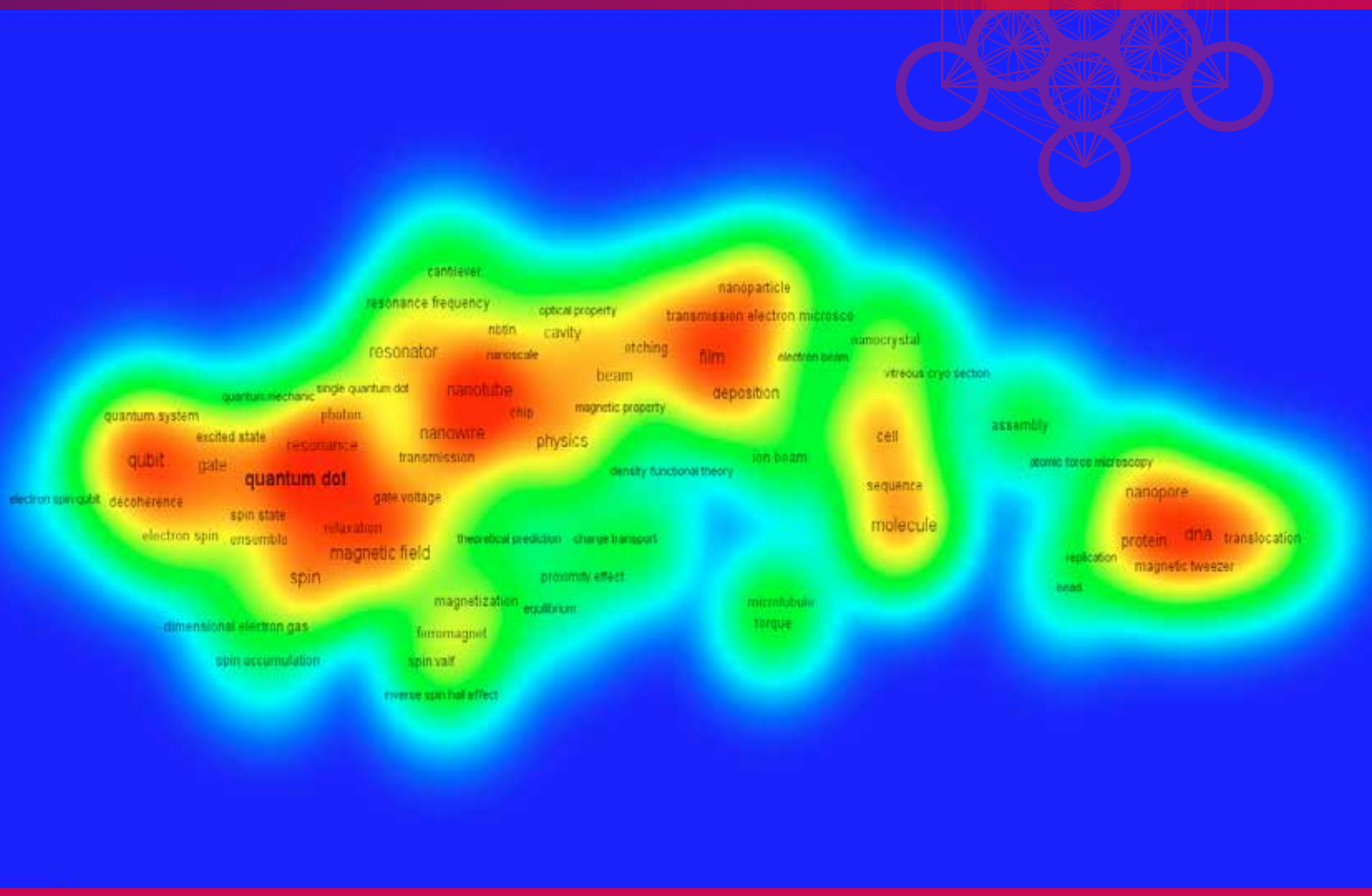
KAVLI NEWSLETTER

Kavli Institute of Nanoscience Delft

No.10

June 2014



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Royal Honours for Leo Kouwenhoven and Cees Dekker

J. van Aartsen, L. Kouwenhoven, C. Dekker

On 25 April in Theatre Diligentia in The Hague, Cees Dekker and Leo Kouwenhoven have been named Knight in the Order of the Netherlands Lion. They were presented with the Order for their pioneering scientific work of great societal relevance.

