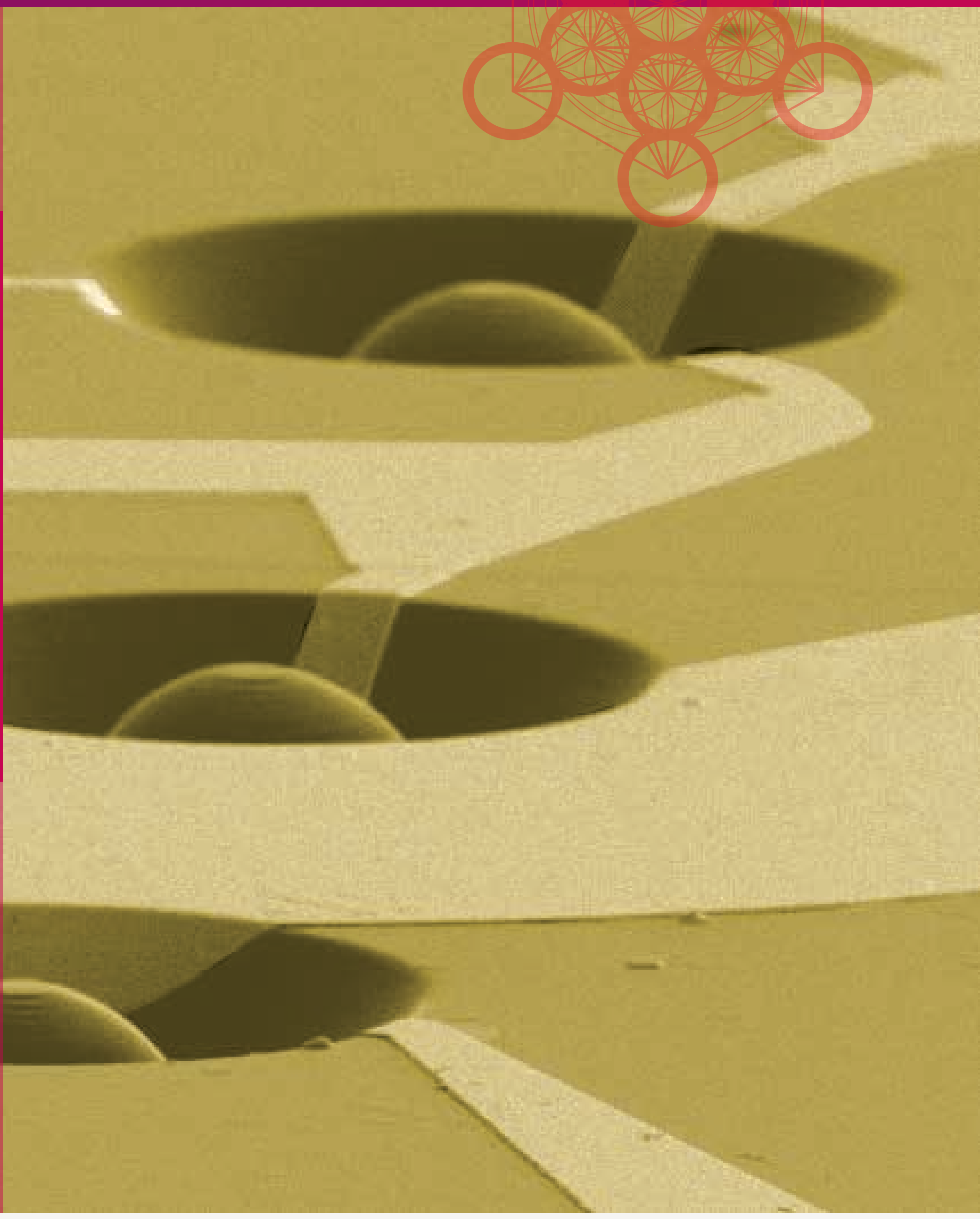
KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft
No.07
June 2013



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From the director

IN THIS NEWSLETTER: THE UPCOMING KAVLI COLLOQUIUM WITH CHARLES MARCUS, RONALD HANSON'S QUANTUM INTERNET, THE START OF NANOFRONT, AND MORE

On March 7th, we will host Charlie Marcus as our Kavli Colloquium speaker. Last year, Marcus moved from his position as Professor of Physics at Harvard University to the University of Copenhagen where he became the director of the Center for Quantum Devices at the Niels Bohr Institute. His research focuses on the quantum properties of electrons in quantum dots, carbon nanotubes, and graphene. He is working toward physical realizations of quantum information processing systems, involving quantum coherence in electronic devices. We very much look forward to his Kavli Colloquium on June 13th. In this Colloquium, see page 2 and 3 of this newsletter, Markus will question whether 'nano' is the way to go to build a quantum computer – an intriguing question, so don't miss it.

A recent highlight from our Kavli Institute's research is the work by Ronald Hanson's group where they managed to bring two electrons into a quantum-entangled state, even when they were physically separated by 3 meters. This interesting result was advertised as establishing a main building block of a quantum network for communication between future quantum computers – a quantum internet, where the entanglement can be used for teleportation of quantum states, offering the possibility of sending information in a completely secure way. Read about it on page 10. In this newsletter, we also inform you of the enthusiastic start of NanoFront (see page 6 and 7), where we have now allocated 22 PhD projects and decided on the directions for hiring 9 new faculty members.

