KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft
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IN THIS ISSUE:

Changes within our Institute

Recently, we intensively discussed the strategy and future vision for our Kavli Institute. With all Kavli faculty members, we exchanged ideas on how to keep coherence between our quantum and bionanoscience and on how to involve faculty members from QuTech, the recently established advanced research center for quantum computing and quantum internet.

Following this discussion, it has been decided to extend the membership of our Kavli Institute to interested QuTech faculty members. We believe that this will open new exciting possibilities and ensure that the groundbreaking quantum nanoscience done within QuTech will remain part of our Kavli Institute. QuTech's focus – quantum information processing – fits the scope of Kavli naturally, and it makes thus great sense that the frontline fundamental nanoscience research at QuTech will remain part of our Kavli Institute. Because the focus of QuTech includes a stronger application-driven approach to quantum nanoscience, the new constellation of our Kavli Institute at Delft will cover a somewhat wider spectrum of research, with the quantum nanoscience of QN as the central focus and the extension to quantum information applications in QuTech on one side of the spectrum, and the extension to biological nanosystems in BN on the other side. On page 6 of this newsletter, we feature the new QuTech Kavli faculty members.

Furthermore, we decided to change the leadership of our Institute into a 2 co-directors structure. Over the years, we have chosen to pursue the two main research directions within the nanosciences that we deem most challenging and interesting, i.e., biological nanoscience and quantum nanoscience. Thanks to their successes, both research directions have developed enormously and are still growing. We felt that these two elements – the substantial growth as well as our choice for two main research lines – should be reflected in its leadership. In the new structure, the institute will no longer be governed by a single director, but by a team of 2 co-directors with equal responsibilities: 1 co-director with a background in biological nanoscience, and 1 co-director with a background in quantum nanoscience. The current director Cees Dekker will stay on as a co-director for the remaining 2 years of his mandate. Lieven Vandersypen has been appointed now as co-director for a period of 4 years. See page 4 of this newsletter for an interview with Lieven.
Finally, we may expand the activities of our Kavli Institute in the near future. If – as we hope – an increase of our endowment will be realised, we plan to initiate a number of interesting synergetic research directions at the bio-quantum interface, start a Kavli visiting professorship, and begin a range of other initiatives.

Overall, these developments in our Kavli Institute will pave the way to continue the exciting research in quantum and bionanoscience at Delft.

IN THIS NEWSLETTER

It was an interesting summer! With multiple faculty meetings where we fruitfully discussed the future of our Kavli Institute. The most concrete outcome, inclusion of QuTech faculty members and a change to two co-directors, are described in this newsletter. Read about all these exciting plans, starting at this page. Don't miss the interview with new co-director Lieven Vandersypen on page 4, and the brief introduction of 8 new Kavli faculty members from QuTech on page 6.

A highlight looking ahead will be on December 1, when we will host Steven Block from Stanford for a Kavli Colloquium on optical tweezers for studying gene regulation at the single molecule level. Steven is a true single-molecule biophysics pioneer who developed optical tweezers and did groundbreaking single-molecule experiments on the molecular motors of biology. He is also an outstanding and energetic speaker (and an accomplished bluegrasss musician which fits my personal interest). We thus look forward to an exciting Kavli Colloquium. The preprogram will highlight the 2016 Nobel Prizes 2016, which is your chance to quickly get informed about their background and content.

Furthermore in this newsletter: a self-introduction by new faculty member Stan Brouns, a column by Martin Depken, a photo recap of the 2016 Kavli Day in Amsterdam, and lots of other news. Enjoy!

Cees Dekker

COLUMN

Against scientific visions: stop dreaming and do the work!

As a postdoc I was once asked about my *Manhattan project*. I did not even understand the question at first, and when the penny finally dropped, I drew a blank on my long-term vision. Was I expected to be clairvoyant? I was doing science, exploring uncharted territory, and still, I should know what lies ahead!? Though the lay of the land has since come into better focus, and I have grown a keener sense of what directions might be fruitful, I still often find myself scrambling up summits different from those I headed out for.

Alexander Flemming did not set out to discover penicillin, nor did Wilhelm Röntgen set out to discover X-rays. Science is mapping the unknown, and my suspicion is that the dots are often connected after breakthroughs, retrofitting history to make an appealing story. Believing in visions come true is attractive, as it lets the touted visionary take full credit for the path, while we can take pleasure in imaging our own grand visions bearing fruit—well before we have done the work needed to make it so. If visions seldom track reality, what, then, is their use? I suspect visions are fairly useless as roadmaps, and mainly function to provide the inspiration, enthusiasm, and drive required to get going—wherever the journey takes you in the end.

Though keeping ourselves prepared for unknown unknowns is less exciting than contemplating grand visions, it might actually be the more important task. As was the case for Flemming and Röntgen, it is estimated that up to half of all scientific discoveries are due to serendipity, where the prepared mind is able to cease on fortuitous events to make progress. Though inspirational, visions unfortunately also move the focus from what to do, to what to achieve; from path to goal; from working to dreaming; from what you can control to what you cannot. Keeping prepared for chance events requires work now, while visions imagine the work already to be done.

If you are just setting out on your scientific career and lack a grand vision, I would suggest that you do not go looking for one. Instead, prepare yourself for the journey ahead, broaden your toolset and perfect your skills. Focus on the good work you can do and control right now, for this is what will take you to higher ground from where you can better see the trek ahead. You need to be lucky in science, and, as Seneca once said, *Luck is what happens when preparation meets opportunity.*
Get going, and keep curious. Soon enough, when exploring some little offshoot from your original path, it will bring you through the dense underbrush and put you right in front of some hidden vista with the grandest summits in full view.

Martin Depken

INTERVIEW

Interview with Steven Block

Let me introduce you to our Kavli colloquium guest speaker for the month of December, who is one of the founders of the single molecule biophysics research area.

With his hermit-like appearance and unkempt beard, you could perhaps be tempted to think that Steven M. Block (SMB) from Stanford University is an all-time serious academic. Indeed, his email signature says 'S.W. Ascherman Professor of Sciences in the Departments of Biology and Applied Physics'. But it also includes a cartoon showing a 5-string banjo. Added to this is the fact that SMB "has not used Skype very much before" while running a lab in this digital age. Time for me to start a conversation with this intriguing Stanford professor, who is at the forefront of technological breakthroughs in biophysics.

I hit off my conversation on a cautious note with a bit of small talk, asking him if he'd visited the Netherlands previously. It turns out that he visited Delft during his honeymoon. What a full circle that life brings! Both of us agree (and now the conversation starts to flow emphatically) that Delft is a beautiful place.