IN THIS NEWSLETTER

On June 12, we will host Eric Betzig as our Kavli Colloquium speaker. Betzig is a remarkable scientist with an unusual history (read about it on page 2). He did groundbreaking work when he pioneered the PALM super-resolution technique to optically image below the diffraction limit. The recent superresolution techniques, of which Betzig is one of the heroes, open up the nanoscale world to optical imaging with near-molecular resolution. In his Kavli Colloquium, Betzig will focus on some fascinating applications to biological systems, see page 3 of this newsletter. Furthermore, he will give 'a highly opinionated' technical overview of various forms of superresolution microscopy on Friday June 13.

In this newsletter, we also highlight some of the – perhaps surprising – links between our two departments of quantum and bionanoscience, see page 5. Furthermore, you can learn what stirs most attention in our institute in a column on food by Bojk Berghuis and one on new 'qpads' by Miriam Blaauboer. So, enjoy this newsletter!

• Cees Dekker

COLUMN

At the QApple Store

The scene is a QApple Store, around 2050. An elderly customer enters the store and looks around uncertainly. A young salesman notices and approaches.

Salesman Can I help you, Sir?
Customer Eh… yes… (hesitates) … I… eh… am looking for a personal quantum computer.
S Certainly, Sir. PQC's are our main business. We have the qMac 6 or the A-wave 10.
C (looking puzzled) Eh… what are the differences?
S The qMac 6 is QApple's latest model PQC. It runs the turbo-Shor algorithm which decrypts any RSA code in less than nanoseconds. It also predicts the weather for the next forty-two days with 100% accuracy.
C Forty-two days?
S And increasing, Sir. By at least two days with every new version of the weather app.
C (doubtfully) Aha. (Pause) And the other one you mentioned, the… eh…
S The A-wave 10? Well, that's a bit of a story. We at QApple took over a small quantum computer company many years ago. The machines they fabricated were vastly inferior to our MacBook Pro, but we did see some potential in them. We exchanged their chips for QApple ones, did ultra-slim restyling and gave the computer a new name. The A-wave is now a fabulous PQC, Sir. Version 10 comes both in touchscreen and eyeblink.
C Eyeblink?
S (patiently) You operate it by blinking with your eyes.
C I see. (He stands for a moment deep in thought) I think I would prefer touchscreen.
S The A-wave 10 is a great special purpose machine. It can for example predict in which wonderful shape the proteins in your cells are most likely to fold. (The customer looks at him, dumbfounded) Are you taking any medicine, by any chance, Sir?
C (taken aback) Eh… well…
S (without taking any notice) Based on protein shapes this computer calculates the optimal way for you to take your monthly dose. It tells you whether to for example take your pills one per day or drink the whole lot in one go and then wait for a month.
C Ah. (Quietly, after a pause) Well, actually, what I wanted to ask is… Can I play Pac-Man on a quantum computer?
S Excuse me, Sir?
C (clears his throat) Can I play Pac-Man on this computer?
S (after the slightest hesitation) Sure, you can play quantum Pac-Man on any of our computers.
C (eagerly) How much faster is he? On a quantum computer?
S Well, since quantum Pac-Man is able to take several routes simultaneously and interfere with himself, he is exponentially faster.
C (intently) Really? And how about the ghosts? How much faster is the enemy?
S I am not sure, Sir, but… (conspiratorially) I heard that they are only $\sqrt{t}$ faster.
(The customer's face lights up).
S I recommend our quantum tablet, Sir. (He takes a box out of a cupboard) This is the qPad 13. An excellent choice for quantum gaming. All you need to do is to download quantum Pac-Man via qTunes.
C (nods and smiles) Finally… (He leans towards the salesman and shakes his fist)
I'll beat them.

• **Miriam Blaauboer**

INTERVIEW

Interview with Eric Betzig

A career path less traveled

After a very successful career at Bell Labs in near-field optics, and having captured the first image of single molecules at room temperature, Eric Betzig became dissatisfied with the structure of academic science. He started to work for his father's machine tool company, where ultimately his product was not financially successful. Jobless, but never having lost his passion for doing science, he and his friend Harald Hess developed the super-resolution technique PALM. The setup was realized at "La Jolla Labs" (a.k.a. Harald's living room), and funded entirely by Harald and Eric themselves. Eric is now a group leader at Janelia Farm Research Campus (JFRC), where his group works on developing novel optical imaging tools for biologists. He encourages his lab members not to follow the academic herd, but rather to look for new and unexpected roads to travel.

