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Introduction

The Delta Institute for Theoretical Physics unites the three existing Institutes for Theoretical Physics of Utrecht, Leiden and Amsterdam. These three institutes share similar research interests, and have come together to further raise the profile of Dutch theoretical physics. The aim of the collaboration is to increase the quality of research, to attract a number of highly talented scientists from the next generation, and to promote a greater connection between theoretical physics and society.



The consortium received a huge boost in December 2012, when it received a grant worth 18.3 million euros to be spent over the next ten years. The grant was awarded by the Netherlands Organisation for Scientific Research (NWO), as part of its 'Gravitation Program'.

Kickoff

The Delta ITP kickoff took place on the 31st October 2013 at Westerliefde, Amsterdam. It was a busy and jubilant occasion, hosted by master of ceremonies and coordinator of Delta ITP Jan Pieter van der Schaar. Prof. Erik Verlinde, chairman of the executive board, gave an overview of the institute's plans and ambitions.

The audience watched the premiere screening of the promotional video of the Delta Institute. Among the many attendees were also the representatives from the Delta ITP industrial partners: ABN-AMRO, the Dutch National Forensic Institute, Shell and McKinsey. The event concluded with a panel discussion, moderated by the Dutch science journalist Margriet van der Heijden, who quizzed the panellists about the Delta ITP research ambitions.



The promotional video's of Delta ITP can be found on the website: ► www.d-itp.nl
More photo's of the kickoff event can be found at Delta's facebook page, ► www.facebook.com/DeltaITP.nl



New staff

As part of the Delta ITP Gravitation program, three new staff members were appointed in 2013. Their expertise is tuned such as to both strengthen the three institutes, and to connect the various research themes.



Lars Fritz (Utrecht)

Lars' research interests range from zero to three dimensional (strongly correlated) electronic and bosonic systems. More specifically, he is interested in quantum impurity problems, transport properties of critical systems, (frustrated) spin systems, ultra-cold atomic systems, and systems with topological order.

More recently, Lars is trying to understand the properties of topological electronic systems under disorder, and understanding order-by-disorder mechanisms in highly frustrated spin systems on the swedenborgite lattice.



Wouter Waalewijn (Amsterdam)

Wouter is a particle physicist, who works on QCD and LHC physics. Until now, there have been no clear hints of physics beyond the Standard Model yet, so it is a good time to develop a more thorough understanding of observables that can be used to identify and characterize new physics. Much of his work has focused on jets, which are sprays of collimated hadrons that are copiously produced at the LHC.

Wouter also works on precision QCD calculations that help reduce the uncertainty on signal and background predictions for the LHC, which is for example important in extracting the Higgs couplings from measurements.



Vladimir Gritsev (Amsterdam)

With a thorough background in string theory and gravity, Vladimir turned to condensed matter physics to get in closer touch with real world systems. His research interests vary on a broad spectrum, and include quantum optics, cold atoms and strongly correlated quantum systems.

His main interest nowadays lies in various aspects of quantum non-equilibrium systems. In his research he uses methods of field theory and integrable models.

Granted proposals

Every year, Delta ITP expects to fund a number of PhD and postdoc positions, assigned to those research projects that serve best the general objectives of the Delta ITP initiative. The projects should strengthen the cohesion, and will have to involve scientists from at least two of the three institutes. In 2013, three postdoc and three PhD research proposals were granted.

Postdoc positions

Topological states at the interface of oxide heterostructures
Cristiane Morais Smith, Kareljan Schoutens, Jan Zaanen

Charting the String Inflationary Landscape
Enrico Pajer, Ben Freivogel, Jan Pieter van der Schaar

Non-trivial Scaling in Holographic Theories in Physics
Umut Gürsoy, Diego Hofman

PhD positions

Holography for Ultra-cold Bosons at Unitarity
Henk Stoof, Jan de Boer, Stefan Vandoren

Impurities in Dirac and Weyl Semimetals
Lars Fritz, Vadim Cheianov, Carlo Beenakker

A topological take on open quantum systems
Vladimir Gritsev, Dirk Schuricht, Jean-Sébastien Caux

Science: output and activities

For a complete list of all refereed publications we refer to the annual report of the Dutch Research School for Theoretical Physics. In total, Delta ITP staff published 227 papers in refereed journals in 2013.

Delta ITP intends to fund three international specialist workshops each year, distributed evenly over the three themes that are part of the Delta research program. All Delta ITP members can send in proposals for such a specialist workshop. In the start-up year, Delta ITP supported the international workshop *Integrability in Gauge and String Theory* (August 19-23, Utrecht). About 150 attendees took part in the event.

In addition, six triangle meetings on theoretical cosmology were organised in 2013.