SMB also mentioned that he knows many of the Bionanoscience faculty here first-hand and that his associations go back a very long way (thanks in part to the bi-annual biophysics conference at Aspen, also known as the famous 'SMB = Single Molecule Biophysics' conference that he organizes). SMB also referred to the research here as being "first-rate," and I could not stop beaming and blushing. Thankfully, he does not notice this since we are on the phone instead Skype.

With my mood upbeat at this point in our conversation, I asked SMB what he thinks have been the turning points in the development of the field of optical tweezers. He offered several important milestones in the field:

a. Biological. The labs of Erwin Neher and Bert Sakmann, for their seminal work in the early 1970's on single-channel recording of ion flow in neuroscience, for which they were awarded the Nobel Prize in Medicine or Physiology in 1991. Also, the lab of Howard Berg at Harvard University, for his seminal studies around the same time, on the rotation and mechanical properties of the bacterial flagellar motor.
b. In vitro motility assays. The labs of James Spudich at Stanford University and Toshio Yanagida at Osaka University, for their development of the first single-molecule assays for myosin, and his own group, plus work by Joe Howard carried out with Ron Vale, for developing the first single-molecule assays for kinesin, in the late 1980's.
c. Instrumentation. The advent of atomic force microscopy (AFM) was his first mention (Gerd Binnig and Heinrich Rohrer shared the Nobel Prize in Physics in 1986 for inventing the scanning tunneling microscope). This was followed by the optical trap (invented by Arthur Ashkin at Bell Labs in 1986, and subsequently developed for work in biophysics by SMB's own lab), magnetic tweezers (developed for single-molecule purposes in the lab of Vincent Croquette and David Bensimon at ENS in France), and single-molecule FRET (first reported by Taekjip Ha and co-workers in the late 1990's).

Reminiscing about his earlier days, on mention of the history behind the single molecule field, SMB recalled how his group, then based in Rowland Institute for Science in Cambridge, Massachusetts, avoided working on kinesin stepping during the daytime, and performed their measurements only after midnight. We both had a hearty laugh when he mentioned that this was because the nearby Longfellow Bridge, which was used by the Boston subway system, known as the "T", generated vibrations during the daytime, but the trains stopped running at 1:00AM.

Next, I asked him how much the single molecule field has changed over the decades, as more and more researchers have joined the juggernaut. He remarked after a brief pause that the most important upshot, obviously, was precisely that more and more researchers have joined! As a case in point, he mentioned how much of a change he observes nowadays at the Biophysical Society Annual Meeting in the USA, which is now dominated by posters on single molecule research.

On the mention of technologies, I asked him what were the bottlenecks that needed to be resolved. SMB thought that scientists should make progress in fusing together other methods, for example, next-generation sequencing with single molecule approaches for a better understanding of phenomena. He also cites instrumental stability issues in AFM as something to be remedied, and considers the work by Tom Perkins lab at University of Colorado to be important in this respect.

KAVLI COLLOQUIUM

"Optical Tweezers: gene regulation, studied one molecule at a time"

Steven Block

Stanford University

Prof. Dr. Steven M. Block (1952) is the S.W. Ascherman Professor of Sciences at Stanford University with a joint appointment in the departments of Biological Sciences and Applied Physics. Block holds degrees from Oxford and Caltech, and served as faculty at the Rowland Institute and Harvard, then Princeton, prior to joining Stanford in 1999. He is best known as one of the founders of the field of single molecule biophysics.

His research lies at the interface of physics and biology, particularly in the study of biomolecular motors such as kinesin and RNA polymerase and the folding of nucleic acid-based structures. His group pioneered the use of laser-based optical traps, or 'optical tweezers,' to study the nanoscale motions of biomolecules. In what's left of his spare time, he enjoys skiing and playing bluegrass music on the banjo and mandolin.

December 1, 2016 will feature a Kavli colloquium by Steven Block

Advances have led to the new field of *single molecule biophysics*. Single-molecule techniques can record characteristics that are obscured by traditional biochemical approaches, revealing behaviors of individual biomolecules. Prominent among the techniques is the laser-based optical trap, or 'optical tweezers,' which uses radiation pressure. Optical traps can now measure biomolecular properties with a precision down the atomic level—achieving a resolution of 1 angstrom over a bandwidth of 100 Hz—while exerting controlled forces in the piconewton range. Among the successes for optical traps have been measurements of the molecular steps produced by motor proteins (for example, kinesin and myosin) and by processive nucleic-acid enzymes (for example, RNA polymerase), determinations of the strengths of noncovalent bonds between proteins, and studies of the energetics and kinetics of structure formation by nucleic acids. Optical trapping instruments have been particularly useful in mapping the energy landscapes for folding RNA molecules. Beyond that, we're now able to follow the co-transcriptional folding of RNA in real time, as it's synthesized, revealing how such folding can regulate downstream genes, mediated by structured elements called *riboswitches*. In recent developments, optical traps have been used in conjunction with single-molecule FRET (Förster Resonance Energy Transfer) to report on the folding configurations and internal degrees of freedom in biomolecules.

15.00 h	Pre-programme
	Hans Mooij 2016 Noble prize in physics Judith Klumperman 2016 Noble prize in medicine Rienk Eelkema 2016 Noble prize in chemistry
15.45 h	Break
16.15 h	Kavli colloquium by Steven Block: "Optical Tweezers: gene regulation, studied one molecule at a time"
17.15 h	Drinks & time to meet

KAVLI COLLOQUIUM

Date: December 1, 2016 at 15.00 hours
Location: Faculty of Industrial Design, Joost van der Grinten lectureroom

HOT TOPICS

For PhD students/postdocs.
Register on Casimir website

'The simultaneous use of optical-force spectroscopy and FRET on the TPP riboswitch'

Date: December 2, 2016 at 10.00 – 11.30 hours
Location: A1.100

SMB also finds it disconcerting that major universities across the world (at least, in the US), there are few, if any, formal curricula for biophysics. He told me that most of the people working in this field tend to come from the traditional fields of biochemistry, biology, physics, or engineering. While this interdisciplinary mix has certain advantages, he felt that there should be an option on the table for students to directly "plunge" into biophysics.

I found it really interesting when he said "It is easier to teach biology to a physicist than to teach physics to a biologist". Being a biologist myself, I take this statement as a sign of compliment that biology is more appealing than physics because it can trigger curiosity in everyone.
My last question was, "In this age of cut-throat competition and shrinking funding, is there any room for budding scientists to pursue experiments born out of pure curiosity or fun?" How would he advise on this, I wondered?