What is one of the main character traits one needs to have to do science?
Nature is far more complicated that any human can understand while sitting at a desk. You just have to work extremely hard. If you go to my website at the bottom, there's a link to something that a guy who was at Bell wrote, called "You and Your Research". (http://www.cs.virginia.edu/~robins/YouAndYourResearch.html)
It describes what you need to do to do great research. One of the things is about working hard. Work is like compound interest. If you work 10% harder than the other guy, the experience that you get from that extra 10% compounds, and so in say 7 years, you're twice as productive as the other guy. I really believe in that.

What three main characteristics should a PI have, in your opinion?
"Lead by example" would be number one. You can't tell your guys to work hard if you don't work hard. You can't tell your guys to be creative if you are not being creative. Number two would be "have a vision". You have to have an idea of what you want to do and the passion to do it. The third one is "self-criticism". This is the one that I think is missing too much. You have to look at all of the negatives and all of the weakness, and don't fool yourself – be your own hardest critic.

The value system in academia is quite publication-orientated. Often it seems to be more important where you publish, than the actual discovery published. What is your view on this?
Yeah, that annoys me very much. This whole high-impact factor thing, those journals just have way too much power. You'll submit a paper and the editor will start telling you what kind of experiments he thinks you should do, even before it goes out for review. Who is he or she to tell me what experiments to do? Using the number of high-impact factor papers a person has as a proxy for judging his academic career is just insane. It's laziness on the part of the hiring committees. That's a beautiful thing about Janelia. Gerry, the director, says that one of his proudest days as director is going to be when he re-appoints a group leader who hasn't published a single paper during their 7 year renewal process. Because they are working on something so challenging and difficult and hard that it takes longer than that. Any smart person can see if you are making good progress towards that goal, and you don't need a paper to prove that. If I did not have post-docs, I would not publish at all. I would put everything on some blog with a comment section, and I would just go back and forth having a debate with people about the results. "Gee, you're right, I guess I will go back into the lab and get something else."

Do you still go into the lab?
Almost every day. It seems crazy to me that a guy spent his entire life preparing to be a trained physicist to work in the lab, and then they are going to rip all that away from you, and you are just going to be in some office somewhere. That whole model is insane. Some people are good at administration but a whole lot aren't. Why not have a guy that is talented in the lab stay in the lab and be able to guide the experiments?

You go into the lab regularly, but that seems impossible with a big group. What size group, in your opinion, is a good size to still be able to do that?
Ah, good question. I'm a bit of a hypocrite on this right now. My group is currently four postdocs. Which is bigger than I like. For the first three or four years that I was here, I had two. When I was at Bell, I never had a post-doc. The thing that I loved about Bell was that it didn't matter whether you were a new hire or had a Nobel: at most you would have one technician and one postdoc. Because the groups were so small, it enforced collaboration. Every paper of mine from that time had a different set of names on it. That is how science proceeds, it's stochastic, not directed. I feel that a group of two or three people is good. I really like to know about everything that is going on with the experiments. If you don't have a good gestalt picture of everything, you can't contribute as much. I don't know how big groups do it.

Even having this great environment at JFRC, do you still sometimes have the desire to do something new and different?
Absolutely. I've been here now for 8.5 years, which is the longest gig I've had in my life. I think I have about 2 years of microscopy left in me, and then all of the ideas that have been bubbling in my head will basically be exhausted. We will have three really solid technology papers this year, and a huge amount of applications. But, it's time to do something new. I've always been really enamored with anything related to space. I've been cheering on from a distance at all the private space transportation companies. Even if I were just to be sweeping the floors of the assembly bay, I think that would be awesome! Just take the blinders off, and take a look at the world and figure out something new.

• **Charl Moolman**

KAVLI COLLOQUIUM

Date: June 12, 2014 at 15.00 hours Location: Aula, lectureroom A

'Imaging Life at High Spatiotemporal Resolution'

Eric Betzig

Janelia Farm Research Campus, HHMI


Eric Betzig

The upcoming Kavli colloquium on June 12, 2014 will by given by Eric Betzig on the topic 'Imaging life at high spatiotemporal resolution'

The abstract of this colloquium reads as follows: As our understanding of biological systems has increased, so has the complexity of our questions and the need for more advanced optical tools to answer them. For example, there is a hundred-fold gap between the resolution of conventional optical microscopy and the scale at which molecules self-assemble to form sub-cellular structures. Furthermore, as we attempt to peer more closely at the dynamic complexity of living systems, the actinic glare of our microscopes can adversely influence the specimens we hope to study. Finally, the heterogeneity of living tissue can seriously impede our ability to image at high resolution, due to the resulting warping and scattering of light rays. I will describe three areas focused on addressing these challenges: superresolution microscopy for imaging specific proteins within cells down to near-molecular resolution; plane illumination microscopy using non-diffracting beams for noninvasive imaging of three-dimensional dynamics within live cells and embryos; and adaptive optics to recover optimal images from within optically heterogeneous specimens.