Furthermore, you can read a column by columnists Miriam Blaauboer, who approaches scientific interactions from a game theoretic point of view, as well as enjoy a column by Bojk Berghuis who challenges the notion that our nanoresearch should be driven by applications. And there is more in this newsletter: self-introductions by faculty members Timon Idema and Andrea Caviglia, and a variety of other new items. Enjoy!

• Cees Dekker

Column

TRUST

Imagine the following. With a group of scientists you are playing a game that revolves around negotiation and cooperation. The game is designed in such a way that although you can win as an individual, it is impossible to get there without making deals with fellow players. Trading takes place in subgroups of players who each hold different assets. At a certain point in the game you and a fellow scientist player are in a position where a certain deal is beneficial for both of you: she, at that moment nearly penniless and without much perspective, will get a chance to reach the deserted island where a treasure is suspected to be buried. You will take her there, thereby making more efficient use of the ferry service you operate, which will bring you into a position where you have a fair chance to win the entire game. It is a clear win-win situation. You close the deal.

And then it happens. A little while later your partner gets an offer from a third player, the one who operates the competing Stena Line. The offer consists of free travel, but a smaller share of the suspected treasure. Slightly different conditions, not obviously more advantageous. Without as much as a blush she takes the offer and breaks your earlier agreement. What do you think?

Interactions among scientists are generally based on trust. This is not a nature-given principle but a choice. In academic institutions-— more so than in many other organisations— trust is chosen as a default basis for professional exchanges, because we believe it to be the best default for scientists to flourish in, the default from which the best science will emerge.

So what do you do when a fellow researcher— a colleague, someone you tend to trust when working together— breaks a deal with you during a game? Or, viewed from the other side: what, as a scientist, is the better strategy — to pursue self-interest even if this might compromise your trustworthiness, or to guard the latter under all circumstances?

Would you, after the experience of the game, enter a real-life collaboration with the deal-breaking fellow player? If yes, then perhaps a strategy proposed by the mathematician Anatol Rapoport in the 1980s will come in handy. Rapoport developed this strategy for obtaining the best outcome in the iterated prisoner's dilemma— the famous game theoretic problem on competition between cooperation and betrayal. The key of his approach, building on earlier work by John Nash, was to start by collaborating with his partner and in subsequent rounds to either keep collaborating or breach collaboration, depending on which of these two the other player had chosen to do during the previous round. It turned out to be a highly successful strategy for showing the other side the benefits of collaboration and thereby offers a practical way to manage trust.

• Miriam Blaauboer

Interview

INTERVIEW CHARLES MARCUS

What would you say are the events or major influences that have steered you toward your present research interests?

My interest in experimental research can probably be traced back to my parents. My mother is a brain scientist and my father, while not a scientist, loved to tinker in the garage on old cars, and build mechanical and electronic gizmos. An early influence in research was working as an undergraduate at Stanford on a large experiment called GP-B, which involved putting gyroscopes in space. I really got into it, spent much of my undergraduate years in the lab, and felt like I was part of a large team. I loved that.

As a graduate student, I ended up (eventually) working in a very interesting field called neural networks, which I still find fascinating in fact, about how large simple elements (switches, neurons, spins) behave when connected together by certain coupling rules, and if these coupled elements can "learn" to have desired dynamics, like programming memories in a brain. I learned a lot during this period, both about myself (that I'm not a particularly talented theorist, but that I am fairly good at identifying open problems, even if I'm not that good at solving them), and I also learned a lot of math and programming. When I decided at the end of graduate school that I really oughtn't be a theorist, I started a postdoc in the same group, Bob Westervelt's group, at Harvard, which was an experimental group anyway. I was very lucky that Bob let me cross back into experimental work at that time.

What were the deciding factors for your move from Harvard to the Niels Bohr Institute in Copenhagen?

It's hard to say, of course, but my family and I felt happy in Copenhagen. We all liked the place, the people we met, and, well, I felt up for a new challenge. Of course, we had good friends in Boston, but we've kept them as we've made new friends here. Maybe the best way to say it is this: it was a new chapter to our lives. The previous chapter was excellent, but it's always a pleasure to start a new chapter.

Do you find any big similarities or differences between research performed in the US and in Europe?

More similarities than differences. One difference is the masters degree program. I don't have a good intuition yet for designing masters projects. I'm learning that. And admitting students for the PhD into groups instead of into departments, that's quite different. But many aspects — the most important aspects, I would say — are not very different. The challenge of research (thinking of good problems), of educating students, of writing papers, of keeping a lab running well: those challenges are the same.

What are the short and long term goals of the new center at the Niels Bohr Institute?

The short term goal of QDev is to create an new research activity that spans experiment, theory, and materials growth, with great instrumentation, great interaction between people, where it's easy to be productive and creative, and where new ideas come quickly because people are talking and thinking, and trust each other.

The long term goals are roughly the same. Copenhagen's role in the history of quantum physics is that it was a place where ideas were born because of the community and culture that Bohr created. That is something to aspire to.

Finally, what words of advice could you pass on to young, budding scientists in the field?

Excellence in any endeavor takes focus and sustained interest. Find something that you enjoy enough to concentrate on it for a long time without getting bored. You'll then get good at it more or less automatically. If you are bored, don't be afraid to switch to something that seems more interesting. So, bored? Move on. It is convenient for universities to discourage lateral moves. But that's just for the school's convenience. Keep moving laterally until you find something that you really find interesting.

