008 (lezing)
- Dijkgraaf, R.H., *Pieken in de Delta*, Beurs van Berlage, Amsterdam, 18 September 2008 (talk)
- Dijkgraaf, R.H., *De bètacanon*, Discovery 08, Amsterdam, 26 September 2008 (talk)
- Dijkgraaf, R.H., *Tot hoever kun je tellen?*, Naturalis, Leiden, 26 October 2008 (kinderlezing)
- Dijkgraaf, R.H., *Wiskundige thrillers*, Studium Generale, Utrecht, 12 November 2008 (talk)
- Dijkgraaf, R.H., *Kosmologie*, Teylers museum, Haarlem, 14 November 2008 (talk)
- Dijkgraaf, R.H., *Canondebat*, Paleis voor schone kunsten, Brussel, Belgium, 17 November 2008 (talk)
- Dijkgraaf, R.H., *Faust*, Wintertuin festival, Nijmegen, 21 November 2008, (dialoog)
- Dijkgraaf, R.H., *Spinozadebat*, Teleac Televisie, 26 November 2008 (interview)
- Dijkgraaf, R.H., *De bovenkamer*, Teleac Televisie, 28 November 2008 (interview)
- Dijkgraaf, R.H., *Parallele werelden*, NWO Exacte Wetenschappen, Amsterdam, 8 December 2008 (lezing)
- Laenen, E.L.M.P., *Theoretische deeltjesfysica in het tijdperk van de LHC*, Nederlands Tijdschrift voor Natuurkunde, August 2008 (article)
- Laenen, E.L.M.P., *Het Standaard Model*, De Leidsche Flesch studentenvereniging, Leiden, 26 November 2008 (lunchlezing)
- Laenen, E.L.M.P., *Elementaire deeltjes, symmetrie en quantumvelden*, Nikhef 6 VWO class, 27 November 2008 (lecture)
- Laenen, E.L.M.P., *Wat gaan we zien met de LHC?*, Natuurkundig Gezelschap, Utrecht, 9 December 2008 (lecture)
- B. Nienhuis, *Is zand een vloeistof of een vaste stof?* UvA voor vwo-scholieren, 14 februari 2008, (masterclass)
- Schaar, J.P. van der, *Alles uit Niets*, Studium Generale Maastricht University, Maastricht, 17 January 2008 (talk)
- Schaar, J.P. van der, *Iets uit Niets*, Lezing Sterrenwacht Oostzaan, Oostzaan, 18 October 2008
- Schaar, J.P. van der, *Donkere Energie*, NSA Energie symposium, Amsterdam, 5 November 2008 (talk)
- Taylor, M., *De ondeeltjes-hype*, NRC Handelsblad, 28 June 2008 (interview)

Program 2: Quantum Matter and Complex Systems

Caux, J.S., *1 + 1 ≠ 2 en andere verrassingen in gecondenseerde materie*, UvA Viva Fysica, Amsterdam, 1 February 2008 (talk)

Nienhuis, B., *Entanglement in a spin chain*, De Theorie Club, Leiden, 7 March 2008 (talk)

Nieuwenhuizen, T.M., *De Grootste Zwarte Gat*, Viva Fysica, Amsterdam, 1 February 2008 (talk)

Schoutens, K, *Jongleren*, column in Scoop,
January 2008

Schoutens, K, *voorlichting Bachelor Natuur- en
Sterrenkunde*, Leiden, 18 November 2008

Program 3: History of Physics

Kox, A.J., *Albert Einstein, Willem de Sitter en de
geboorte van de moderne kosmologie*, Symposium
“Het Heelal” Nederlands Natuur- en Geneeskundig
Congres, Leiden, 28 March 2008 (lecture)

Kox, A.J., *De opkomst van de moderne wetenschap*,
Honours Lecture Course “Geschiedenis in het
Groot”, UvA, 8 April 2008 (lecture)

Kox, A.J., *Einstein vergat wel eens een minnetje*,
ScienceGuide, 30 September 2008 (interview)

