KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft

No. 12
April 2015

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Successful first edition of the Nano-Front Winter Retreat

The NanoFront program encompasses the research of all people in the Kavli Institute of Nanoscience Delft and all nano-oriented researchers in the Leiden Institute of Physics. Almost 150 nanoscientists from Leiden and Delft spent the week of March 16th up to March 21st in Courchevel, France for the first edition of the NanoFront Winter Retreat. During these five days there were many opportunities for the participants to get to know each other and each other's research better, either during the discussion sessions, poster presentations and over 60 lectures, or on the slopes of the Alps during the sunny afternoon breaks. All faculty members, postdocs, and PhD students present at this Winter Retreat participated with great enthusiasm. We can look back at a week full of scientific highly interesting talks and many moments of new Leiden-Delft and BN-QN interactions, which will certainly lead to new collaborations within the NanoFront program in the near future! Read more on page 6.

IN THIS NEWSLETTER

As you can see from the front page, we just came back from a fantastic NanoFront Winter Retreat in Courchevel, France, where we spent a week with almost 150 students and faculty from our Kavli Institute together with colleagues from Leiden. What a great meeting of minds that was, filled with science presentations, science discussions, and skiing fun on the sunny white slopes. In this newsletter we briefly report on it.

Looking ahead, we will host Laurens Molenkamp from the University of Würzburg as our Kavli Colloquium speaker on April 16. Laurens is a leading experimentalist working on quantum transport in nanostructures, semiconductor spintronics, and optical spectroscopy of semiconductors. He is most well known for his experimental observation of the quantum spin Hall effect, which opened the exciting field of topological insulators. On April 16, Laurens will present his Kavli Colloquium on this topic of topological insulators.

This newsletter furthermore features a self-interview by new faculty member Liedewij Laan, columns by Bojk Berghuis and Miriam Blaauboer, an update of the latest about prizes and publications form our Institute, and lots of other news. Enjoy reading!

• Cees Dekker

COLUMN

A cheap and easy way to motivate people

A considerable amount of science funding, such as NWO's 'Zwaartekracht' programme and the European Flagships and ERC synergy grants, nowadays goes to larger scale consortia. These large grants usually allow for a certain amount of freedom to allocate money. Obviously, the bulk of it is used to employ the researchers themselves — PI's, postdocs, PhD students — and to provide them with adequate facilities to carry out their research. But then there is the rest. A portion of the money is spent on 'softer' items such as conferences in nice places, student rotations, outings, parties, Christmas presents, etc. A commonly used argument for spending money on rewards or activities that people experience as pleasant is that these will contribute to their motivation.

This brings us to the question: how does one most effectively motivate people? What is the scientific basis for answering this? In 1968, Frederick Herzberg wrote an influential article entitled 'How do you motivate employees?' (Harvard Business Review – reprinted twice, over 5000 citations and the most requested article from this journal). Herzberg studied the sources of employee motivation in a wide range of professions, including academic science, by distinguishing two sets of factors that influence employees: 'hygiene' (or 'extrinsic') factors that do not lead to motivation (although they can lead to demotivation if managed badly) and 'motivator' (or 'intrinsic') factors that do contribute to intrinsic motivation. He examined many different factors affecting job attitude, investigated into which set they belong and offered clear conclusions on what does and what does not intrinsically motivate people.

Three frequently used tactics that, according to this study, are not effective are:

1. Asking, telling or ordering someone to do something. This may get the person to do the task, but does not generate intrinsic motivation — it is a negative extrinsic factor.
2. Increasing salaries or offering fringe benefits. Perhaps surprisingly, these have no effect on increasing motivation. Rather than being motivators, these benefits in practice are often perceived as basic rights.
3. Providing 'environmental' factors such as great facilities, wonderful workspaces, good food, etc. No matter how brilliantly managed, this does not motivate anybody to work harder either.

What then does intrinsically motivate people? According to Herzberg's study, people at all levels of their careers are motivated by three things only: 1) interesting work, 2) challenges and — above all — 3) responsibility. Providing these three factors — for example by exerting less supervisory control while retaining accountability, granting additional authority to people in their tasks, or giving a person a complete natural unit of work and enabling him or her to become an expert — has the potential to instil an 'intrinsic generator' in a person.

Well — isn't this an optimistic theory? We can keep things sober, spend all allocated money on research, and motivate our people simply by giving them more responsibility. And all of this with the fringe benefit of alleviating our own tasks!

• **Miriam Blaauboer**

INTERVIEW

Interview with Laurens Molenkamp

Laurens Molenkamp was among the recipients of the 2013 Physics Frontiers Prize, together with Charlie Kane and Shoucheng Zhang. Their seminal work involved theoretically predicting as well as experimentally discovering topological insulators profoundly influenced the direction of condensed matter physics over the past few years. Below Laurens Molenkamp is answering some of my questions.

After receiving your PhD degree, you spent almost 10 years in industrial research. How did this experience influence your scientific path?

Well, it influenced it very much. At that time, it was customary in Holland for everybody with a good physics PhD to start working for Phillips directly. Phillips had this research lab where you could do basic research on a topic relevant to the company. After a few years you could choose whether you wanted to continue doing this or join a more product-related division of the company. This was a very nice way to try out whether you were attracted to basic research and, if not, you had a permanent job anyway. It was a bit like Bell Labs in The Netherlands in those days, and it very much influenced my later career. I had done my PhD in spectroscopy of organic crystals and at Phillips I started working on semiconductors. After a while I got involved in this quantum transport project which was collaboration between Phillips and Delft. So Phillips determined my specialization in semiconductor physics. At that time nanostructuring was really new, and that's also something that I profited from to quite an extent. All these things are still present in what I do now.

Your work on HgTe started years before the Quantum Spin Hall effect was predicted. What motivated you to pursue its experimental investigation?

When I moved to Würzburg In 1999, I had been doing spintronics for a while and I had the idea that III-V semiconductors were overly cumbersome to getting these things done. So I figured if I worked with magnetic II-VI semiconductors I could possibly get around a lot of these issues with spin injection. There was also a narrow-gap material grown in the Würzburg MBE labs — HgTe, which I found it interesting because it allowed us to do work with spin-coupled electrons. In 2005, in Korea, I met Shoucheng Zhang from Stanford University. We started talking about the Kane/Mele paper predicting the Quantum Spin Hall effect and whether we could do something in the materials I had. I discussed the inverted band structure of HgTe with him, sent him a thesis describing our band structure calculations – and that is how it all started.

Do you feel that topological materials are at the forefront of condensed matter physics?

Certainly. Topology was something that transport physicists had been neglecting for many years. We did not understand how it could be useful for our line of research. There were some people who had shown that the quantum Hall effect could be described in terms of topology, but at Philips and Delft we could describe all our experiments without it, so we didn't have to think in abstract terms like topology. What the Quantum Spin Hall effect brought about is the understanding that all these things indeed have to do with topology and that you can do much more with it.

Topological insulators are often cited together with exciting technological applications in spintronics. Do you think this is a realistic scenario?

Of course you can think about applications, but you have to be careful about your claims. It is clear that with these new band structures we can go for novel effects. Whether they will make it into applications is not our first interest. In principle, topological materials are very good to create Majoranas, but we are not there yet. Will this really lead to topological quantum computing? I do not really know but it is a very interesting field of research to pursue.