Be completely honest as a researcher. Express doubt when you have doubt, express disagreement when you disagree (politely, of course). Say, "I don't understand" when you don't understand. As scientists, that's all we have.

• Joshua Island

Kavli Colloquium

"QUBITS AND NANOSCIENCE"

IS NANO THE WAY TO GO TO BRING A QUANTUM COMPUTER?

CHARLES MARCUS, COPENHAGEN

June 13, 2013 will feature a Kavli colloquium by Charles Marcus. The abstract of this colloquium reads as follows:

This talk explores the relationship between "nano" and "quantum" for the challenge of building coherent electronics for quantum information processing. Trends and accomplishments in solid-state realizations of qubit systems will be discussed and compared. The tools of nanotechnology have much to offer next-generation electronics, but small sizes can quickly spoil quantum coherence times. Is nano the way to go to build a quantum computer? Work supported by Microsoft, IARPA, and the DNRF. •

Charles Marcus

15.00 h	Pre-program: Topology in nanoscience
	15.00 Timon Idema : Topology in biological development 15.20 Andrea Caviglia : Topology in the new oxide material 15.40 Leo DiCarlo : Topology in quantum circuits
16.00 h	Break
16.15 h	Kavli colloquium by Charles Marcus: "Qubits and Nanoscience"
17.15 h	Drinks & time to meet

Extra seminar

"THE RESONANT EXCHANGE QUBIT"

On June 13 Charles Marcus will additionally present a lecture: "The resonant exchange qubit". The abstract for this lecture reads as follows:

This talk discusses recent work on a three-electron spin qubit that realizes full qubit control using the exchange interaction between two pairs of electrons to create both the static longitudinal field and oscillatory transverse field. One qubit operations are demonstrated and plans for two-qubit circuits discussed. Work supported by IARPA and the DNRF. •

Kavli Colloquium

"QUBITS AND NANOSCIENCE"

Date : June 13 2013 at 15.00 hours
Location : Theaterzaal, building 37/38, Mekelweg 8-10

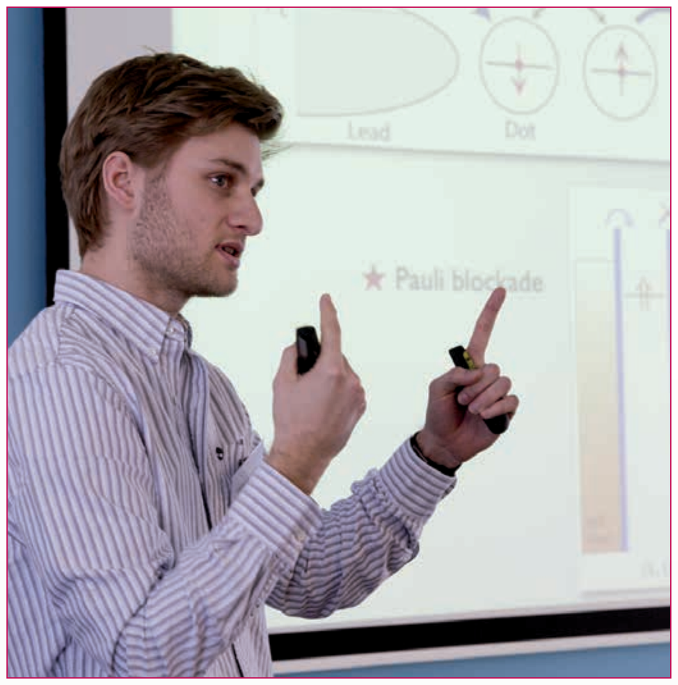
Extra seminar

"THE RESONANT EXCHANGE QUBIT"

Date : June 13, 2013 at 11.00 hours
Location : Lecture room F, TN Building, Lorentzweg 1

News

JOINT MEETING WITH THE MAX PLANCK INSTITUTE OF QUANTUM OPTICS



On April 17 and 18, a joint meeting between the Max Planck Institute of Quantum Optics (MPQ) and the Kavli Institute took place here in Delft. The groups of Gerhard Rempe, Ignacio Cirac and Immanuel Bloch from MPQ came to confront ideas and experiences from their field - quantum physics with atoms and photons - with those emerging in Delft in the quantum control of solid-state systems.

The two fields can seem distant at first sight, especially as they require very different experimental systems and skills. However, the talks and discussions at the meeting showed important similarities. Not only are we all building a better understanding and control of the quantum world, but we are also addressing, with different tools, very similar questions.

To give an example, I am currently building a periodic array of quantum dots to study how the momentum of the electrons, constrained by periodicity, interplays with their angular momentum, constrained by magnetic fields. It was for me very inspiring to see experiments aimed at forcing neutral atoms to behave as charged particles in a magnetic field in order to study the very same interplay with cold atoms. There were also theoretical proposals showing how trapped ions could allow studying the physics related to the quantum Hall effect and its topological consequences.

My impression from the meeting is that solid-state devices, trapped ions, photons and atoms offer complementary tools to study the quantum world and that we all need to learn from the research in the other fields to make progress in our own.

This impression seemed to be shared at the MPQ, as they invited us to repeat the meeting next year in Garching. Along with the invitation came a challenge for a Kavli-MPQ soccer game… Hup Holland Hup!