It was fascinating to hear him state that funding agencies tend to concentrate mainly on the purely technological frontiers whereas scientists are generally more driven by desire to address fundamental questions. He also stated that striking an appropriate balance between the two is imperative. He considers himself to be lucky with respect to funding, perhaps a reflection of his modesty. As a bottom-line, his advice to me was "Keep a necessary eye on the pocket book, but always try to follow your heart when selecting any line of scientific inquiry".

As the conversation drawing to a close, I was touched by the warmth of his character, when he asked me whether he could meet me in person when he is here. I could see that while he has a busy morning schedule and multiple errands to attend to, he still has not lost his everyday human touch. He is delighted when I tell him that we have a provision for "lunch with guest speaker" for PhDs and postdocs.

Finally, let me mention that Stanford University uses an alternative platform for its video conferencing: some software called BlueJeans. This, lest you thought he is a luddite like your grandpa, is mainly why he doesn't use Skype.

Sumit Deb Roy

A new co-director: Lieven Vandersypen

Lieven Vandersypen (44) has been appointed co-director of the Kavli Institute of Nanoscience Delft. A leading scientist responsible for pioneering research into mesoscopic quantum structures and quantum computers, Vandersypen holds an Antoni van Leeuwenhoek professorship in TU Delft's Quantum Nanoscience department. As Roadmap Leader in QuTech, he was the driving force behind QuTech's $50-million partnership with Intel that was announced last year. How does he see his new role and the future of Kavli?

Can you tell us something about yourself?
'Certainly. I am married and have two daughters and a son. I play squash, but have had less time for other hobbies since the children arrived. I also co-founded a classical choir in which I sometimes sing bass. Apart from that, I enjoy water sports such as windsurfing and kite surfing, although recently only during the holidays. Having now invested in new equipment, I plan to start kite surfing again in Scheveningen or Kijkduin soon.'

How did your professional career start?
'After studying mechanical engineering in Belgium, I did a Master's and PhD in Electrical Engineering at Stanford University. I researched quantum computing with NMR, using the spin of atoms in molecules as quantum bits.'

What triggered the move to quantum computing?
'It started with an interest in small-scale mechanics. In the mid-1990s, I saw the first images of tiny mirrors on a chip flapping backwards and forwards, and small rotors rotating. It's called micro-machining and it interested me immensely. Since I was also captivated by quantum mechanics, I started to think about looking at the quantum aspects within these moving mechanical objects. But then I came into contact with Ike Chuang, who became my Ph.D. advisor and told me about quantum computers. I immediately immersed myself in the subject, often being so fascinated that I could hardly sleep.'

And next you came to Delft?
'Yes. I had been thinking about what approach to quantum computing I wanted to research for my post-doc. I eventually decided to work on electron spins in semi-conductor quantum dots. Leo Kouwenhoven's group in Delft was one of the best groups in that field. At a conference, I asked him why he had not tried quantum computing with his quantum dots. It turned out that he had only just taken an interest in it and had secured funding. He was able to take me on as a post-doc.'

Are you still interested in developing a quantum computer?
'Definitely. After joining TU Delft as a tenure track Assistant Professor, I started my own group in 2003 and we were able to make major advances in research. In the beginning, the main question was whether developing a quantum computer was even possible. The answer remains uncertain, but there is definitely greater confidence now. We have taken major steps in the past years, both theoretically and in our experiments that have made me optimistic.

Is it true that here is also increasing involvement from the industry?
'Yes. Apart from fundamental physics, we now also find ourselves confronted with more and more technological hurdles. That was partly the reason for setting up QuTech, in which we are collaborating with engineers from TNO and from the university. We started a major partnership with Intel just a year ago. It's very unusual for us, but also for them, because they are making available their people and facilities for our research.'

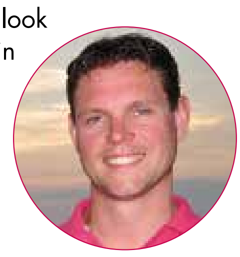
How will working with Intel contribute to the quantum computer?
'We aim to create larger numbers of uniform quantum bits. Currently, qubits have personalities, which is something we need to move away from, as these personalities are difficult to deal with. If you want to work with larger numbers of quantum bits – and we are talking dozens rather than thousands – it requires an important improvement in the uniformity and reliability of the processes you use to make them. We are working actively in partnership to achieve that.'

How do you view your role as co-director?
'The way I see it, each of the two co-directors represents the entire institute. I am not here to represent the quantum scientists, I am a co-director for everyone. Just like Cees Dekker, and Hans Mooij before him. Next, we have now invited QuTech group leaders from outside the QN and BN departments to also become part of Kavli and most of them have already agreed to do so. I intend to see to a successful integration, by organising opportunities to meet each other, for example. With the BN department moving to another building, there is also a risk of the departments drifting apart. My explicit aim is to keep the two groups together, for instance by encouraging joint research projects.'

What is Kavli's strength, in your view?
'I think that it exemplifies the best science in our field. We allow ourselves to be driven by what excites us, which is why we continue to innovate. We are the first Kavli Institute to have been established outside the US and together with Harvard, Cornell, Berkeley and Caltech, we are certainly in good company. I think we are successful in identifying promising new directions. We are also not afraid to pursue completely different paths, such as the partnership with Intel. That was almost unthinkable five years ago, as we were not quite ready for it mentally. But when the field starts moving in such a direction, you want to identify opportunities and seize them. The major joint programmes we have set up with Leiden, such as NanoFront and the Casimir Research School are also great initiatives. Together with Kavli, they have created a strong and dynamic nanoscience community. Finally, we have succeeded in attracting some outstanding tenure track staff to TU Delft in recent years, both in bio and in quantum.'

What else do you hope to achieve?
'I think there is potential for further strengthening the mutual bonds within the institute. At the Kavli faculty meeting in the summer, we brainstormed about the overlaps between bio and quantum, and there are plenty. Based on these, we intend to establish more joint research projects. As Kavli directors, it is our job to encourage that. It starts by becoming better acquainted with each other, and accordingly I plan to visit all my bio colleagues to get updated on their research. This will increase our knowledge and understanding of what others are doing and have to offer and, of course, how it can be linked to one's own research. We are already doing a lot in this area, but I aim to stimulate this so that the Institute can get more out of it.'