15.00 h	Pre-programme: Background on the 2014 Kavli Prizes
15.45 h	Break
16.00 h	Kavli colloquium by Eric Betzig: 'Imaging Life at High Spatiotemporal Resolution'
17.15 h	Drinks & time to meet

EXTRA SEMINAR

Date: June 13, 2014 at 10.00 hours Location: Applied Physics, lectureroom E

'Super-Resolution Microscopy: The Good, the Bad, and the Ugly'

On June 13, 2014 Eric Betzig will additionally present a lecture: "Super-Resolution Microscopy: The Good, the Bad, and the Ugly". The abstract for this lecture reads as follows:
Despite the enormous attention super-resolution (SR) microscopy has garnered in the past decade, the number of significant biological insights it has provided has been limited. I will give a highly opinionated technical overview of various forms of SR microscopy, describing their strengths and weaknesses, and offer suggestions as to what I believe is needed for SR to have a greater impact in biology.

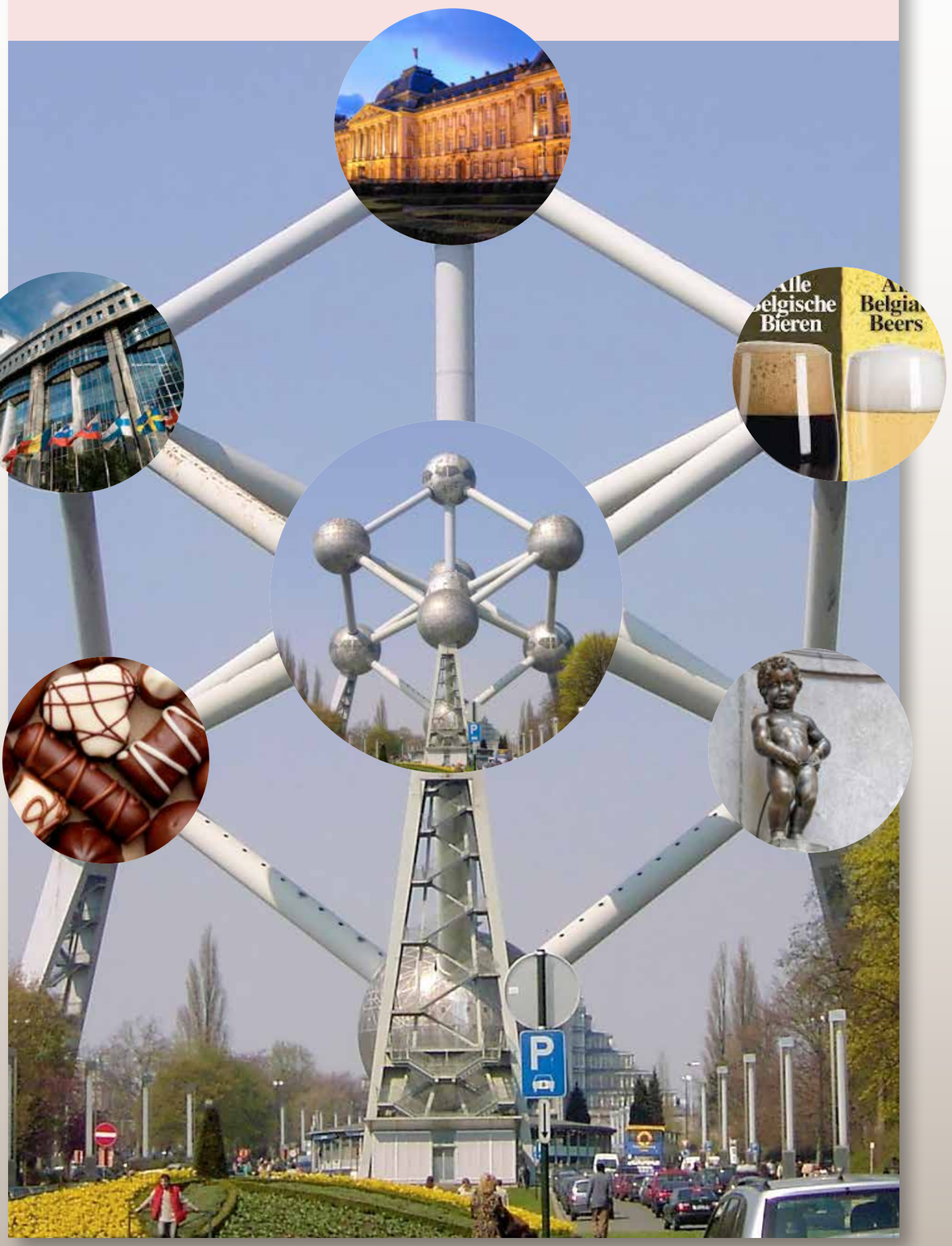
UPCOMING KAVLI DAY 2014

A special Kavli day in Brussels

To mark the 10th anniversary of the Kavli Institute of Nanoscience

Location: Brussels, Belgium

Save the date: Thursday September 11, 2014



Bio and Quantum Nanoscience cross paths more often than you might think!

Until 2010, our Kavli Institute consisted of a single Department of Nanoscience that focused on 'everything nano'. And while 'nano' is small, 'everything nano' became too big. Therefore, it was decided to split the department in order to