Another important thing is that you can have transport without too much dissipation and that may have applications in actual devices. But again, it is unclear whether these materials will ever be good enough to be used in a semiconductor plant. But we have a new playground, and we should see where we can take these materials: I think that should be the message.

How has your daily work as a researcher changed since the beginning of this exciting ride? Do you still spend some time in the lab?

I get into the lab every now and then but I don't do experiments anymore. The closest contact I have with research is mainly in the work meetings with our students, where they show what they have been doing and we discuss how to continue. At that level there still is a very intense contact, but filling a cryostat is not something I do anymore.

KAVLI COLLOQUIUM APRIL

KAVLI COLLOQUIUM

Date: April 16, 2015 at 15.00 hours   Location: Aula, lectureroom A

Laurens Molenkamp, Physics Institute (EP3), Wuerzburg University

Topological Insulators - A New State of Matter

Topological insulators are a novel class of materials that exhibit a novel state of matter – while the inside (bulk) of the materials are electrically insulating, their surface is metallic. This effect occurs because the band structure of the materials is topologically different (in a mathematical sense) from the outside world.
This talk describes our discovery of this type of behavior while studying the charge transport properties of thin, two-dimensional layers of the narrow-gap semiconductor HgTe. These layers exhibit the quantum spin Hall effect, a quantized conductance which occurs when the bulk of the material is insulating. Using various tricks one can show that the transport occurs along one-dimensional, spin-polarized channels at the edges of the sample.
Also thicker HgTe samples can be turned into topological insulators, but now the surface states are two-dimensional metallic sheets. The metal in these sheets is rather exotic in that the band structure is similar to that encountered for elementary particles – the charge is carried by so-called Dirac fermions. This means that experiments on these layers can be used to test certain predictions from particle theory that are difficult to access otherwise.


Laurens Molenkamp

15.00 h	Pre-programme on Bio-Quantum Nanoscience Synergies
	Bertus Beaumont: Multi-level biophysics of electrically conductive bacterial nanowires Miriam Blaauboer: Towards a new generation of switchable nanoparticle devices Anne Meyer: Bacteria-mediated fabrication of nanostructured artificial nacre
15.45 h	Break
16.00 h	Kavli colloquium by Laurens Molenkamp : 'Topological Insulators – a New State of Matter '.
17.15 h	Drinks & time to meet

EXTRA SEMINAR

Date: April 17, 2015 at 10.00 hours   Location: Applied Physics, lectureroom F

'HgTe as a Topological Insulator'

On April 17, 2015 Laurens Molenkamp will additionally present a lecture on : HgTe is a zincblende-type semiconductor with an inverted band structure. While the bulk material is a semimetal, lowering the crystalline symmetry opens up a gap, turning the compound into a topological insulator.
The most straightforward way to do so is by growing a quantum well with (Hg,Cd) Te barriers. Such structures exhibit the quantum spin Hall effect, where a pair of spin polarized helical edge channels develops when the bulk of the material is insulating.
Our transport data[1-3] provide very direct evidence for the existence of this third quantum Hall effect, which now is seen as the prime manifestation of a 2-dimensional topological insulator.
To turn the material into a 3-dimensional topological insulator, we utilize growth induced strain in relatively thick (ca. 100 nm) HgTe epitaxial layers. The high electronic quality of such layers allows a direct observation of the quantum Hall effect of the 2-dimensional topological surface states[4,5]. Due to the screening properties of Dirac fermions, these states turn out to be decoupled from the bulk for a very wide range of densities[5]. This allows us to induce a supercurrent is induced in the surface states by contacting these structures with Nb electrodes[6]. AC investigations indicate that the induced superconductivity is strongly influenced by the helical character of the charge carriers.

On top of your research, you are also the editor of Physical Review B. Why do you do that?
I do this job at Physical Review B because I think it is important that physics has journals that are run by their own societies and not by private companies. I think it is very important that physicists keep control of what they think it is important in the field. I know everybody likes to go to journals with high impact, but we should really think about whether this high impact is a measurement of its importance in physics and whether we want to be run by commerce.

From your experience as a scientist, what is your advice to young researchers?
I believe it is important in physics research that you are good in a couple of disciplines and can combine them to find new things. Looking back, what I have done is to become really good in a new thing (in my case lithography for nanodevices for quantum transport), and then apply this knowhow to a number of interesting material classes. When working in a new material class, it is important to really dig into its growth for many years, constantly optimizing its quality, and then you will see it will always pay off.

• **Mafalda Monteiro**

Marileen Dogterom receives Physica prize 2015

Marileen Dogterom is a world-leading expert in experimental cell biophysics who pioneered biophysics research of the microtubule cytoskeleton. She is one of the pioneers who is largely responsible for establishing a high reputation and bringing a worldwide attention to the field of single molecule biophysics in the Netherlands. Congratulations to Marileen for this well deserved prize!

Ronald Hanson receives Ammodo KNAW Award for fundamental research

On March 11 Ronald Hanson was one of the eight scientist that received the Ammodo KNAW Award for his fundamental research. The eight 2015 winners were selected from 114 nominations. They may use their award in the coming years to explore new avenues of fundamental research.
Ronald manipulates individual atoms and electrons, he manages to break through old barriers – for example, he was the first person in the world to communicate information between computer chips without displacement of matter or light. Will his quantum teleportation device bring us one step closer to realizing the elusive quantum computer?

Kavli Delft Thesis Prize - Nominations welcome!

A prize will be awarded for the best PhD thesis written by a graduate student at our Kavli Institute of Nanoscience at Delft in the past two years. This prize, which consists of an award and an amount of € 3000,- which can be freely spent by the laureate, is given out every two years and is awarded at the annual Kavli day in September. A PhD thesis is eligible for the 2015 prize when the research was done at the Kavli Institute and when the defense ceremony was held between 1-4-2013 and 1-4-2015.
We are now inviting nominations for the 2015 Kavli Delft Thesis Prize. Deadline for submission is May 1st. Everyone is welcome to nominate – please send suggestions to Cees Dekker, c.dekker@tudelft.nl. Please send a motivation letter that explains why you think the thesis deserves the PhD thesis prize and its merits. Moreover, please provide an access to the thesis so that five copies of it can be printed by the committee.