• Pierre Barthelemy

EPJ YOUNG SPEAKERS CONTEST

HANNES BERNIEN WINS THE EPJ YOUNG SPEAKERS CONTEST AT FYSICA 2013

With his talk entitled "Quantum entanglement over 3 metres" Hannes won the national EPJ Young Speakers Contest at the annual meeting of the Dutch Physics Society - Fysica 2013. The prize is a cash award, a certificate and eternal fame. •

ROYAL HONOUR TEUN KLAPWIJK

Teun Klapwijk was appointed appointed Knight in the Order of the Dutch Lion. Teun received this award for his pioneering and leading academic work in the field of superconductors. Furthermore he was at the forefront of initiatives like the Casimir Research School Delft-Leiden, the Lorentz Centre and the Zernike Institute. We congratulate Teun for this honorable award. •

RECTIFICATION

In the last Kavli Newsletter (No.6) the second paragraph of the article on ERC Synergy was mixed up with a paragraph of another article. We apologize for the inconvenience. The correct text of the ERC Synergy article can be found in the pdf-version of the Kavli Newsletter No. 6 on the Kavli website (http://kavli.tudelft.nl/wp-content/uploads/2013/03/TU_KAVLI_NEWSL_NR06-13_WEB.pdf). •

Introduction new faculty

Timon Idema

A SELF-INTERVIEW BY TIMON IDEMA

Last December, at the (presumably) traditional BN Christmas dinner, the PhD students reported the results of their (presumably also traditional) annual investigation into the running of the department. They found that the answer to the question "What does it take to be hired as a PI at BN?" this year simply seemed to be: "Be a theorist." Though I somewhat doubt whether this truly was the search committee's criterion, I am happy that the department decided that it would be good to have a theory section, and I am glad to be hired as a member of it.

I must confess it was daunting - joining a department that is predominantly experiment-focused - when, whenever I happen to find myself in a lab, I make sure not to touch anything. At the same time, my expectations were high - I've always tremendously enjoyed working directly with experimentalists on a joint project. The possibilities of doing so again at the Kavli Institute seemed excellent, and so far I've had a great time learning what everyone is busy doing. I see no reason why this shouldn't get even better once actual joint projects get started.

So, when I like working with experimentalists so much, why don't I do experiments myself? Leaving aside for the moment the question of if I even could do experiments if I wanted to, the reason I chose to study theoretical physics is because it combines two sides of my personality. On the one hand, I am fascinated by the natural world and intensely curious about how things 'work'. On the other hand, I love the abstract world of mathematics, which, perhaps surprisingly, embodies many aspects also found in language and art. The mere fact that you can use the one (math) to make some sense of the other (nature) never ceases to amaze me and makes me feel privileged to be able to work at the intersection of both.

Now that biology has joined the mix, the number of possibilities has exploded once more, to the extent that it is hard to choose what is the most fascinating problem to work on - in the Kavli Institute alone there are already so many interesting experiments being done that I need never worry about not having anything to work on. My main focus at present is on collective dynamics. On the nanoscale of proteins embedded in membranes, we study how they interact via deformations they impose on that membrane, and use those to self-organize into patterns. On the microscale of cells and bacteria, we look how signaling of different kinds - by chemical or mechanical means - results in complex collective behavior. Like with the magnetic beads that we got at the Nanofront kickoff, the number of different things you can create in this way is almost endless, even though the basic particle-particle interaction is simple and well understood. Nature, of course, has exploited pretty much every single one of these possible combinations, creating for us the wonderful puzzle of finding out exactly how nature did that. A puzzle which will keep me, and hopefully through collaborations many of you, busy for many years to come.

As a theorist, not bound to working in a lab, there is the pitfall that you're working (or thinking about work, which in my case is pretty much the same thing) always and everywhere. Sometimes this is true, particularly so when there's a new puzzle to think about. The best way to leave the work behind is to do some completely unrelated, fun, activity - say hiking in some more mountainous country than this one, or visiting a museum. Both of these my wife, Mariska, and I enjoy a lot (and yes, they are typical scientist's hobbies, I know). At such relaxed moments, it often happens that something unexpected will strike my eye, prompting me to start speculating about the underlying principle right away. Fortunately, this usually makes Mariska smile.

Since we're both Dutch, it's good to be back here after our extended honeymoon (2.5 years) in the US. It's great to be able to bike to work again, or take the train to go have dinner with friends visiting Amsterdam. A new thing I picked up recently (thanks to the workshop at the Kavli day) is photography, which I'm having great fun learning, and helps me see many aspects of familiar places from a fresh perspective. Which of course starts me off speculating again.

So, I'm glad there's now a place for theorists at Kavli-BN, glad to be one of them, and I am looking forward to talking and possibly working with all of you!

• Timon Idema

NANOFRONT KICK-OFF EVENT

15 April 2013

Credit: Rob von Römer and Angela de Ceuninck van Capelle

NANOFRONT NEWS

News

NANOFRONT RESEARCH IS TAKING OFF

NanoFront – the consortium of nanoscientists at the Kavli Institute of Nanoscience Delft and the Leiden Institute of Physics (LION), already connected in the joint Casimir Research School – will explore three themes: Frontiers of Quantum Nanoscience, Frontiers of Bionanoscience, and Frontiers of Nanotechnology. The 51 M€ grant will be used for new investments in infrastructure and general equipment (about 10 M€), 9 new hires with start-up funds, 88 new PhD students and many other activities like retreats, workshops, education, knowledge utilization and outreach.

NanoFront has made a start with an exciting kickoff (See previous page).