How do you envisage the period ahead for the Kavli Institute of Nanoscience?
'We intend to set up various new activities. For example, we want to establish a prestigious visiting professor programme, inviting the most prominent nanoscientists in the world to spend several months in Delft. We also have plans to set up a new post-doc programme with Kavli Postdoc Fellows. Another idea is to have an artist or writer in residence, with a view to initiating a creative exchange of ideas. We would also like to engage in more outreach and offer strategic support for the Kavli Nanolab Cleanroom. We hope to secure an additional contribution from the Kavli Foundation to help make these plans possible.' 'The Kavli Institute has now been in existence for 12 years and it has always had an exceptionally positive reputation. I can only see that growing still further. In ten years' time, Kavli will be a more active community. It will also be bigger, both as a result of the reinforcement from QuTech and the fact that the two departments continue to attract new staff. My genuine hope is for the institute to look completely different in ten years' time, but in a way that is impossible to predict at this stage. If it does, it would mean that we have remained dynamic, and that we have continued to explore and develop new initiatives.'



Jerwin de Graaf

QC Lab 2 open

Following several months of rebuilding and renovation work, the festive opening of the second part of the QC Lab took place in the summer. The work is an extension of the first lab and is located on the first and second floors of the B-wing in the TN building. The ceiling of the first floor has been fitted with dilution refrigerator units that can cool to extremely low temperatures approaching absolute zero. Quantum effects can become visible at these temperatures, and can then be measured in the experimental set-ups on the second floor.
There are currently three such set-ups in QC Lab 2, and a total of eight set-ups are planned. These set-ups will be added in the coming six months. Menno Veldhorst, who has been working at QuTech for the last six months, is one of the team leaders who will be carrying out experiments with his team in QC Lab 2. He came from Australia where he was a post-doctoral researcher. In Australia he worked with a team to try and rebuild ordinary silicon transistors so that they can store single quantum bits. Their great breakthrough was the demonstration of a two-qubit system. "Thanks to the enormous developments in semiconductor technology, we are now able to put billions of transistors on a single silicon chip. The trick now is to use this technology to create quantum chips." Menno was recently awarded a Vidi grant to work on quantum bits in silicon.

Robust building blocks for a quantum computer

In his Vidi research, Menno and his team are trying to create quantum bits that also work well at higher temperatures. It is a huge challenge to develop quantum bits that can cope with the external interference associated with higher temperatures. Achieving this would have immense advantages for scaling up, one of the greatest challenge for quantum technology. Not only could quantum bits then be made using industrial semiconductor technology, the same chips could be fitted with electronics to control the quantum bits. However, there is still a long way to go and many fundamental questions to be answered before this can be achieved.
The roadmap Fault Tolerant Quantum computing within QuTech, co-led by Lieven Vandersypen, is working with a large team to develop all the components needed for a silicon quantum computer. Giordano Scappucci, who began as team leader last year, is working on the materials science-related aspects with his group. The development of the electronics is in the hands of the groups led by Edoardo Charbon and Ryoichi Ishihara, and Koen Bertels and his group are tackling the challenges of quantum computer engineering and quantum algorithms.
QuTech recently embarked upon a long-term collaboration with Intel, with whom they are actively working on taking the next steps. The huge amount of quantum expertise within QuTech, combined with Intel's know-how and facilities for semiconductor technology, creates an ideal foundation for realising their ambitions.

Create distance

We are already able to create single quantum bits in silicon and control them very accurately. In recent months Lieven Vandersypen's group have also succeeded in linking quantum bits together. The challenge now is not only to do this with great accuracy, but also to link quantum bits that are a greater distance apart. While there are several coupling schemes under intensive investigation, very recently a breakthrough was made at QuTech, by coupling spin qubits using a quantum mediator. On a higher level, work is also taking place on architectures that could make it potentially possible to scale up to billions of quantum bits. Great ambitions that they want to achieve in the upcoming years. And QuTech is the place to be for these ambitions, it's an inspiring and enjoyable quantum environment.

Heera Dijk en Menno Veldhorst

NEW EMPLOYEES

Name	Date of employment	Title	Lab
Iasonas Katechis	01-07-16	PhD	Chirlmin Joo lab
Evgeny Repin	01-07-16	PhD	Nazarov Group
Majid Ahmadi	03-07-16	Postdoc	ZandbergenLab
David Foschepoth	15-08-16	PhD	Christhophe Danelon lab
Alessio Fragasso	01-09-16	PhD	Cees Dekker lab
Sebastian Kieper	01-09-16	PhD	Stan Brouns lab
Rebecca McKenzie	01-09-16	Reseacher	Stan Brouns lab
Jochem Vink	01-09-16	PhD	Stan Brouns lab
Patrick de Jonge	01-09-16	PhD	Stan Brouns lab
Niels van den Broek	01-09-16	Technician	Greg Bokinsky lab
Franklin Luzia de Nobrega	01-09-16	PhD	Stan Brouns lab
Sonia Conesa-Boj	15-09-16	Faculty member	Conesa-Boj lab
Marc Westig	01-10-16	Postdoc	Klapwijk lab
Lin Wang	01-10-16	Postdoc	Akhmerov Group
Xiang Zhang	01-10-16	PhD	Blaauboer Group
Kobus Kuipers	01-10-16	Department Chair QN	Kuipers lab
Dolfine Kosters	01-10-16	PhD	Kuipers lab
Lorenzo de Angelis	01-10-16	PhD	Kuipers lab
Filippo Alpeggiani	01-10-16	Postdoc	Kuipers lab
Su-Hyun Gong	01-10-16	Postdoc	Kuipers lab
Miguel Tinoco Rivas	01-10-16	Postdoc	Conesa-Boj lab
Yildiz Saglam	16-10-16	PhD	CavigliaLab & SteeleLab
Sabina Caneva	01-11-16	Postdoc	Van der Zant lab

8 new QuTech faculty members join our Kavli Institute

Attila Geresdi

Background: Physics • PhD 2011 Budapest • postdoc Delft • QuTech since 2015

Research topic: My research interests include mesoscopic superconductivity and semiconductor nanostructures. Currently I am working on experiments getting the best from both worlds: inducing topological electron states such as Majorana particles by combining semiconductor nanowires with superconducting thin films. Even though a proof of principle topological quantum bit is still to be demonstrated, Majorana states hold great potential for quantum computation due to their intrinsic noise resilience.

Kavli: Having been engaged with quantum transport during my entire research career, I find the Kavli Institute membership a nice opportunity to widen my horizon towards other disciplines within nanotechnology. I also think that by the involvement of the researchers at QuTech, the Kavli Institute will further extend its scientific diversity which has made it a great community.