Inaugural Symposium of the newly established Kavli Energy NanoScience Institute at Berkeley

A new Kavli nanoscience institute was recently founded at Berkeley. On January 15 and 16, about 200 graduate students, postdocs, and researchers came to Berkeley Lab to discuss the latest in nanoscience advances and to celebrate the endowment of this Kavli Energy NanoScience Institute (ENSI) at Berkeley Lab and UC Berkeley.
In his opening words, Lab Director Paul Alivisatos emphasized that the Kavli Foundation has "a deep reverence for fostering new ideas and foundationally new science." Alivisatos added: "It's wonderful the Kavli Foundation is enabling us to work on problems that are deep and of practical importance."
Announced last October, ENSI has a $20 million endowment; the Kavli Foundation and UC Berkeley each provided $10 million of funding. ENSI joins four other Kavli Institutes—Cornell University, California Institute of Technology, Harvard University and Delft University of Technology—focusing on nanoscience. ENSI is the 17th Kavli Institute worldwide.
In addition to Alivisatos' introduction, the first day of the symposium featured welcoming remarks by the chairman of the Kavli Foundation, Rockell Hankin, and an opening address by the president and CEO of the foundation, Robert Conn. Directors from the other four Kavli nanoscience institutes—Paul McEuen of Cornell, Nai-Chang Yeh of CalTech, George Whitesides from Harvard, and Cees Dekker of Delft—as well as Sir Richard Friend of the University of Cambridge, also spoke on topics that ranged from tools used in making and measuring nanotechnology to nanoscale experiments with bacteria.
The second day of the symposium featured talks by Berkeley Lab and UC Berkeley researchers as well as the winner of ENSI's Best Thesis Prize, Ziliang Ye of Columbia University. Carlos Bustamante spoke on molecular motors and biological nanomachines; Alex Zettl on carbon nanotube radios and using synthetic nanostructures to control energy transfer processes; Omar Yaghi on metal-organic frameworks and nanoscale energy-storage systems; and Eli Yablonovitch on record-breaking, thin-film solar cells and converting heat to power.

Excited to be part of this energetic and interactive department

Nice to meet you! I am Liedewij Laan, a new group leader in the Bionanoscience department. As my name reveals, I am Dutch, born and raised in Hengelo, an industrial town, near the German border. Since I was small, my brothers and twin-sister teased me with my curiosity. "They would often bombard me with questions such as: "Why? How much? How far? How big? How do you know? ..." I liked all subjects in high school, and for a while I wanted to study Latin and Greek. But in the end I studied Applied Physics at Twente University. I found (and still find) applying the tools of math and the laws of physics to solve problems deeply satisfying. I still remember the day that marked my entry into biology as a student: In our third year, I went to a master-program introduction. The biophysical techniques group introduced us to optical tweezers and the molecular motor, Kinesin. I was fascinated by these and other concepts in single molecule biophysics! I had always been intrigued by biology, but so far I hadn't found a way to enter biological research. It was clear to me that living matter had to obey the same physical laws as non-living matter, but I didn't know how to link those two worlds.

This master-program introduction was my entry into biophysics research. I moved to Amsterdam to Marileen Dogterom's group, which was at AMOLF at that time. There we studied, as nicely put by a reviewer, "molecules showing life-like behaviour". I built a minimal in vitro system, in which a microtubule aster was dynamically positioned in a microfabricated chamber with motor proteins at the boundary, mimicking a living cell. This system showed us how the emerging properties of nanometer-sized proteins can organize a micrometer-sized artificial cell.

During my PhD research, I began to realize just how regulated and precise the mechanisms governing cellular organization were. This made me wonder how well they can evolve. So for my post-doc, I moved to the genetics lab of Andrew Murray at Harvard University where I got to know the real living cell. I used experimental evolution to investigate how hard it is for cells to rearrange their molecular machineries during evolution. And the answer is: surprisingly easy. In my own lab, we like to mechanistically understand why and how those mechanisms evolve so rapidly.

It has been 5 months since I started my group here in Delft and so far it is great. The support staff is very helpful with setting up the lab and the science meetings are interactive, energetic and constructively critical. And, best of all, many people just come into my office to talk to me about their research, just how I like it.

So what about non-science? I like to explore: travel to new places, see stimulating art, hear interesting music etc. However, my favourite way to spend time is with my family and friends. Nothing beats the combination of good company and good food. Dinner is the highlight of my day, when we eat and sing songs with Ivar, our 20 month-old-son.

• **Liedewij Laan**

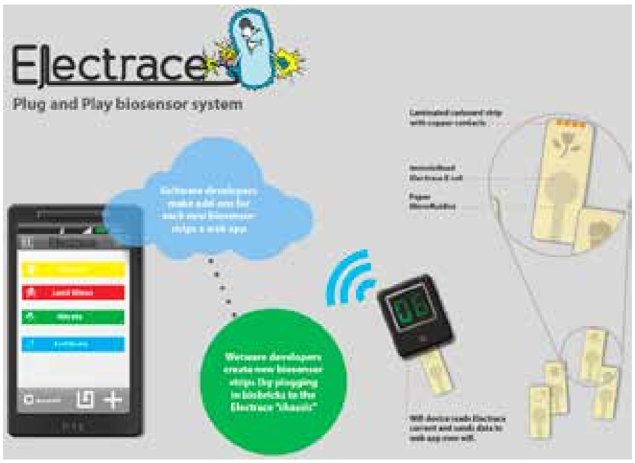
NEWS

TU Delft iGem team wins gold medal!

In November 2014, our iGEM team, representing TU Delft, finished competing in the World Championships in Boston, and our team won the awards for Best Microfluids Project as well as a gold medal!

TU Delft competed in the 2014 iGEM (International Genetically Engineered Machines) competition in Boston with 245 other teams from around the world. The team was advised by Dr. Anne S. Meyer as well as several staff from the Departments of Bionanoscience and Biotechnology at TU Delft. The thirteen students on the team come from TU Delft, Leiden University, and Hogeschool Rotterdam. The students had diverse backgrounds ranging from Life Sciences and Technology and Nanobiology to Industrial Design and Applied Physics.

In their project "Electrace," the team engineered bacteria



to detect explosive chemicals that leak from landmines. The bacteria can then generate an electrical signal that can be detected by end users in a simple and quantitative manner. This fundamental advance raises the possibility for the future development of biological-electrical communication. The team members also custom designed a novel microfluidics device that can detect electrical current within microvolumes of analyte. This device can be produced for approximately three euros. This affordable technology raises the possibility for inhabitants of countries affected by landmines to make their own in-field measurements to detect the dangerous objects.

NANOFRONT WINTER RETREAT

It was already a number of years ago when I first heard the idea that there might be a winter retreat at some point in the future. Now that it has come and past, I can say I was fortunate enough to have experienced this first edition of what is sure to become a recurring event. With the hotel right on the edge of the piste in Courchevel, it was a week packed with talks, skiing/snowboarding, and social events.

The scientific sessions spanned the diverse range of topics found within the Leiden Institute of Physics and the Kavli Institute of Nanoscience in Delft. The mix of presentations and the constant interaction between different groups certainly helped to bring people from the quantum and bio research areas closer together. The introduction of the collaboration prize help spark new links and foster a great atmosphere at the poster session. There was a noticeable excitement in the air on Tuesday as people got their skiing and snowboarding equipment, with skills ranging from novice, to the expert, with others, like me, starting again after years of absence from the slopes. Dinner talk on Tuesday spanned from stories of falls, crashes, conquests of the piste, to discussions of the other valleys and the 600 km of pistes to choose from.

On Wednesday night, groups competing in the quiz were hit with six rounds of questions heavily focused on comic books. What is a Mine Turtle anyway? and why is it so dangerous to step on? Sometime on Thursday between the Q&A and the subsequent late night party, a group of unnamed bandits from the north stole the Delft flag and subsequently held it for ransom. Security around the flag is sure to increase in future events. The week finished off on a high note with a legendary head-to-head competition in the form of a slalom race on the Epicea piste. Racers flew around a total of 19 gates with single run times ranging from around 30 seconds to infinity. The subsequent awards ceremony rounded off the program to a fantastic week and I'm sure many people were left asking, when is the next one?