A decision was made regarding the research direction of the 9 new faculty hires – quite an extensive expansion of LION and our Kavli Institute – see table. Three outstanding candidates were already identified: Andrea Caviglia (nanodevices from new oxides) has already started working and Anton Akhmerov (theory of quantum devices) and Luca Giomi (biophysical theory) will start this fall.

Finally, following the first competitive internal PhD call in NanoFront, 22 PhD-projects were granted as listed below. Upon hiring these PhD students and starting these projects, NanoFront is well on its way to some exciting science!•

Research direction of new NanoFront hires	Location
Theory of quantum devices	Kavli-QN
Nanodevices from the new oxides	Kavli-QN
TEM of quantum materials	Kavli-QN
Hybrid quantum-bio devices	Kavli-QN
Nanophysics of quantum matter	LION
Biophysics theory	LION
Physics of cancer	LION
Cellular chromatin biology	Kavli-BN
Bottom up synthetic biology	Kavli-BN

Title of proposals	Applicants
Synergy proposals (in alphabetic order)	
Controlling supercurrents with spin currents	Jan Aarts, Paul Alkemade
Functionalized gold nanorods: local biosensors of intracellular redox homeostasis	Thijs Aartsma, Gerard Canters and Michel Orrit
Bacteria-mediated fabrication of nanostructured artificial nacre	Marie-Eve Aubin-Tam, Anne Meyer
Improved nanowire materials for Majoranas	Erik Bakkers, Leo Kouwenhoven
Sequence dependent plectoneme dynamics	Gerard Barkema, Helmut Schiessel
Bionanoelectronics: unlocking the secrets of bacterial nanowires	Bertus Beaumont, Herre van der Zant
Towards a new generation of switchable molecular devices: tunable nanoparticles networks driven by multiple cotunneling	Mirjam Blaauboer, Sense Jan van der Molen
Quantum matter nanodevices	Andrea Caviglia, Lieven Vandersypen
Probing chromatin structure using novel magnetic tweezers approaches	Nynke Dekker, John van Noort
Real-time TEM imaging of DNA dynamics	Cees Dekker, Henny Zandbergen
Shaping membranes through self-assembly of adsorbing nanoparticles	Doris Heinrich, Daniela Kraft
Exploring nano experiments on quantum matter	Hans Hilgenkamp, Tjerk Oosterkamp, Jan Zaanen
The molecular-size spectrometer	Gary Steele, Peter Steeneken
Single-Applicant proposals (in alphabetic order)	
Topology in nanomechanics	Anton Akhmerov
Signatures of topological superconductivity in oxide interfaces	Carlo Beenakker
Optical lattices with Ag: DNA Origami	Drik Bouwmeester
QuEEN: Quantum-Entangled Electronic Networks	Leo DiCarlo
Go Live: TEM nano-imaging of catalysts 'in action' under relevant conditions	Joost Frenken
How bacteria program their genome to fight against viruses	Chirlmin Joo
Can we predict and control quantum jumps?	Yuli Nazarov
Imaging majoranas	Sander Otte
Towards dc current driven nanomachines	Jan van Ruitenbeek

TASTY ATOMIC SANDWICHES

News

KAVLI NANOSCIENCE NEXUS IN PUERTO RICO

Around the world, the Kavli Foundation has initiated and funded four institutes that pursue cutting-edge research in the area of nanoscience, located at Caltech, Cornell, Harvard, and Delft. For the first time, scientists from these four institutes will gather for a joint scientific meeting: The Kavli Nanoscience Nexus in Puerto Rico from May 29th until June 1st. This is a scientific meeting where leading scientists from these institutes meet to exchange information. It features talks by all participants and open discussions about future areas in nanoscience. The meeting aims to foster future collaborations among scientists of the different institutes. It also marks the start of a new student exchange program where PhD students will have the opportunity to do some research in a group in one of the other Kavli Institutes. •

New employees

NEW EMPLOYEES DEPARTMENT BIONANOSCIENCE

Name	Date of employment	Title	Lab
Mathia Arens	05/01/13	PhD	Anne Meyer lab
Richard Janissen	05/01/13	Postdoc	Nynke Dekker lab
Orkide Ordu	05/01/13	PhD	Nynke Dekker lab
Huohg Thi Bui	05/06/13	Postdoc	Christophe Danelon lab
Eldad Ben Ishay	07/17/13	Postdoc	Nynke Dekker lab

NEW EMPLOYEES DEPARTMENT QUANTUM NANOSCIENCE

Name	Date of employment	Title	Section
Caroline Westerhout	3/04/13	Management assistant	KN
Olli-Pentti Saira	1/15/13	PD	QT
Marijn Tiggelman	2/18/13	Technician	QT
Paul Baireuther	2/01/13	PhD	TN
Sébastien Plissard	4/01/13	PD	QT
Shun Yanai	4/01/13	PhD	MED
Ahmed Erdamar	5/01/13	PD	HREM

KAVLI DAY 2013
SAVE THE DATE !
SEPTEMBER 12

at 12.00h
at Prinsenhof, Delft

INVITED SPEAKER:
Hans Mooij,
'Delft - the history of its city and its university'.