Giordano Scappucci

Background: Physics • PhD Rome 2004 • postdoc UNSW • QuTech since 2015

Research Topic: I have a multidisciplinary expertise in semiconductors that has enabled me to span the traditional boundaries between materials (by designing and optimising crystal growth), chemistry (by understanding at the atomic-level the interactions of molecules with surfaces), fabrication (by developing new nanofabrication techniques), and physics (by exploring electron transport). My group at QuTech designs, makes, and studies innovative materials by the assembly of group IV elements. The goal is to tailor the structural and electronic properties of such heterostructures for applications in quantum technologies, including quantum computation.

Kavli: I am pleased to join the Kavli Institute of Nanoscience Delft and look forward to be part of a stimulating intellectual environment which will foster exchange of ideas, promote collaborations, and underpin new scientific breakthroughs.

Menno Veldhorst

Background: Physics • PhD Twente 2012 • postdoc UNSW Australia • QuTech since 2016

Research Topic: The spin states of electrons confined in silicon quantum dots can now be operated as qubits and with very high precision, while the devices are fabricated in a remarkably similar manner as the billions of transistors in our computer chips. My group has the focus on the crucial challenges that are on the road towards a silicon quantum computer. We create control over the individual personalities that qubits tend to have and work on mechanisms that can couple qubits on a short or on a long distance. The experiments that we carry out require a deep understanding and a lot of creativity, but have the potential to pave the road towards a large-scale quantum processor.

Kavli: The Kavli Institute of Nanoscience Delft is an inspiring environment. I look forward to stimulating discussions increasing our knowledge, bringing my group closer to our goals, and leading to joint research efforts.

Tim Taminiau

Background: Experimental physics • PhD ICFO Barcelona 2011 • postdoc Delft • QuTech since 2015

Research topic: I use spins in diamond to experimentally investigate quantum physics and quantum information. My overarching goal is to build coupled quantum networks hundreds of such spins. With such quantum networks I hope to understand how decoherence emerges in complex quantum systems and how we can protect quantum states and operations from such decoherence so that large-scale quantum computations become possible.

Kavli: What it already is: A fun community that stimulates thinking beyond my own research.

Ryoichi Ishihara

Background: Physical Electronics ● PhD Tokyo Inst. of Technology 1996 ● then TU Delft. Also visiting professor Japan Advanced Institute of Science and Technology since 2013

Research topic: My current research focus in QuTech is fabrication of control electronics on the Si spin qubit plane and also advanced packaging technology for integration of qubit. Ultra-low-power CMOS circuits using the same material as 2D array of many Si spin qubit is a challenging topic. Stacking of cryo CMOS and spin qubit with dense 3D interconnect with Si interposer is another challenge for scalable quantum computer.

Kavli: Participation to Kavli activities will broaden my knowledge and network and stimulate new idea/direction for my research. In near future I would like to contribute as well to Kavli in my field of research: quantum integration technology, by presentation and others.

Michael Wimmer

Background: Theoretical Physics ● PhD Regensburg (Germany) 2008, ● postdoc Leiden ● QuTech since 2013

Research topic: I investigate theoretically the quantum properties of hybrid nanodevices, with a focus on systems that are *topologically protected*. This protection implies that certain quantum properties are robust, and thus may be used for quantum applications. One particular example are hybrid systems of semiconductor nanowires and superconductors hosting topologically protected Majorana bound states – those are the basic building blocks for fault-tolerant, topological quantum computing which is pursued in the topo roadmap in Qutech. (You may have noticed that in our field we like the word "topological".) Due to the complexity of the systems we are studying, we often use numerical simulations. I develop these numerical methods together with collaborators/friends in the framework of the software package Kwant.

Kavli: I actually was part of Kavli before QuTech was formed – I always enjoyed the collective Kavli events like the colloquium and the Kavli days. Hence it feels good to be back! The Kavli institute really unites all the nanoscience research in Delft, and I am proud to be part of that.

Viatcheslav Dobrovitski

Background: Theoretical Physics ● PhD Moscow State University 1997 ● Ames Laboratory (Iowa, USA) ● QuTech since 2016

Research topics: Quantum and classical spin dynamics, relaxation and decoherence in many-spin systems, coherence protection in quantum registers, numerical modelling of non-equilibrium many-spin quantum dynamics. The goal of my work is to understand the dynamics of real many-spin quantum registers, where the qubits interact with each other and with their environment, and employ this knowledge for enabling and improving quantum information processing in solid-state systems. I have been working on several topics, such as quantum dynamics of the electronic spins in quantum dots, decoherence and coherence protection of the single- and few-spin quantum registers in diamond, spin dynamics in ESR and NMR experiments, quantum spin effects in magnetic molecules, etc.

Kavli: I hope that as a member of the Kavli Institute of Nanoscience Delft I will be able to connect and, hopefully, collaborate with other members of the Institute on the projects which are of interest for QuTech, but also have significance and impact in broader areas of physics and nanosciences. I expect to be able to contribute my knowledge and interest in a range of topics of the solid-state physics, AMO, and the quantum-related areas to other projects, and to the overall progress in the areas pursued by the Kavli Institute of Nanoscience Delft.

Edoardo Charbon

Background: Electrical Engineering and Computer Sciences ● PhD Berkeley 1995 ● Industry Silicon Valley ● EPFL ● at Delft since 2008

Research: We are working on cryogenic electronics for qubit control and error correction. This infrastructure will be built in complementary metal-oxide semiconductor (CMOS) technology operating near base temperature, so as to ensure a compact, scalable interface with thousands or perhaps millions of qubits. Operating at deep cryogenic temperatures allows for low-noise and high-speed electronics in close proximity to the qubits, however it also introduces strict constraints on power dissipation and volume. We are observing several new and well-known effects, often discovering new challenges at device, circuit, and system levels that require a creative fresh look at design as a whole: an exciting journey for researchers in all engineering domains.

Kavli: Kavli is an excellent place to meet people and exchange new ideas, often at the frontier of science and engineering. It is also the right place to disseminate the results of our research right outside our alley, where people are curious and yet sensitive to scientific advances. I hope to bring a fresh engineering perspective at Kavli in this exciting new journey in the quantum world.

SELF-INTERVIEW WITH STAN BROUNS

Delft has a very rich history of Microbiologists. It all started with Antonie van Leeuwenhoek who was born in in the 17th century. He looked through his self-made microscope and observed the fascinating microscopic world around us for the very first time, including bacteria, plant cells, muscle fibers and his own spermatozoa. In his 90 years of existence, he reported hundreds of observations in letters to the Royal Society in London. Great names such as Beijerinck and Kluyver followed a few decades later putting the Delft School of Microbiology permanently on the worldwide map with discoveries such as viruses, nitrogen fixing bacteria in plant roots and sulfate reducing bacteria giving off that awful smell in city canals in summer. Scientific progress has since enabled studying interactions down to the nanoscale where even cellular processes carried out by proteins and nucleic acids can be individually visualized.