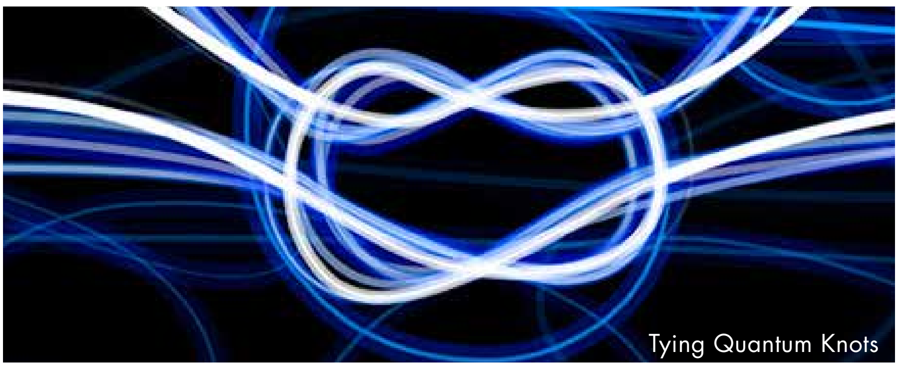
• Calin Plesa

MOOC – Topology of Condensed Matter

First experiences with the online education tool

When I just started my masters project with Anton Akhmarov, (on orbital effects on Majorana bound-states), I felt like I was drowning in a sea of information. This feeling persisted for quite some time, as all fields of physics that come together in topology are colossal.
It was just my luck that Anton Akhmarov (among others), had some of the material for the MOOC already finished. MOOC is short for Massive Open Online Course, which means that this course is available for everyone who is interested on edX. It helped me a lot and got me on the right track!
The course is going to cover a great deal of physics, and will touch subjects that I never dared to discover on my own. What I like about the course is that there are at least 15 experts in the field cooperating (e.g. making videos) to realise it. Also the material feels really interactive, because all of the graphs and numbers are generated with (fairly) easy simulations that you can further explore. Observing the fact that even some professors that work in this field subscribed to the course might tell you enough about the need and its value. If the quality of the course remains high over the coming 12 weeks, I'll be a student till the end!

Bas Nijholt
Master Applied Physics



Tying Quantum Knots

Marileen Dogterom participated in National Science Quiz

In this 21st edition of the National Science Quiz, three female scientists battled against three sustainability entrepeneurs.
Prof.dr. Marileen Dogterom defended the honour of the academic world, together with Liesbeth van Rossum (Erasmus Medical Centre) and Vanessa Evers (TU Twente). They battled against sustainable entrepreneurs Boyan Slat, Daan de Leeuw and Remco Wilcke. The female scientists defeated the entrepreneurs.

Prolongation of the industrial Partnership Program with Microsoft, FOM en Qutech

FOM and Microsoft have prolonged their collaboration in a new Industrial Partnership Program (IPP). The research that Leo Kouwenhoven and his Qutech team will be conducting is focused on fundamental issues necessary for the development of topological quantum bits (qubits).

Tenure for Christophe Danelon

We would like to congratulate Christophe Danelon, assistant professor at Bionanoscience, who received tenure end of September 2014. Christophe is one of the pioneers of BN. After the establishment of the Department, he was one of the first new faculty to join (in 2010), and now be the first to receive tenure.

NEW EMPLOYEES

Name	Date of employment	Title	Lab
Chantal Smith	24-11-2014	Management Assistant	BN
Werner Daalman	1-12-2014	PhD	BN/Liedewij Laan lab
Hyun Youk	1-1-2015	Assistant Professor	BN/ Hyun Youk lab
Nicola Manca	01-01-2015	Postdoc	QN/MED
Mafalda Monteiro	01-01-2015	PhD	QN/MED
Vera Janssen	01-01-2015	PhD	QN/MED
Martijn Cohen	01-01-2015	PhD	QN/MED
Dirk Groenendijk	01-01-2015	PhD	QN/MED
Michal Nowak	01-01-2015	Postdoc	QN/QT
Anne Schwabe	16-1-2015	Technician	BN/Danelon/Dogterom lab
Magda Pieczynska	1-2-2015	Postdoc	BN/Bertus Beaumont lab
Esengul Yildirim	1-2-2015	Technician	BN/Danelon/Dogterom lab
Mathijs Vleugel	1-2-2015	Postdoc	BN/Dogterom lab
Sergii Pud	1-2-2015	Postdoc	BN/Cees Dekker lab
Misha Klein	1-2-2015	PhD	BN/Martin Depken lab
Shruti Agrawal	15-2-2015	PhD	BN/Hyun Youk lab
Anke Amweg	1-3-2015	Logistic support	BN
Louis Reese	1-3-2015	Postdoc	BN/Marileen Dogterom lab
Ilyong Jung	1-3-2015	Postdoc	BN/Nynke Dekker lab
Joao Pinto Moura	1-3-2015	PhD	QN/MED
Davide Stefani	1-3-2015	PhD	QN/MED
Holger Tierschmann	1-3-2015	Postdoc	QN/MED
Jan Girovsky	1-3-2015	Postdoc	QN/MED
Eve Helguero	15-3-2015	Technician	BN/Laan/Youk lab
Peter Brazda	1-4-2015	Postdoc	BN/Nynke Dekker lab
Frederico Fanalista	1-5-2015	PhD	BN/Cees Dekker lab

GRANTS

ERC starting grant for Anton Akhmerov

Topology is like a new tool in the toolbox of a quantum physicist. It allows us to make materials with properties that are very hard or even impossible to obtain otherwise. It can serve as a shielding to protect quantum information or electrical conduction or to create new phases of matter living on the surface of a specially constructed bulk. The realization of its use came from the cold and quantum condensed matter systems, but recently we also learned how to apply the idea of topological protection to optical or even mechanical systems.

The topological protection relies on having a specially constructed bulk material and presence of some symmetry, such as time reversal. If the symmetry is not fulfilled exactly, the topological protection is gone and the shiny new tool is broken. In my ERC starting grant research I am going to fix that. The topic of my study is going to be disordered systems, which only have the symmetry on average. So for example instead of requiring that the material is non-magnetic, which is necessary for it to have time reversal symmetry, I am going to find materials where the magnetization may appear, but in a disordered way with a zero average.

Since these new systems have a symmetry only on average, in a statistical sense, I called them "statistical topological insulators".
Right now all I have is just the abstract idea which proves that statistical topological insulators are possible, and I am going to work hard to find actual examples of them that can be realized experimentally.