Introduction new faculty

Andrea Caviglia

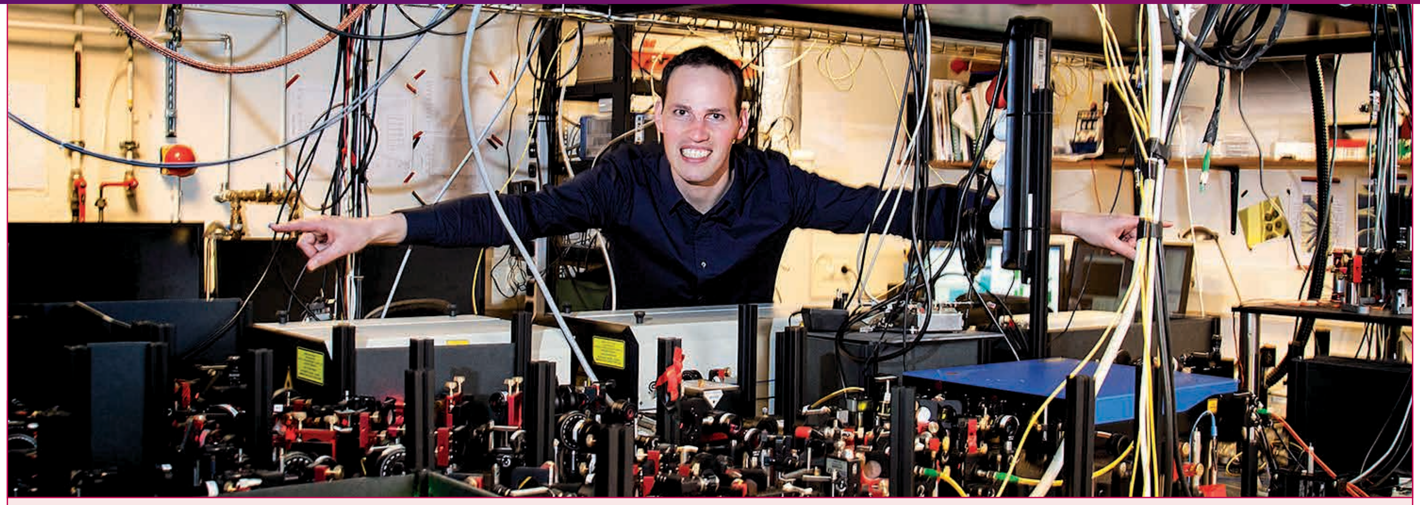
A SELF-INTERVIEW BY ANDREA CAVIGLIA

Our behaviour is strongly influenced by our surroundings. This principle is well known to anyone that lives close by a fast food restaurant. In my research I expose quantum materials to unusual surroundings to try and influence their behaviour and, sometimes, generate new unexpected properties. I do this by creating sandwiches on the atomic scale: a very thin layer of an "unstable" material finds itself surrounded by unfamiliar neighbours. How will he react? In a way I find myself in a similar scenario, being surrounded by an unfamiliar language and new responsibilities. I certainly hope that this new environment will cement my love for science and spur new collaborations. The quality of research at the Kavli Institute is outstanding and I am counting on some sort of "proximity effect". Hopefully this effect works both ways.

The path that led me here begins in a beautiful Riviera beach town in the north of Italy, where I grew up. It continues on the way to Genoa, where I did my undergraduate studies. During this time I met quantum mechanics and my English wife. Both have had a permanent effect on my life. The path then crosses the Alps towards Geneva, where I started tinkering with materials. Here, I was privileged to be involved in a beautiful discovery: at the interface between two very good insulating materials you can find a superconductor. I also rediscovered the French language, how much I love mountains, and skiing became a new passion. There is something special about coming down from the top of a mountain on your own legs. The path finally takes me to northern Europe via Hamburg, where I carried out a fruitful postdoc project. There, I began toying with light and free-electron lasers to influence the behaviour of my atomic sandwiches and watch their transformation on the femtosecond time scale. The way I tried to achieve this was unorthodox: rather than directly stimulate a certain material with light, I shook the lattice of its neighbour. My brain so far has resisted the German language tooth and claw. Hopefully it will give way to Dutch.

At the Kavli Institute I plan to start a condensed-matter physics research programme with a strong focus on quantum nanoscience. The commissioning of my lab is underway and I am recruiting a small team. There we will cook up the tastiest atomic sandwiches. I do look forward to plenty of interactions with the other members of the Institute. Lieven already wants to grab a bite. Anyone else peckish? Who knows, maybe quantum materials could find their way into bionanoscience applications?

• Andrea Caviglia



TU DELFT RESEARCHERS LAY SOLID FOUNDATION FOR A 'QUANTUM INTERNET'

The group of Ronald Hanson has managed to bring two electrons, three metres from each other, into a quantum-entangled state. This result marks a major step toward realizing a quantum network that can be used to connect future quantum computers and to send information in a completely secure way by means of 'teleportation'. The results have been published online on 24 April in Nature.

Entanglement is arguably the most intriguing consequence of the laws of quantum mechanics. When two particles become entangled, their identities merge: their collective state is precisely determined but the individual identity of each of the particles has disappeared. The entangled particles behave as one, even when separated by a large distance. Einstein doubted this prediction, which he called 'spooky action at a distance', but experiments have shown that entanglement is real. Entangled states are interesting for computers as they allow a huge number of calculations to be carried out simultaneously. A quantum computer with 400 basic units ('quantum bits') could, for example, already process more bits of information simultaneously than there are atoms in the universe. In recent years, scientists have succeeded in entangling quantum bits within a single chip. Now, for the first time, this has been successfully achieved with quantum bits on different chips.