Four months ago I joined the department of Bionanoscience at the Kavli Institute of Nanoscience. My experience at BN has been excellent so far. BN is really one of those rare places where high quality curiosity driven research still thrives. My research fits right in. We focus on the interactions between microbes and their parasitic stalkers, better known as bacteriophages. Microbes have to use an arsenal of defense systems to fend off bacteriophages, including the now well-known CRISPR system. Nowadays, CRISPR is famous for the revolutionary genome engineering toolbox that may one day cure human disease, but my interest has always been to find out how these systems operate and how they help bacteria survive in the ongoing evolutionary battle with bacteriophages. We are furthermore interested in how bacteriophages avoid host defense systems for example by rapid mutation of their DNA or by encoding proteins that inhibit host defense systems.

Being a scientist is one of the best jobs in the world. I feel privileged to be around young people on a daily basis and to collaborate with interesting scientists in the Netherlands and around the world. Although I do not consider myself a workaholic, I am passionate about my work and it is almost like a hobby to me. I cherish the moments in science when I was one of the first persons in the world to see a certain aspect of biology for the first time. These moments include observing a new protein complex, seeing a protein structure for the first time, or witnessing a special biochemical activity. It feels incredible to uncover the molecular mechanisms that evolved over billions of years, and to describe these phenomena for science.

My spare time I spend with my family and friends. I have a lovely wife Marloes and two sons; Timo and Jurrian who are now seven and five years old. It's a lot of fun watching them grow up. I see the same curiosity I have in them, and I am eager to know where they will end up later. In the weekend I like to take my boat out fishing the big lakes in the Netherlands, ideally with my neighbor. Being on the water helps me getting the stress out of my system and allows me to organize my thoughts to get ready for a new week.

I look forward to many good years at the Kavli Institute of Nanoscience, and I hope that my research can contribute to the long and successful history of Microbiology in Delft.

2016 Kavli Prize in Nanoscience

On 6 September, in Norway, Oslo, the 2016 Kavli Prizes were awarded. The Kavli Prize is a partnership between The Norwegian Academy of Science and Letters, The Kavli Foundation, and The Norwegian Ministry of Education and Research. The Kavli Prizes recognize scientists for pioneering advances in our understanding of existence at its biggest, smallest, and most complex scales. The Prizes are presented every two years in the fields of astrophysics, nanoscience and neuroscience.

The 2016 Kavli Prize in Nanoscience, the largest prize in our field of interest, is shared between **Gerd Binnig**, former member of IBM Zurich Research Laboratory, Switzerland, **Christoph Gerber**, University of Basel, Switzerland, and **Calvin Quate**, Stanford University, USA. They receive the prize "for the invention and realization of atomic force microscopy, a breakthrough in measurement technology and nanosculpting that continues to have a transformative impact on nanoscience and technology."

2016 Kavli Delft publication prize for Bas Hensen's paper

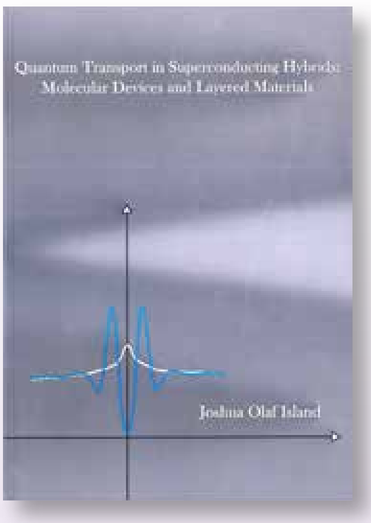
On our Kavli Day, the 2016 Kavli Delft publication prize was awarded, a prize for the best publication that resulted from our Kavli Institute in the previous two years. The prize, which consists of an award and an amount of € 3000 for the laureates, is given out every two years. Various nominations had come in. A selection committee consisting of 4 senior and junior professors from our Institute read the papers that were sent in and ranked them. The selection committee had a hard task because of the excellent quality of many of the papers that were sent in, but in the end, the committee reached a verdict and selected the winning paper.

The 2016 Kavli Delft publication prize was awarded to B. Hensen, H. Bernien, A.E. Dréau, A. Reiserer, N. Kalb, M.S. Blok, J. Ruitenberg, R.F.L. Vermeulen, R.N. Schouten, C. Abellán, W. Amaya, V. Pruneri, M.W. Mitchell, M. Markham, D.J. Twitchen, D. Elkouss, S. Wehner, T.H. Taminiau and R. Hanson for their paper "Loophole-free Bell inequality violation using electron spins separated by 1.3 kilometres" that appeared in Nature on 29 October 2015. This paper reports the first loophole-free violation of Bell's inequality, ending a decades-long hunt by many experimental groups. Both the detection and the locality loopholes were closed for the first time in a single experiment. The paper got enormous attention. Upon pre-publication, virtually all the prominent researchers in the field went on record discussing the importance of the paper in scientific media. Besides the direct scientific impact, the paper also drew great attention of the general public. Many "breaking news"-items appeared in the popular scientific media as well as in worldwide general media. Upon publication the work was covered in probably every country with evening news tv items from the Netherlands to Australia, and notably the work appeared on the cover of the New York Times.

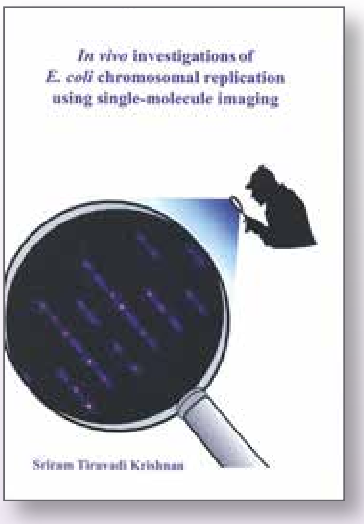
We are proud that we can award Bas Hensen, Ronald Hanson, and all co-authors the 2016 Kavli Delft publication prize for this wonderful work.