give the worlds of biological nanoscience and quantum nanoscience more focussed attention. The Quantum Nanoscience (QN) department researches quantum aspects in a wide variety of materials and devices, focussing on quantum theory, quantum information science and quantum devices and materials. The Department of Bionanoscience (BN) explores the largely unexplored territory between nanoscience and molecular, cellular, and synthetic biology.

The shared background and common interest of both departments in nanoscience is reflected both by their affiliation with the prestigious Kavli Institute of Nanoscience Delft and in the ongoing collaborations between QN and BN labs. Below, we highlight a few examples.

DNA translocation through solid-state nanopores

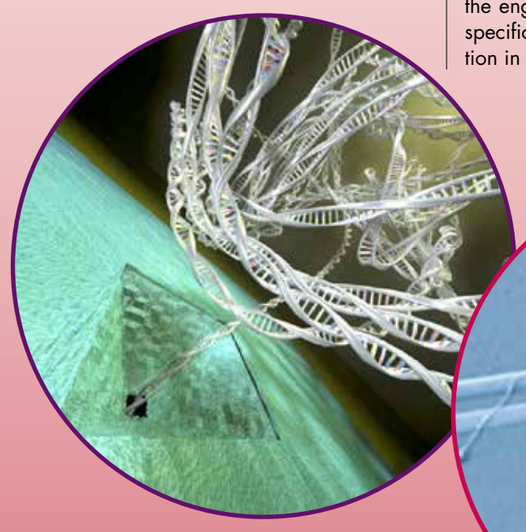
One example of a successful link between BN and QN is the long-term collaboration between biophysicist Cees Dekker (BN) and electron microscopist Henny Zandbergen (QN). For more than a decade, their labs have been exploring DNA translocation through solid-state nanopores, where members of Zandbergen's group fabricate nanopores in SiN and graphene membranes, which are used by Dekker's group to explore the biophysics of single-molecule DNA transport. More recently, the groups have begun another extremely challenging project, the visualization of DNA molecules within liquid cells by the use of TEM.

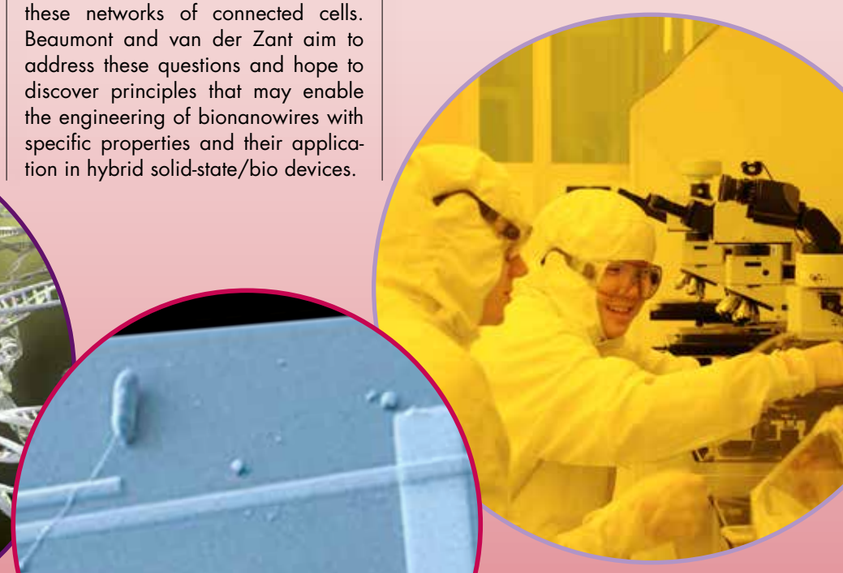
From nano-electronics to bacteria and back