Large STW grant for Henny Zandbergen

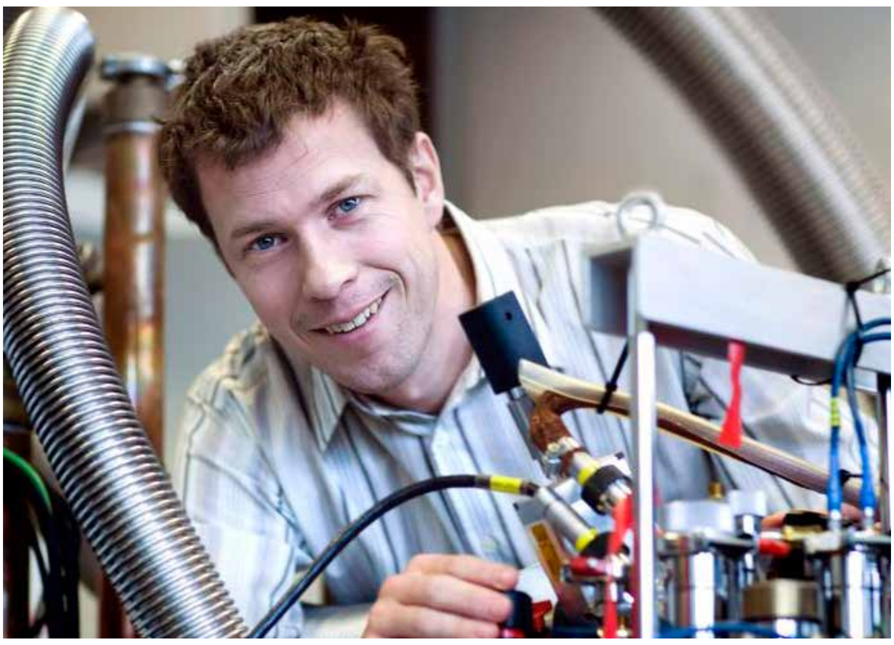
The Dutch Technology Foundation STW funded a M€2.8 project UPON (Understanding Processes Using Operando Nanoscopy), focused on developing and application of tools to accurately study atomic scale processes in Materials and Life sciences.

A major challenge is to develop tools to be able to study the materials by electron microscopy under realistic conditions, in a gas or liquid, when heated, under (changing) pressure, or in an electric field. This can be called Operando Nanoscopy (ON). Operando Nanoscopy can be considered as the next development step in electron microscopy.
ON can be achieved through miniaturizing the sample manipulations and by using nanoreactors that contain two membranes with electron transparent (~ 10 nm thick) windows, whereby gasses or liquids can be lead over the sample, and other stimuli like heating, electric fields and straining can be applied.

Henny Zandbergen

Vici grant for Lieven Vandersypen for Quantum simulation on a chip

Kavli scientist Lieven VanderSypen will receive a Vici grant of one and a half million euros from the Netherlands Organisation for Scientific Research (NWO). His research will be funded to enable him to conduct research for the next five years and to allow him to create his own research group.
Materials and molecules are often too complex to be calculated on computers. The researchers will therefore simulate and measure complex materials and molecules in the lab with nanotechnology. They hope to gain new insights that can lead to the creation of better medicines and cleaner technology.



KAVLI STUDENT EXCHANGE PROGRAMME

In 2014, with support by the Kavli Foundation, 5 students from our Kavli Institute visited fellow Kavli Institutes of Nanoscience in the US. Read about their experiences:

Roban van Herk

My research project was about taking the very first steps towards synthetic division of an artificial cell. An artificial cell, built from scratch, would be a unique compartment that could theoretically fulfill tasks, which are normally associated with life. To investigate the synthetic division of such an artificial cell I used a container that could resemble the artificial cell, with a diameter of 80 micrometers. I studied those containers in narrow channels (below 1 millimeter) filled with water. This methodology of using small channels is called microfluidics. The Weitz lab of Harvard University in particular is highly experienced with microfluidic devices that could give the joint research project between the Cees Dekker and Weitz lab an advantage. by doing the research at the Weitz lab and transferring the results and knowledge to Delft. This group at Harvard is a large group of around 70 members, which sometimes resulted in chaotic situations during the group meetings. The members had a variety of backgrounds such as physics, chemistry and biology. The atmosphere was very international and open-minded with every member of the lab being collaborative and very happy to assist and help you. People would frequently discuss ideas on the whiteboardand I enjoyed this atmosphere in the group a lot.

Felix Hol

Right after my PhD defense in June, I had the honor and pleasure of joining the Whitesides Lab at Harvard's department of Chemistry and Chemical Biology. Supported by a Kavli Exchange Fellowship I travelled to Cambridge (MA) to start a collaborative project in the broad area of 'diagnostics for resource limited settings'. In Cees Dekker's lab , we aim to start a new line of research in this area at the Kavli Institute in Delft. Due to its pioneering work in the development of low-cost diagnostics and paper-based microfluidics, the Whitesides lab was the perfect place to give this project a head start. Both scientifically and personally the visit was very rewarding: working in a large and dynamic team of talented postdocs made it easy to pick-up new techniques and methods, and, more importantly, the interdisciplinary group turned out to be a superb place to discuss and develop new ideas.

The interactions with prof. Whitesides were very stimulating and offered a perspective on science and scientific culture that draws on a richness in experiences that is hard to match. At the end of my stay, we had initiated two new projects: one focused on developing a cheap diagnostic for Human African Trypanosomiasis, and one to develop a new paper-based laboratory platform for bacterial ecology. In short, my experience at the Whitesides lab was absolutely terrific!

Fokko de Vries

In the light of the Kavli exchange program I visited the lab of professor Yacoby at Harvard University for three months. The greater Boston area and particularly Harvard University is a very inspiring environment. I very much enjoyed the many talks on a broad range of physics topics, but also just the atmosphere around Harvard yard with all the old buildings. The research done in the Yacoby group is similar to the research in the quantum transport group in Delft, where I did my master's research project and will start as a PhD-candidate. Four major topics are being investigated: graphene, spin qubits, NV centers in diamond and topological quantum systems. The purpose of my visit was to gain more experience with topological quantum systems and to strengthen the ties between the groups in Delft and Cambridge on this topic. The research I did focused on a two-dimensional topological insulator, the InAs GaSb double quantum well. We did several electronic transport measurements to characterize the topological insulator and to look for the theoretically predicted edge states. If superconductivity is induced, these edge states in the topological insulator could host Majorana bound states. Establishing Majorana's and using them for topological quantum computation is the long term goal of the research. Back in Delft I will continue working on this and I hope the experience I obtained during my Kavli exchange will give me a head start on my PhD.

Shibabrata Basak

I am a PhD student in Henny Zandbergen's HREM group studying the working mechanism of electrode nanoparticles and/or catalysts during lithium battery operation, using in-situ transmission electron microscope (TEM). The Kavli student exchange fellowship gave me a nice opportunity to visit Prof. Paul Alivisatos' lab in the Kavli Energy NanoSciences Institute at the University of California, Berkeley, US for two and a half months. The Alivisato's lab is one of the leading groups in the world in nanoparticle synthesis.

In Berkeley, we synthesized different colloidal catalyst particles with desired facets for lithium air battery. These catalysts have the potential to improve the slow kinetics of the lithium air battery. They also taught me tricks on how to prepare good graphene liquid cell for studying materials in solutions inside TEM. Furthermore we studied sublimation of faceted gold nanoparticles using a highly stable in-situ TEM heating holder from our group at Delft. This resulted in collaboration between our two groups where we will be studying melting, sublimation, and catalytic behavior of noble nanomaterials in-situ with TEM.

I had the chance to work with extremely knowledgeable and helpful persons. I really liked the work culture; we regularly had discussions on various topics and I learnt a lot from these. All in all, I had an excellent time during this visit and I thank the Kavli student exchange fellowship for providing me this opportunity.