Hanson and his colleagues worked with electron quantum bits in different diamonds separated by several metres. As the two electrons do not feel each other at this large distance, the researchers used light particles to mediate the required interaction. To prove the resulting entanglement, the spin orientation of both electrons was read out and compared. Although the spin orientation of each electron individually was completely random, exactly as predicted by quantum mechanics, the researchers found that the two orientations were always exactly opposite to each other. This proves that the two electrons are entangled and behave as a single entity. 'Incidentally, the three-metre distance between the electrons was chosen quite arbitrarily. We could conduct this experiment over much larger distances', Hanson adds.

Besides being of fundamental interest, the publication in Nature is likely to be an important impulse for the development of new quantum-based technologies. Firstly, remote entanglement is the main building block of a quantum network for communication between future quantum computers – a quantum internet. Secondly, the entanglement can be used for teleportation of quantum states, offering the possibility of sending information in a completely secure way. •

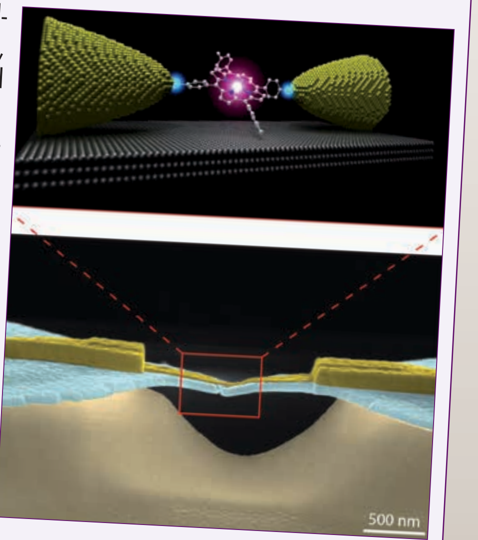
H. Bernien, B. Hensen, W. Pfaff, G. Koolstra, M.S. Blok, L. Robledo, T.H. Taminiau, M. Markham, D.J. Twitchen, L. Childress, and R. Hanson.
Nature doi :10.1038/nature12016, Published online 24 April 2013

LARGE SPIN-ORBIT COUPLING IN CARBON NANOTUBES

The spin-orbit interaction is a relativistic effect that couples the spin of an electron to its orbital motion. In their recent report in Nature Communications, Steele et. al explored spin-orbit coupling in ultraclean carbon nanotube devices, finding anomalously large spin-orbit interactions, an order of magnitude larger than expected. These intriguing new results raise questions about our understanding of electronic states in these remarkable materials. •

G.A. Steele, F. Pei, E.A. Laird, J.M. Jol, H.B. Meerwaldt &
L.P. Kouwenhoven
Nature Communications,
Volume: 4, Article number: 1573,
DOI: 10.1038/ncomms2584

EFFECT OF IMAGE-CHARGES ON ELECTRON TRANSPORT BETTER UNDERSTOOD



A single molecule between two metallic electrodes is an electronic device, as it can be used as an extremely small transistor or a very accurate sensor. PhD student Mickael Perrin has discovered an effect that plays a major role in such devices: the formation of so-called 'image-charges' in the metal contacts strongly enhances electron transport through the molecule. It was already known that image-charges influence charge transport through molecules, but for the first time this effect has been demonstrated experimentally in a single molecule and systematically investigated. •

M.L. Perrin, C.J.O. Verzijl, C.A. Martin, A.J. Shaikh, R. Eelkema, J. H. van Esch, J.M. van Ruitenbeek, J.M. Thijssen, H.S. J. van der Zant & D. Dulić
Nature Nanotechnology 8, 282-287, DOI: 10.1038/nnano.2013.26

HIGHLIGHT PAPERS

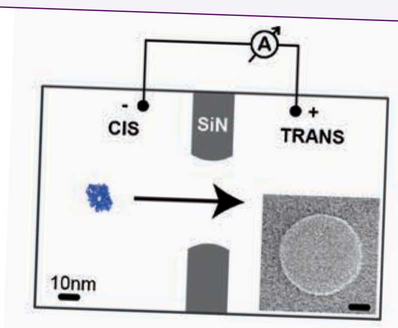
LONG-DISTANCE COHERENT COUPLING IN A QUANTUM DOT ARRAY

Scientists from Delft University of Technology and the FOM Foundation have successfully allowed electrons to jump between quantum dots located far from each other. The electron jumped between the ends of a chain of three small semiconducting islands (so-called quantum dots) without crossing the island in the middle. This process makes it easier to use quantum dots in future quantum computers. The researchers published their findings on 28 April online in the journal Nature Nanotechnology. •

F.R. Braakman, P. Barthelemy, C. Reichl, W. Wegscheider, L.M.K. Vandersypen
Nature Nanotechnology, advance online publication (2013)

FAST TRANSLOCATION OF PROTEINS THROUGH SOLID STATE NANOPORES

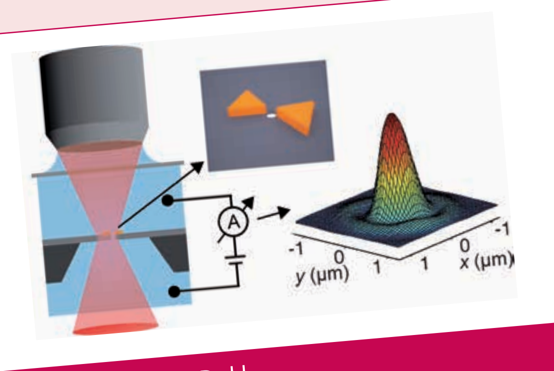
When proteins translocate through a solid-state nanopore, one finds that the event rate is extremely low: orders of magnitude smaller than what is theoretically expected. Using a number of experimental and theoretical approaches, we study this phenomenon in detail and conclude that the vast majority (>99.99%) of proteins move though the pore so fast that they escape detection. The paper suggest a number of technical improvements. •