Microbiologist Bertus Beaumont (BN) and molecular electronics expert Herre van der Zant (QN) recently joined forces in a unique project aimed at studying 'bionanowires'. It was recently discovered that some bacteria use conductive nanowires to transport excess electrons from their metabolism to metal oxide particles in the environment. Such bacterial nanowires are comprised of protein molecules that may facilitate charge transport over micrometer distances, forming conductive networks of populations of bacterial cells that connect efficiently. The details of the mechanisms by which the conduction occurs remain unresolved, and little is known about the structure and function of these networks of connected cells. Beaumont and van der Zant aim to address these questions and hope to discover principles that may enable the engineering of bionanowires with specific properties and their application in hybrid solid-state/bio devices.

Joint efforts in the Kavli nanolab

As members of the Kavli Institute of Nanoscience, the QN and BN departments also share access to the state-of-the-art Kavli Nanolab cleanroom. Nanofabrication is a central theme in both the QN and BN research programs. While nanodevice architecture can be quite different for bio and quantum devices, individual processes and process modules can be very similar. Examples of cooperation and synergy include e-beam lithography, fabrication of very thin membranes and graphene processing. BN and QN each participate as partners who contribute to the Nanolab's vision, strategy and investment plans.





Leo Kouwenhoven foreign associate member United States National Academy of Sciences

On April 29th the United States National Academy of Sciences announced the election of 84 new members and 21 foreign associates from 15 countries in recognition of their distinguished and continuing achievements in original research. Among them is Leo Kouwenhoven. With his nomination Leo is now one of 10 such members in the Netherlands and the only one from TU Delft.

Leo Kouwenhoven honorary member of KIVI NIRIA

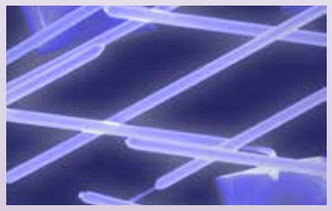
On March 19th KIVI, the Dutch royal institute of engineers, organised the 'Day of the Engineer'. During this event Leo Kouwenhoven was appointed honorary member of the royal institute KIVI for his excellent service to engineering sciences in the Netherlands, his leading role in technical innovations and for being a role model for engineers and students alike. The board of KIVI praised Leo Kouwenhoven for the uniqueness of his work and the leading role he takes in the field of quantum structures and quantum transport.

Leo DiCarlo receives IUPAP Young Scientist Prize in Low Temperature Physics 2014

Leonardo DiCarlo received the IUPAP Young Scientist Prize for his outstanding low-temperature experiments on semiconducting and superconducting mesoscopic circuits, and for establishing an innovative research program on measurement and feedback control of superconducting qubits.

ERC GRANT

ERC grant awarded to Erik Bakkers



Semiconductors based on heavy elements feature the highest electron mobilities, strongest spin orbit coupling and lowest thermal conductivity. One-dimensional nanowires of these materials are promising for thermoelectric devices and for Majorana physics. With his ERC project Erik Bakkers will investigate the growth mechanism of heavy element nanowires and their thermoelectric properties.

NEW EMPLOYEES

Name	Date of employment	Title	Lab
Dijana Boric	01/04/14	Management Assistant	QN/KN
Allard Katan	01/05/14	Technician	BN/QN
Marek Noga	01/05/14	Technician	BN/Greg Bokinski lab
Lucas Schweickert	15/05/14	PhD student	QN/QT
Nodar Samkharadze	26/05/14	Postdoc	QN/QT
Hsiu Fang Fan	15/06/14	Guest researcher	BN/Nynke Dekker lab
Andreas Reiserer	01/07/14	Postdoc	QN/QT
Michiel de Moor	01/07/14	PhD student	QN/QT
Andrea Fognini	01/08/14	Postdoc	QN/QT
Alex Proutski	01/08/14	PhD student	QN/QT
James Kroll	01/08/14	PhD student	QN/QT
Viktorija Globyte	15/08/14	PhD student	BN/Chirlmin Joo lab
Jonas Noguera Lopez	01/09/14	PhD student	BN/Christophe Danelon lab
Helena Shomar	01/09/14	PhD student	BN/Greg Bokinski lab