Tatiana Kozlova,

My research is mainly devoted to electromigration phenomena at the nanoscale, which I study as a PhD student under the supervision of Henny Zandbergen. This effect is pretty easy to explain: I pass a current through metallic nanobridges, electrons "push" material along the bridge, which at high current densities will lead to material redistribution and bridge breakage. In the lab we can perform experiments from making chips in the 'clean room', in-situ electromigration investigations in the transmission electron microscope, to data analysis. We are also faced with the problem of theoretical explanation of our observed studies. The problem is that the existing continuous approach for describing electromigration is not applicable to the nanoscale.

With this difficulty, we turned to the group of Prof. Frans Spaepen at Harvard University who has a large amount of experience with electromigration. This summer I worked with him to develop an atomistic approach. I also had valuable conversations with other Harvard professors –Ariel Amir and Zhigang Suo. As many of you know, within walking distance from Harvard another "knowledge giant" – MIT – is placed. There I had good discussions with Profs. Carl Thompson and Caroline Ross. All the professors were responsive, kind, showed scientific interest and willingness to help.

Finally, just a few words about the culture and people. During my visit, Harvard campus was calm due to the students being on Summer holidays, but all the PhD students worked very hard (I suppose all year long). I had the impression that the PhDs are quite independent, without 'total professor control', self–motivated, hard–working, friendly and helpful. I was impressed by the "Harvard spirit"; I can't precisely explain that feeling…: It's probably the historic libraries, reading on a grass, red brick walls, a feeling of "accumulated knowledge" and its motto VERITAS.

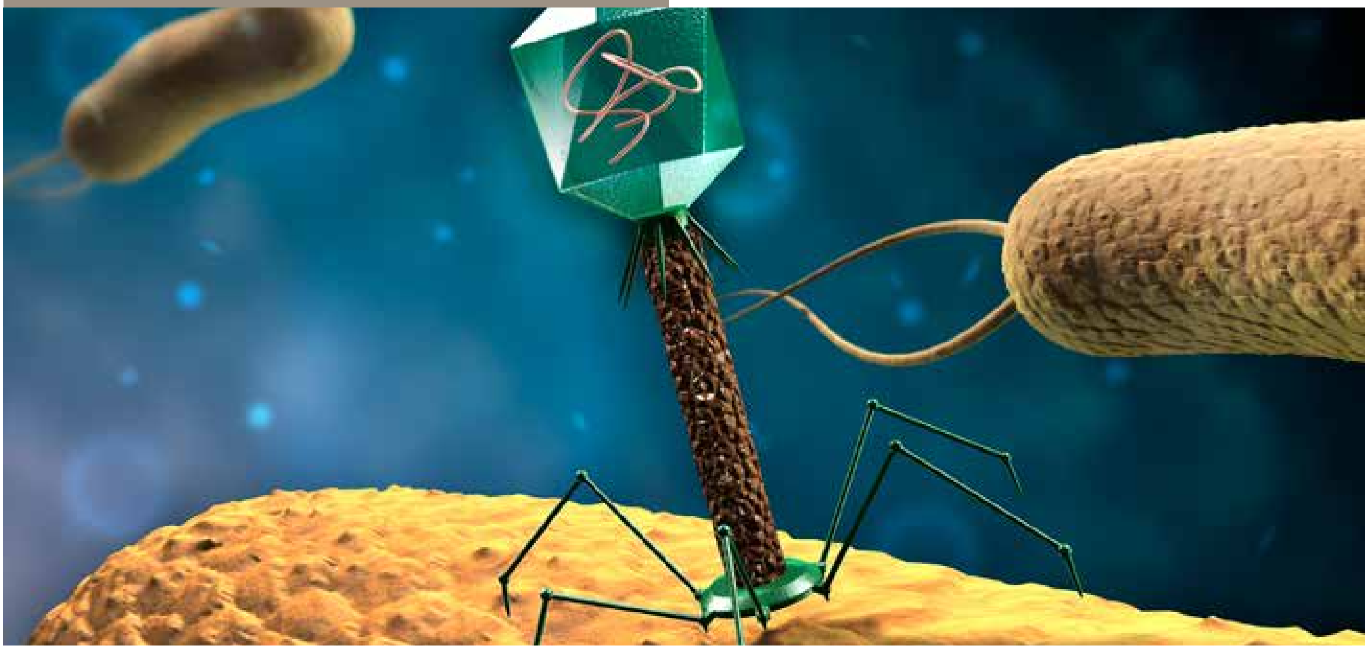
HIGHLIGHT PAPERS

Two distinct DNA binding modes guide dual roles of a CRISPR-Cas protein complex
Bacteria harbor an adaptive immune system (CRISPR) to identify and remember invading viral genomes. Viruses may escape this immune system via rapid genomic mutations. To date it has remained unknown how the CRISPR effector complex copes with mutated viral genomes. Using single-molecule fluorescence, we showed that E. coli CRISPR effector complex uses a distinct DNA binding mode to flag mutated targets and consequently update CRISPR memory. (see illustration below)

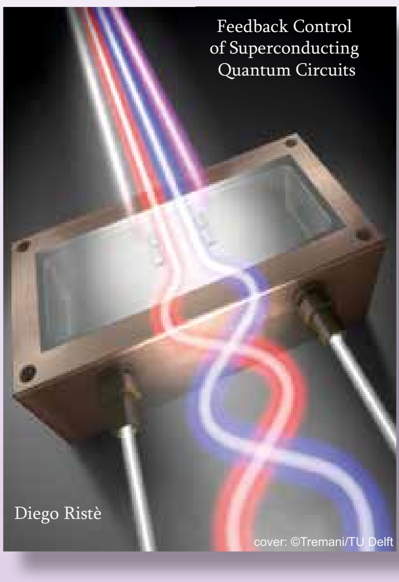
T.R. Blosser*, L. Loeff*, E.R. Westra, M. Vlot, T. Künne, M. Sobota, C. Buyzerd, C. Dekker, S.J.J. Brouns, C. Joo. Molecular Cell (2015) *Equal contribution

Slow unloading leads to DNA-bound β2 sliding clamp accumulation in E. coli
We use a combination of live cell fluorescence imaging and microfluidics to follow the behavior of individual replisomes in the bacterium E. coli in real time. We find that the number of beta sliding clamps, which are processivity factors that aid in DNA replication, is of order twenty per replisome, much higher than other observations in the published literature. These beta sliding clamps, likely left behind following replication, may serve as platforms for the docking of proteins that play roles in e.g. DNA repair.

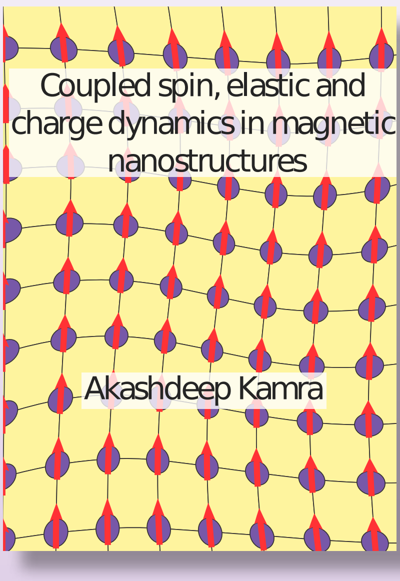
M.C. Moolman, S. Tiruvadi Krishnan, J.W.J. Kerssemakers, A. van den Berg, P. Tulinski, S.M. Depken, R. Reyes-Lamothe, D.S. Sherratt, and N.H. Dekker, Nature Communications, online publication Dec. 18 (2014).