Grants, awards and honours

Prof. Koenraad Schalm (Leiden University) received a prestigious Vici award for his research program *Applied String Theory: Explaining Quantum Matter with Black Holes*. In recent years, it has turned out that the mathematics of string theory and black holes can also be used to describe condensed matter systems as encountered in everyday laboratories. The most striking example can be found in high temperature superconductors, whose behaviour still begs for an explanation. With his Vici award, Schalm aims to elucidate the mysteries of these types of strongly interacting quantum systems.



Dr Umut Gürsoy (Utrecht University) received a Vidi award to further develop his research program *Wisdom of black holes*. Plasma of elementary particles such as quarks and gluons and plasma of excitations in metals share a surprising property: both are related to the physics of black holes. Gürsoy will explore this peculiar relationship for strongly interacting plasmas.



Prof. Erik Verlinde (University of Amsterdam) has been appointed as member of the *Koninklijke Hollandse Maatschappij der Wetenschappen* (Royal Holland Society of Sciences and Humanities). Verlinde was invited for this honorable membership on account of his accomplishments in theoretical physics. Verlinde was welcomed as new member during the KHMW meeting of 25 May 2013.



Prof. Jan Zaanen (Leiden University) received a grant from the John Templeton Foundation for the research program *Quantum matter: emergence under the spell of the fermion signs*. This research program exploits the very recent discovery that mathematical techniques of string theory (the AdS/CFT correspondence) seem to offer a description of certain condensed matter states. As a direct result of this project, the researchers hope to help pin down a whole new class of material behavior that is of potential consequence to all of fundamental physics.



Education

Twice a year, Delta ITP organises a course on advanced topics in theoretical physics. In the near future, these courses will be given in close collaboration with the Dutch Research School of Theoretical Physics (DRSTP). The lectures are given by staff members from Delta ITP. The courses are intended for PhD and advanced Master students.

The Spring Course 2013 was held in Utrecht, on *Field Theory in Condensed Matter*. Lectures were given by **Cristiane Morais Smith**, **Jean-Sébastien Caux** and **Carlo Beenakker**.

The Fall Course 2013, *Renormalisation, Conformal Field Theory and AdS/CFT*, was held in Amsterdam. Lectures were given by **Henk Stoof**, **Jean-Sébastien Caux**, **Koenraad Schalm** and **Richard Davison**.

The two courses attracted about 60 students in total. The full program of the courses can be found online ► www.d-itp.nl/education

Outreach

Many research members of Delta ITP actively seek opportunities to reach out, to increase the awareness for and the popularity of the exact sciences. Not only by publishing books or articles for a general audience, but also by public appearances at various events, on television, and sometimes even at pop concerts. For a full overview of outreach activities, see ► www.d-itp.nl/public
Some examples from 2013:

Books

Behind the scenes of the universe – From Higgs to Dark Matter (Oxford University Press) In this book, **Gianfranco Bertone** (Amsterdam) illustrates in non-technical terms the far-reaching implications of the discovery of dark matter.

2013 was also the year in which the reissue appeared of the famous *Bouwstenen van de Schepping* (Building Blocks of Creation) by **Nobel laureate Gerard 't Hooft** (Utrecht). The book first appeared in 1992. For the new issue, 't Hooft rewrote several chapters, and even added a few new ones, covering the most recent scientific discoveries as well.

World Science Festival Amsterdam

The Delta Institute also facilitated a preview of the **World Science Festival Amsterdam** (October 4 and 5). The festival opened with the multimedia show *Icarus at the Edge of Time* (written by Brian Greene, music by Philip Glass). Special guest was Dutch ESA-astronaut **André Kuipers**. The opera was performed by the Dutch Metropole Orchestra, and was narrated by the former mayor of Amsterdam, Job Cohen. About 300 children enjoyed the spectacle; their tickets were sponsored by Delta ITP.

The beautiful Lutherse Kerk was the perfect location for the presentation of *Our Universe exposed? Planck's Perfect Echo of the Past Cosmology*. It was introduced by **Briane Greene**, renowned scientist, bestselling author, and, with producer Tracy Day, co-founder of the World Science Festival. It was followed by a panel discussion with **Marco Bersanelli** from the Planck team, and Delta scientists **Erik Verlinde** and **Gianfranco Bertone**. The discussion was moderated by science journalist **Martijn van Calmthout**.

Various

During the *Nacht van Kunst en Kennis* (The Night of Art and Knowledge, Sept 14, 2013), **Carlo Beenakker** (Leiden) gave a public lecture on teleportation as a way of future transport (*Teleportatie: Het vervoermiddel van de toekomst?*).

Stefan Vandoren (Utrecht) appeared in an episode of the Dutch science program *Labyrint* on the nature of time (Dec 8, 2013). The episode can be watched online: ► www.npowetenschap.nl/programmas/labyrint/labyrint-tv/2013/december/Tijd.html