Frans Godschalk
9 January 2014

Hannes Bernien
10 February 2014

Pieter de Visser
11 March 2014

Sairam Malladi
2 April 2014

Barbara Witek,
25 April 2014

Gabriele Bulgarini,
12 May 2014

Rifka Vlijm,
6 June 2014

COLUMN

WILL WORK FOR FOOD

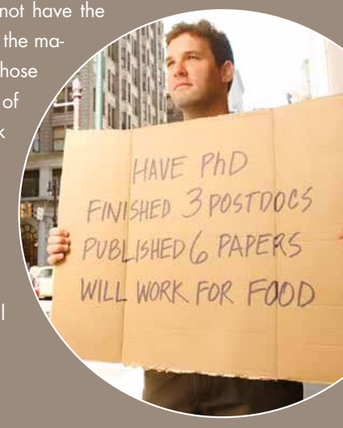
Like all nationalities, the Dutch have something with food. However, unlike quite a few other nationalities, for the Dutch 'having something with food' does not mean 'having a sophisticated cuisine'. The Dutch approach to life – sober, functional, yet efficient – also holds for their eating habits. Though sliced bread is officially an American invention, the Dutch deserve a prize for so eagerly embracing this concept. Indeed, with their endless plain cheese or peanut butter sandwiches, the Dutch are often ridiculed as being prepared to eat anything. Having grown up in Belgium – the culinary buffer zone between France and The Netherlands – I definitely also sensed a gradient (a step function, actually) of culinary complexity when crossing the border.

From those new to The Netherlands, I have heard personal accounts of going through various stages of surprise, to astonishment, disbelief, disgust, rebellion, and finally to acceptance by sticking with home cooking. While home cooking might be a good alternative meaning for 'going Dutch', it is only then that people realize that the supermarkets do not offer what could be bought abroad. In many occasions I have seen to what great lengths people go for their favorite dishes or ingredients. For instance, I suspect my French flat-mate of having a Paris-based girlfriend for the sole purpose of being able to bring back his favorite cheeses, wines and charcuterie every other week... And I have heard stories of our very own Kavli PI's driving all the way to France regularly for their favorite cuts of beef. For many, access to good food is essential to happiness, essential to feeling at home.

It is exactly this – the importance of good quality food at a reasonable price – that the TU Delft gravely underestimates. While you could argue that this is underestimated at university canteens worldwide, those in charge of designing the new building for the Bionanoscientists appear to have taken this underestimation ad absurdum. Indeed, the rumors are true: the current design for the new building has no planned food court whatsoever !