RECENT PHD THESES



Diego Riste
17-10-2014



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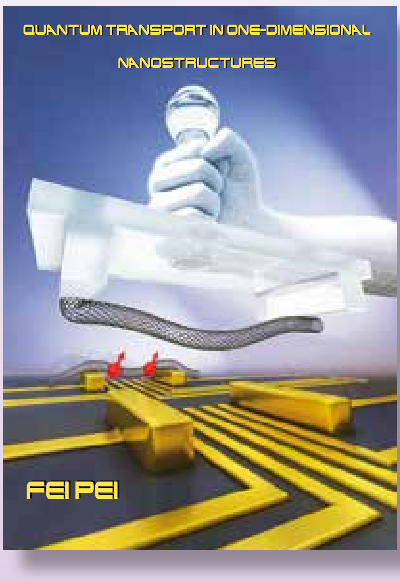

Fei Pei
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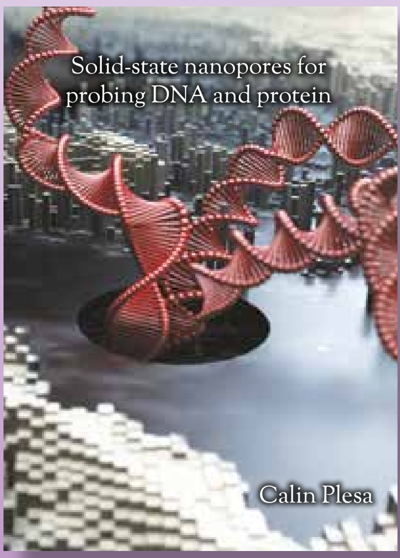
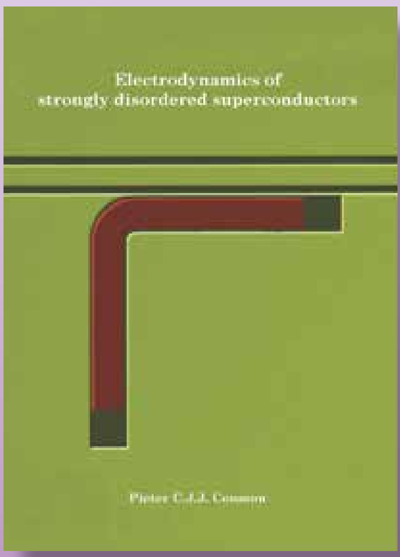
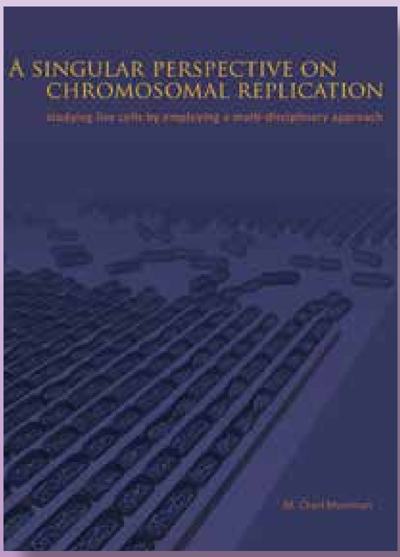


Calin Plesa
30-01-2015



Pieter Coumou
06-02-2015



Charl Moolman
13-03-2015

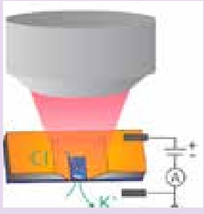
Observation of decoherence in a carbon nanotube mechanical resonator

In their recent article in Nature Communications, Schneider et. al in the SteeleLab have investigated the concept of decoherence of mechanical objects, and observed decoherence of the mechanical motion of a suspended carbon nanotube.

Ben H. Schneider,Vibhor Singh, Warner J. Venstra, Harold B. Meerwaldt and Gary A. Steele, Nature Communications 5, 5819, doi:10.1038/ncomms6819 (2014)

Photoresistance Switching of Plasmonic Nanopores

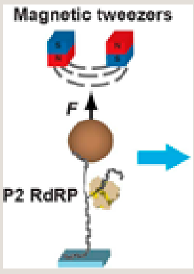
This paper presents the first demonstration of a reversible plasmon-controlled nanofluidic valve. We systematically investigate the effects of laser illumination of single plasmonic nanopores and experimentally demonstrate photoresistance switching where fluidic transport and ion flow are switched on or off. The photoresistance switching effect is attributed to plasmon-induced formation and growth of nanobubbles that reversibly block the ionic current through the nanopore.



Y. Li, F. Nicoli, C. Chen, L. Lagae, G. Groeseneken, T. Stakenborg, C. Dekker, P. Van Dorpe, M.P. Jonsson. Nano Letters 15, 776–782 (2015)

Elongation-competent pauses govern the fidelity of a viral RNA-dependent RNA polymerase

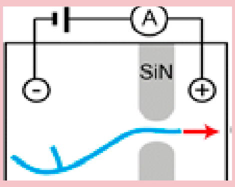
We use high-throughput single-molecule techniques to monitor the elongation process carried out by an RNA-dependent RNA polymerase. in doing so, we determine that through analysis of polymerase pausing, we can identify when the polymerase incorporates an error (an incorrect nucleotide) into the strand it is synthesizing. Determining the error rates for such viral RNA-dependent RNA polymerases is important, because these error rates determine viral mutation rates, and influencing them provides a means for viral attenuation.



D. Dulin, I.D. Vilfan, S.M. Depken, B.A. Berghuis, S. Hage, D. Bamford, M. Poranen, S.M. Depken, and N.H. Dekker, Cell Reports, online publication Jan. 22 (2015).

Velocity of DNA during translocation through a solid state nanopore

In this paper we use linear double-stranded DNA molecules, assembled by the DNA origami technique, with markers at known positions in order to determine for the first time the local velocity of different segments along the length of the molecule. We observe large intramolecular velocity fluctuations, likely related to changes in the drag force as the DNA blob unfolds. Furthermore, we observe an increase in the local translocation velocity toward the end of the translocation process, consistent with a speeding up due to unfolding of the last part of the DNA blob.



C. Plesa, N. van Loo, P. Ketterer, H. Dietz, C. Dekker. Nano Letters 15 , 732–737 (2015)

Zooming in to see the bigger picture: using nanofabrication to study bacteria

This paper reviews the new scientific insights gained by using a diverse set of nanofabrication and microfluidic techniques to study individual bacteria and multispecies communities. This toolbox is beginning to elucidate disparate bacterial phenomena—including aging, electron transport, and quorum sensing—and enables the dissection of environmental communities through single-cell genomics.

F.J.H. Hol and C. Dekker. Science 346, 1251821 (2014)

COLUMN

SCIENTIFIC LUBRICANT

Remember me writing about how stressful life as a 4th-year grad student was? How many of us walk around sleep deprived, nervous and pale in the face? Forget about all that, life as a final year grad student rocks!