RECENT PHD THESES

Natalia Vtyurina
9 september 2016



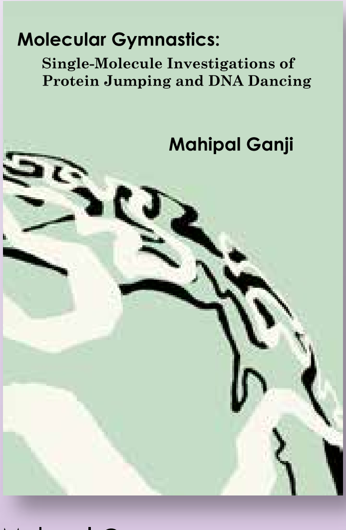
Joshua Island
12 september 2016



Sriram Tiruvadi Krishnan
19 september 2016

Iman Esmaeil Zadeh
30 september 2016

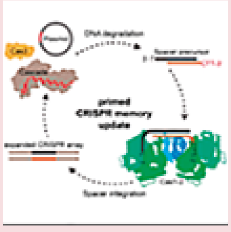
Nuria Taberner Carretero
10 oktober 2016



Mahipal Ganji
25 oktober 2016

Cas3-Derived Target DNA Degradation Fragments Fuel Primed CRISPR Adaptation

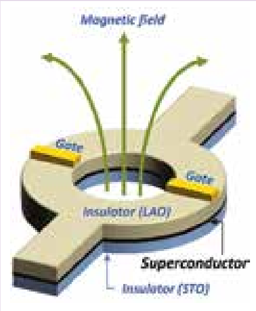
This paper describes how CRISPR systems cleverly couple target interference to CRISPR memory update. The Cas3 nuclease fragments invader DNA into pieces of near-spacer length enriched for PAM sequences in their 3′ ends to form ideal spacer precursors.



Künne T, Kieper SN, Bannenberg JW, Vogel AI, Miellet WR, Klein M, Depken M, Suarez-Diez M, Brouns SJJ
Mol Cell. 2016 Aug 18.

Quantum interference in an interfacial superconductor

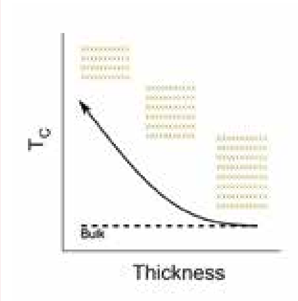
The researchers have created nano-electronic circuits using a recently discovered two-dimensional superconductor. What makes this material unique is that its superconductivity can be turned on and off remotely, very much like the switching of electrical current in a transistor on a microchip. Utilizing this effect at the nanoscale, the researchers created superconducting circuits in a completely new way, which is impossible to achieve in other commonly known superconductors.



S. Goswami, E. Mulazimoglu, A.M.R.V.L. Monteiro, R.Wölbing, D. Koelle, R. Kleiner, Y. M. Blanter, L.M.K. Vandersypen, A.D. Caviglia
Nature Nanotechnology advance online publication (2016), arXiv:1512.04290

Enhanced superconductivity in atomically thin TaS2

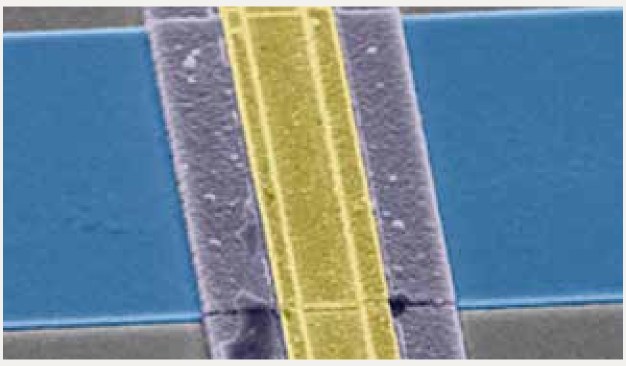
Through the simplicity of mechanical exfoliation, the thickness of layered materials can be controlled with atomic resolution. This presents the opportunity to investigate how a gradual reduction in dimensionality affects the bulk properties of layered materials. In this study we probe the thickness dependent superconducting properties of the layered material tantalum disulfide (2H-TaS_2) and find that superconductivity is enhanced at reduced dimensions due to an increase in the effective electron–phonon coupling constant for sufficiently large bare Coulomb repulsion.



E. Navarro-Moratalla, E, J.O. Island, S. Manas-Valero, E. Pinilla-Cienfuegos, A. Castellanos-Gomez, J. Querada, G. Rubio-Bollinger, L. Chirolli, J.A. Silva-Guillen, N. Agrait, G.A. Steele, F. Guinea, H.S.J. van der Zant & E. Coronado,
Nature Communications (2016)

Gapless Andreev bound states in the quantum spin Hall insulator HgTe

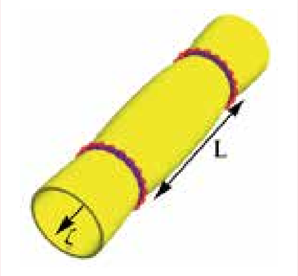
A Josephson junction with a weak link made of the quantum spin Hall insulator HgTe shows evidence of topological superconductivity in response to an a.c. excitation



Erwann Bocquillon, Russell S. Deacon, Jonas Wiedenmann, Philipp Leubner, Teunis M. Klapwijk, Christoph Brüne, Koji Ishibashi, Hartmut Buhmann and Laurens W. Molenkamp
Nature Nanotechnology 2016

Pointlike inclusion interactions in tubular membranes

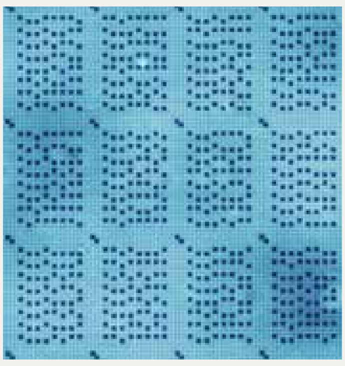
We theoretically study how the geometry of membranes affects the interactions of proteins embedded in them. We found that even for a simple tube, those interactions are very different then they would be on a flat plane. Repulsive interactions become attractive, and lead to the self-assembly of biologically relevant configurations, such as protein rings around the tube.



Afshin Vahid and Timon Idema
Phys. Rev. Lett. 117, 138102 (2016)

A kilobyte rewritable atomic memory

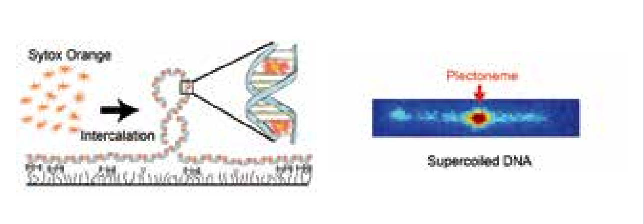
For 25 years the ability to manipulate individual atoms was limited to manual placement of several tens of atoms. By switching to manipulation of atomic vacancies in a chlorine layer on a copper crystal substrate, we now demonstrate a fully automated placement of tens of thousands of atoms. This allowed us to engineer a prototype atomic memory device storing a full kilobyte of data.