Appendix A: Facts & Figures

Finances

| Finances 2008 (in kEuro) | |
|--|-------------|
| Income | |
| UvA/FNWI lump sum* and other UvA income | 2275 |
| NWO and EU | 695 |
| FOM | 690 |
| Total income | 3660 |
| Expenses | |
| Personnel costs | |
| UvA* | 1780 |
| NWO and EU | 850 |
| FOM | 577 |
| Uva matching projects | 240 |
| Uva matching NWO and EU projects for total costs | -240 |
| Other expenses | |
| UvA | 343 |
| NWO and EU | 89 |
| FOM | 113 |
| Total expenses | 3752 |
| Net result | -92 |

**from 2006 UvA lump sum includes total costs*

Funding

The table show the University and other funding over the period 2005-2008

| Funding 2008 (in kEuro) | | | | |
|---------------------------------|------|------|------|------|
| | 2005 | 2006 | 2007 | 2008 |
| Running budget UvA* | 1098 | 1881 | 1969 | 2212 |
| External budgets (NWO, FOM, EU) | 1801 | 1394 | 1624 | 1385 |
| Other UvA income | 341 | 351 | 484 | 63 |

*from 2006 UvA lump sum includes total costs

Scientific input (fte)

In the table below we have given the full time equivalent of research carried out at the institute in 2008. The research input is related to the human resource input in the following way: regular staff spend 50%, postdocs/fellows 100%, and PhD students 80% of their time on research. The research input is in accordance with the agreements with the Dutch Research School of Theoretical Physics.

Scientific input 2008 (fte)

| Personnel category | program 1 | | program 2 | | program 3 | | total | | all |
|---------------------|------------|-------------|------------|------------|------------|------------|------------|-------------|-------------|
| | FNWI | other | FNWI | other | FNWI | other | FNWI | other | |
| full professor | 1,8 | 0,5 | 1,5 | | | 0,1 | 3,3 | 0,6 | 3,9 |
| associate professor | 0,6 | | 1,5 | | 0,2 | | 2,3 | 0 | 2,3 |
| assistant professor | | | | 0,2 | | | | 0,2 | 0,2 |
| postdoc fellows | | 9,3 | | 0,8 | | | | 10,1 | 10,1 |
| Ph.D students | | 10,2 | 1,3 | 1,7 | | | 1,3 | 11,9 | 13,2 |
| Total | 2,4 | 20,0 | 4,3 | 2,7 | 0,2 | 0,1 | 6,9 | 22,8 | 29,7 |

Scientific output

In the overview of publications only the articles which were actually published in 2008 are taken into account.

Scientific output 2008

| Scientific Output | program 1 | program 2 | program 3 | total |
|-----------------------------------|-----------|-----------|-----------|-------|
| PhD theses | 3 | | | 3 |
| Monographs | | | 1 | 1 |
| Publications in refereed journals | 31 | 18 | 3 | 52 |
| Proceedings/book chapters | 4 | 4 | 1 | 9 |
| Scientific talks and lectures | 104 | 46 | | 150 |
| Conference posters | | 3 | | 3 |
| Outreach | 56 | 5 | 3 | 64 |