Let me tell you why. For the better part of 3 years you have spent an innumerable amount of time trying to figure out why you are the right (wo)man for the job, messing up, experimenting with flexible working hours, procrastinating, doing useful and less useful experiments, isolating yourself from family/friends/daylight, feeling insecure about your future and ignoring important e-mails from department secretaries. You may even have contemplated quitting, or at least pondered what life would be like as a diving instructor, mountaineering guide or Buddhist monk. But now all of a sudden the mist that clouded you so hopelessly has cleared up as if being burnt away by the morning sun: now you have a story to tell. This means it's conference time!

Those outside academia might now be wondering whether the clearing of the above-mentioned mist also took away my last bit of sanity, but those in science know better. For scientists may not earn six-figure salaries, they will not find themselves surrounded by groupies on a regular basis, and they may have to spend days on end measuring in a basement, but I have to say: they sure know how to treat themselves to a proper intellectual retreat.

So it happened that last summer I spent a week in an idyllic Tuscan hillside resort with the most fantastic, luscious all-you-can-eat Italian buffets I ever had. A twist of fate at the beginning of this year took me to the most unforgettable skiing-filled week in Aspen, Colorado. And, as soon as I finish this column, I have to start packing for my next adventure: a conference in Whistler, Canada.

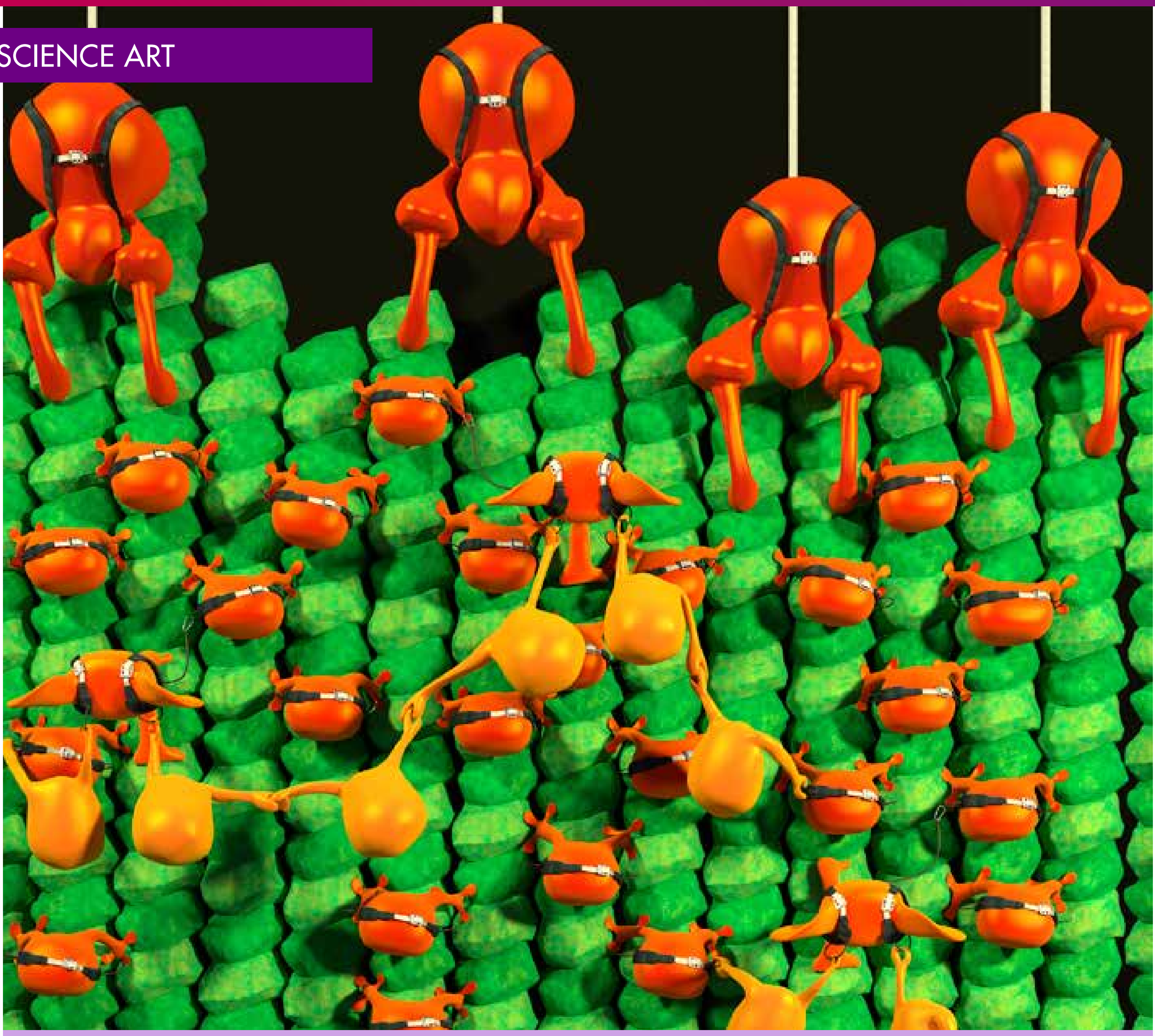
Why spend precious research money on flights, hotels and conferences in far-off places? I hear some ask. Well, while I agree there is definitely a limit to what can be considered reasonable and I know I have been quite the lucky grad student location-wise, I do think conference calls cannot make up for the full-blown conference experience with face-to-face meetings. Throughout the past couple of years I have gotten to know, appreciate and admire my scientific field – for a large part by seeing its constituents in action at conferences.

Besides the science I had the honor and pleasure of getting to know many great scientists informally during dinners, at 6 am runs through Italian forests, or during afternoons of skiing on a rocky mountain powder. If curiosity is the fuel that keeps the community moving forward, it's the conferences – and in particular its activities not related to science – that keeps the engine lubricated.

So what is the last-year Ph.D.? Stress and insomnia-filled, or an absolute blast? I guess one doesn't come without the other: exactly why I'm having the time of my life.

•Bojk Berghuis

SCIENCE ART



Impression of a microtubule (green) with tip tracking proteins (orange). This image decorates a column in the BN department (Applied Sciences Building, TU Delft) to form the tubular shape of a microtubule. It was a present to Marileen Dogterom on her first year anniversary as head of the BN department.
Image by Núria Taberner Carretero

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

UPCOMING KAVLI COLLOQUIUM

Jack Szostak

June 25, 2015

Harvard University

UPCOMING KAVLI DAY

Uri Alon

September 10, 2015

Weizmann Institute of Science

UPCOMING KAVLI COLLOQUIUM

Charles Kane

2016

University of Pennsylvania

COLOFON

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Editorial staff:
Cees Dekker, Esther Reinders,
Etty van der Leij, Emmylou van Hartrop

Lay out:
Media Solutions, Saskia de Been

Contact address:

Kavli Institute of NanoScience Delft
Delft University of Technology
Department of Bionanoscience

Lorentzweg 1
2628 CJ Delft
The Netherlands

Phone: +31(0)15-2789352

E-mail: A.vanderVlist@tudelft.nl

TU Delft Delft University of Technology