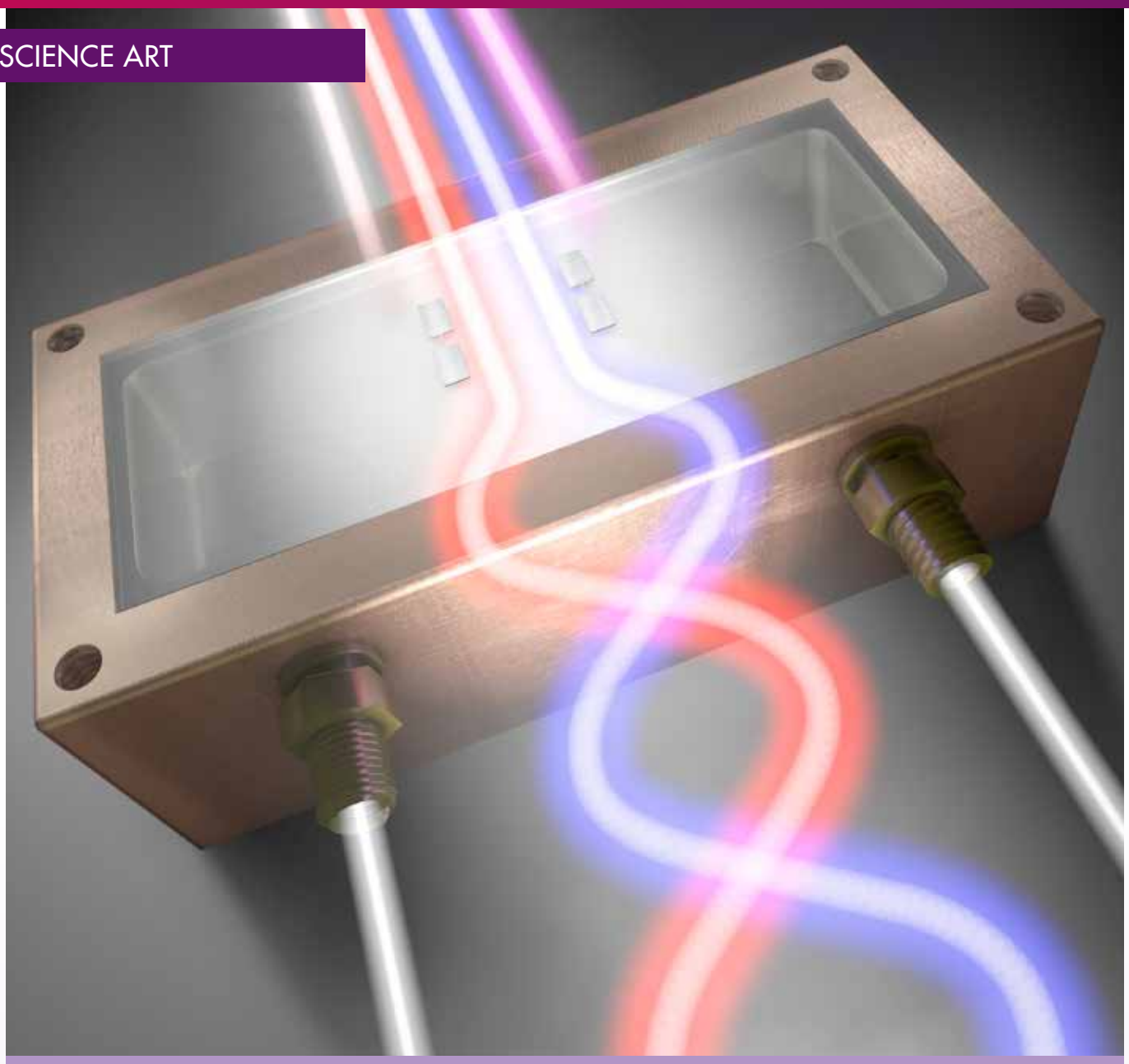
To my astonishment the 'essentiality of having food' has been replaced by the 'essentiality of having vibration-free lab floors'. While every square centimeter of lab space has already been thought through and future experimentalists will be able to enjoy their coffees in total vibrationlessness (sic), I hear many that are worried about the prospect of having to live off a vending machine. Whomever I enquire with replies with resignation that there is indeed a serious issue, but changing the situation is not in their hands. In other words: the-new-and-foodless-building has become an unstoppable train.

Do people realize what this actually means? Scientists also need food! The closest canteen, at aerospace engineering, is already operating at full capacity. The sports center is a good walk away and does not have the capacity either. So on behalf of the majority of bio-scientists, I call to those mysterious forces in charge of designing the building: go back to the drawing board. I will bet you that the availability of good food has a larger impact on scientific output, attracting good people and overall satisfaction than any silent floor will ever give you.



•**Bojk Berghuis**

SCIENCE ART



Artist's impression of two superconducting qubits inside a microwave-frequency cavity, illustrating the creation of their entanglement by a parity measurement. Credit Leo DiCarlo group / Tremani.

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

UPCOMING KAVLI COLLOQUIUM

George Whitesides

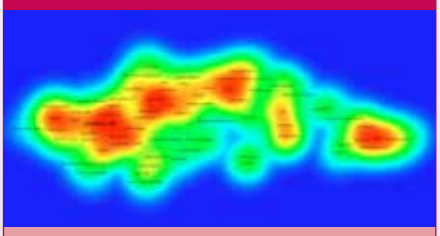
September 11, 2014

Harvard University

KAVLI DAY

SEPTEMBER 11, 2014
BRUSSELS, BELGIUM

ABOUT THE COVER



This image is a density map of key words related to the Kavli Institute of Nanoscience Delft (red high density, blue low density). This map is based on the keywords in the title and abstracts of all publications of the Kavli Institute of Nanoscience Delft (2004 – 2014) based on the Web of Science and created with VOSViewer (www.vosviewer.com)

COLOFON

The Kavli Newsletter is published three times a year and is intended for members of the Kavli Institute of Nanoscience Delft and those interested. PDF versions of all Kavli Newsletters can be found at www.kavli.tudelft.nl

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