C. Plesa, S.W. Kowalczyk, R. Zinsmeester, A.Y. Grosberg, Y. Rabin, and C. Dekker.
Nano Letters 2013 13 (2), 658-663.

PLASMONIC NANOPORE FOR ELECTRICAL PROFILING OF OPTICAL INTENSITY LANDSCAPES

This paper reports a new type of device, plasmonic nanopores, that is used to profile low-intensity optical landscapes at subdiffraction-limited resolution. These plasmonic nanopores combine a gold bowtie nanoantenna and a solid-state nanopore. The plasmonic antenna interacts strongly with light and converts local light intensity to heat. Corresponding changes in the nanopore's temperature are monitored and quantified through changes in the ionic nanopore conductance. •



M.P. Jonsson and C. Dekker
Nano Letters, 2013, 13 (3), 1029-1033

Column

KEEP IT FUNDAMENTAL

As a young kid I was a collector of almost anything one can think of. Natural objects such as rocks, (dried) plants, animal skeletons and insects had my particular interest. I spent hours looking at insect wings and drawing them as I saw them through the objective of my kiddy microscope. Or growing salt crystals with my home chemistry set. In hindsight it must be no wonder for my parents that I ended up doing a PhD in the natural sciences. Because at our Kavli Institute of Nanoscience, people are pursuing exactly what I was practicing for back in the days: purely curiosity-driven research: fundamental research, often without a direct apparent practical application. Take the viral polymerase molecular motors I'm observing through my microscope-for-grown-ups these days; in the far future this may lead to novel anti-viral vaccines, but as for now, all we really want to do is understand how nature works. People in the lab are not in it for the money, they are driven by curiosity.

In the Netherlands, however, I often get the impression that research without an apparent practical application is frowned upon. If the question "how can we make money off of this?" is left unanswered for too long, or if a link with industry isn't made too soon, funding tends to dry up quickly. Even at stichting FOM, the Dutch organization for fundamental research on matter, a strong emphasis is made on how a PhD candidate should be able to 'valorize' his or her research.

At the recent Nanofront kick-off event, speaker Tjerk Oosterkamp set a target saying that 10% of all PhD students in this fundamental field should end up having their own start-up company. I think this is a wrong starting point. Of course more often than not, even the most fundamental research leads to useful practical applications at some point. But having this question in the back of your mind as a researcher leads to primitive, short-term based research.

This is also one of the main conclusions from a recent report from the Dutch advisory council for science and technology (AWT). The council compared the degree of innovation in science and technology between The Netherlands and Germany. A few observations: Germany spends almost double the percentage of its GDP on R&D. As opposed to our germanic neighbors, The Netherlands has made a habit of changing strategies and fund allocations, and cooperation with industry now is often a prerequisite. Since the economic crises of 1970s, The Netherlands, together with other Western countries save Germany, has moved towards becoming a post-industrial society. Germany has consistently invested in fundamental research and (high-tech) industry. In our small country, we've adopted the Anglo Saxon view that companies should be lead by people with financial backgrounds and MBAs instead of people with a background in the core business of the company. The consequences – Germany's booming high-tech industry and the struggles of all other Western nations – are, I think, self-explanatory.

A prime example of this shift away from fundamental research is the decline of Phillips' NatLab in recent decades. This was once a phenomenal research institute where hundreds of world-class scientists were encouraged to pursue their curiosity-driven, fundamental research. NatLab used to be the Dutch equivalent of Bell Labs in the US, and many inventions in radio and audio technology were made. Nowadays enormous budget cuts and reorganizations have decimated NatLab's size and reputation. Phillips has adopted the (ironically, quite appropriate) slogan 'sense and simplicity'. The top management seems more bothered by the look & feel that a certain color LED lamp invokes than developing revolutionary high-tech electronics and devices.

I say it is time for politics and management to wake up and value science for what it is. As for all the PhD students doing fundamental research out there: let curiosity be the main driving force behind your project!

•Bojk Berghuis

Science art

Artistic impression of a minimal protein biosynthesis machinery compartmentalized inside lipid vesicles. (ACS Synthetic Biology, Jan. 2013; DOI: 10.1021/sb300125z).
Credit: C.J.A. Danelon et al.
Artist impression made by Alex de Mulder, www.avalondesigns.nl,

Please send suggestions for 'Science Art' to Amanda van der Vlist, A.vanderVlist@tudelft.nl

Kavli Day

HANS MOOIJ

September 12, 2013

Delft University of Technology

Upcoming Kavli colloquium

PAUL ALIVISATOS

October 31, 2013

UC Berkeley

CONTRIBUTE TO THIS NEWSLETTER

Input to forthcoming newsletters is very welcome. Please send any relevant material to Amanda van de Vlist (A.vanderVlist@tudelft.nl).
If you like to contribute to this newsletter as an editor, please contact Cees Dekker. •

Colofon

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