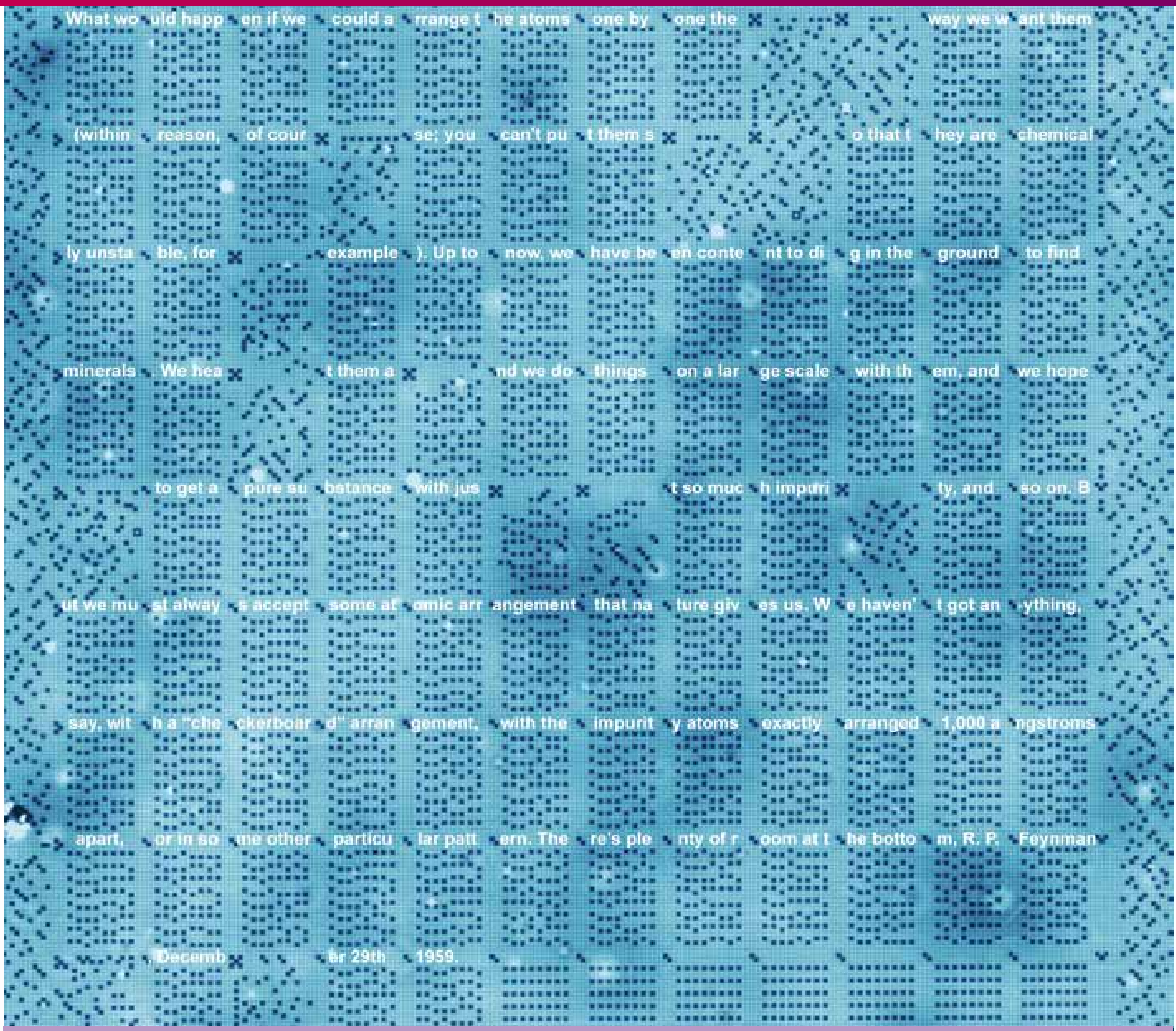
F. E. Kalff, M. P. Rebergen, E. Fahrenfort, J. Girovsky, R. Toskovic, J. L. Lado, J. Fernández-Rossier and A. F. Otte
Nature Nanotechnology, AOP (2016)

Intercalation-Based Single-Molecule Fluorescence Assay To Study DNA Supercoil Dynamics

We reported a novel high-throughput single-molecule assay that visualizes DNA supercoils in real-time. Unlike the existing single-molecule techniques, it does not require any complicated experimental instrumentation, yet it provides detailed information regarding the structure of supercoiled DNA. For instance, we show that plectonemes prefer to localize at mismatched bases along supercoiled DNA.



Mahipal Ganji, Sung Hyun Kim, Jaco van der Torre, Elio Abbondanzieri, Cees Dekker
Nano Letters 16,4699-4707 (2016)



Scanning tunneling microscope topography image (96 nm wide, unprocessed data) of an atomic-scale data storage system, reported in Kalff et al., Nature Nanotechnology AOP 2016 (DOI 10.1038/nnano.2016.131). With a data density of 500 Terabits per square inch, this atomically assembled memory outperforms state-of-the-art hard disk drives by almost three orders of magnitude. The encoded text is an excerpt from Richard Feynman's lecture *There's plenty of room at the bottom.*
Ottelab, 2016

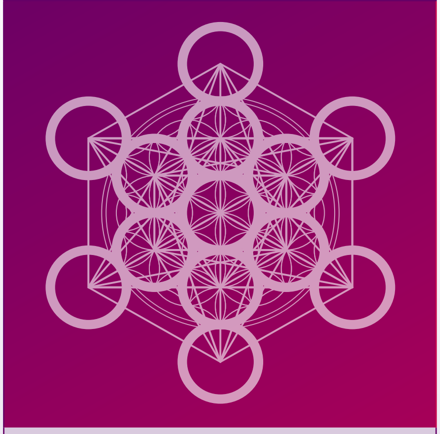
UPCOMING KAVLI COLLOQUIUM

Markus Aspelmeyer
March 2, 2017
University of Vienna

UPCOMING KAVLI COLLOQUIUM

Michael Elowitz
Date to be determined
Caltech

KAVLI DAY



SAVE THE DATE
September, 7, 2017

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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Haagsblauw

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