Appendix B: Externally funded projects

Program 1: Particle physics, Cosmology and Quantum Gravity

- Supersymmetric gauge theories and matrix models
Researcher: X.D. Arsiwalla, PhD-student
FOM-A-20 (E.P. Verlinde)
- Searching for signatures of strings
Researcher: A.N. Atmaja, PhD-student
NWO Vidi-programma (K.E. Schalm)
- Gauged sigma-models and equivariant mirror symmetry
Researcher: J.M. Baptista, postdoctoral fellow
NWO Veni-programma
- Connecting gauge interactions with gravity through string theory
Researcher: R.A.P. Britto, postdoctoral fellow
FOM-A-20 (E.P. Verlinde)
- String theory and cosmology
Researcher: M.C.-N. Cheng, PhD-student
FOM-A-20 (E.P. Verlinde)
- Cosmological vacua in string theory
Researcher: F.A.H. Dolan
FOM-A-20 (E.P. Verlinde)
- Thermodynamics of strings, fluxes and branes
Researcher: S. El Showk, PhD-student
FOM-A-20 (E.P. Verlinde)
- Mathematical aspects of string theory
Researcher: L. Hollands, PhD-student
NWO-Spinozapremie (R.H. Dijkgraaf)
- Mathematical aspects of string theory
Researcher: J. Hoogeveen, PhD-student
NWO-Spinozapremie (R.H. Dijkgraaf)
- Fundamental interactions
Researcher: L. Kampmeijer, PhD-student
FOM-A-01 (F.A. Bais)
- Holography, duality and time dependence in string theory
Researcher: I.R.G. Kanitscheider, PhD-student
NWO Vidi-programma (M. Taylor)
- Thermodynamics of strings, fluxes and branes
Researcher: A.K. Kashani-Poor, postdoctoral fellow
FOM-A-20 (E.P. Verlinde)
- Wilson lines, long strings and AdS/CFT
Researcher: M. Kulaxizi, postdoctoral fellow
NWO-Spinozapremie (R.H. Dijkgraaf)
- Supersymmetric gauge theories and matrix models
Researcher: J. Manschot, PhD-student
FOM-A-20 (E.P. Verlinde)
- Mathematical aspects of string theory
Researcher: P.L. McFadden, postdoctoral fellow
EU Marie Curie Research Training Network ‘Superstring theory’ and
NWO-Spinozapremie (R.H. Dijkgraaf)
- Searching for cosmic microwave background signatures of new physics
Researcher: P.D. Meerburg, PhD-student
NWO-toptalentprogramma
- Connecting gauge interactions with gravity through string theory
Researcher: I. Messamah, PhD-student
FOM-A-20 (E.P. Verlinde)
- Fundamental interactions
Researcher: M.P. van der Meulen, PhD-student
FOM-A-01 (F.A. Bais)

- Cosmological vacua in string theory
Researcher: J.M. Oberreuter, PhD-student
FOM-A-20 (E.P. Verlinde)
- Matrix models and supersymmetric gauge theory
Researcher: K. Papadodimas, postdoctoral fellow
FOM-A-20 (E.P. Verlinde)
- Conformal field theories with Lie superalgebra symmetry and string backgrounds with fluxes
Researcher: T. Quella, postdoctoral fellow
EU Marie Curie fellowship
- Quantum gravity and particle physics
Researcher: B.C. van Rees, PhD-student
NWO-Vernieuwingsimpuls (K. Skenderis) and
NWO-Spinozapremie (R.H. Dijkgraaf)
- Mathematical aspects of string theory
Researcher: S. Reffert, postdoctoral fellow
EU Marie Curie Research Training Network
'Superstring theory'
- Nonsupersymmetric flux vacua and perturbed
N=2 systems
Researcher: M. Shigemori, postdoctoral fellow
NWO-Spinozapremie (R.H. Dijkgraaf)
- Quantum gravity and particle physics
Researcher: K. Skenderis
NWO-Vernieuwingsimpuls
- Holographic engineering
Researcher: J. Smolic
private grant
- The fuzzball proposal for black hole physics
Researcher: M. Smolic
private grant
- Holography, duality and time dependence in
string theory
Researcher: M. Taylor
NWO Vidi-programma
- Holography, duality and time dependence in
string theory
Researcher: M. Taylor
NWO Van Gogh Travel grant - cooperative
grant with Ecole Normale Supérieure, Paris,
France

Program 2: Quantum Matter and Complex Systems

- The challenges of the chiral metal
Researcher: D.P.A. Faribault, postdoctoral fellow
FOM-A-25 (K. Schoutens)
- Supersymmetric lattice models
Researcher: L. Huijse, PhD-student
NWO-Pionier project (K. Schoutens)
- Cracking the quantum quench
Researcher: J.J. Mossel
FOM-A-25 (K. Schoutens)
- Topological quantum registers
Researcher: J.C. Romers
FOM-A-25 (K. Schoutens)
- Collective behavior vs. entanglement
in atomic matter
Researcher: O.S. Zozulya, PhD-student
FOM-A-25 (K. Schoutens)

Program 3: History of physics

- Biografie van H.A. Lorentz
Researcher: A.J. Kox
Prins Bernhard Cultuurfonds
- Universiteit en bedrijfsleven, 1877-1940
Researcher: P. Huijnen
Stichting Pieter Zeemanfonds en
Commissie Universitaire Geschiedschrijving
Universiteit van Amsterdam

Appendix C: Staff

Scientific Staff

Program 1: Particle physics, Cosmology and Quantum Gravity

Program leaders

prof.dr.ir. F.A. Bais
prof.dr. E.P. Verlinde

Permanent staff

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