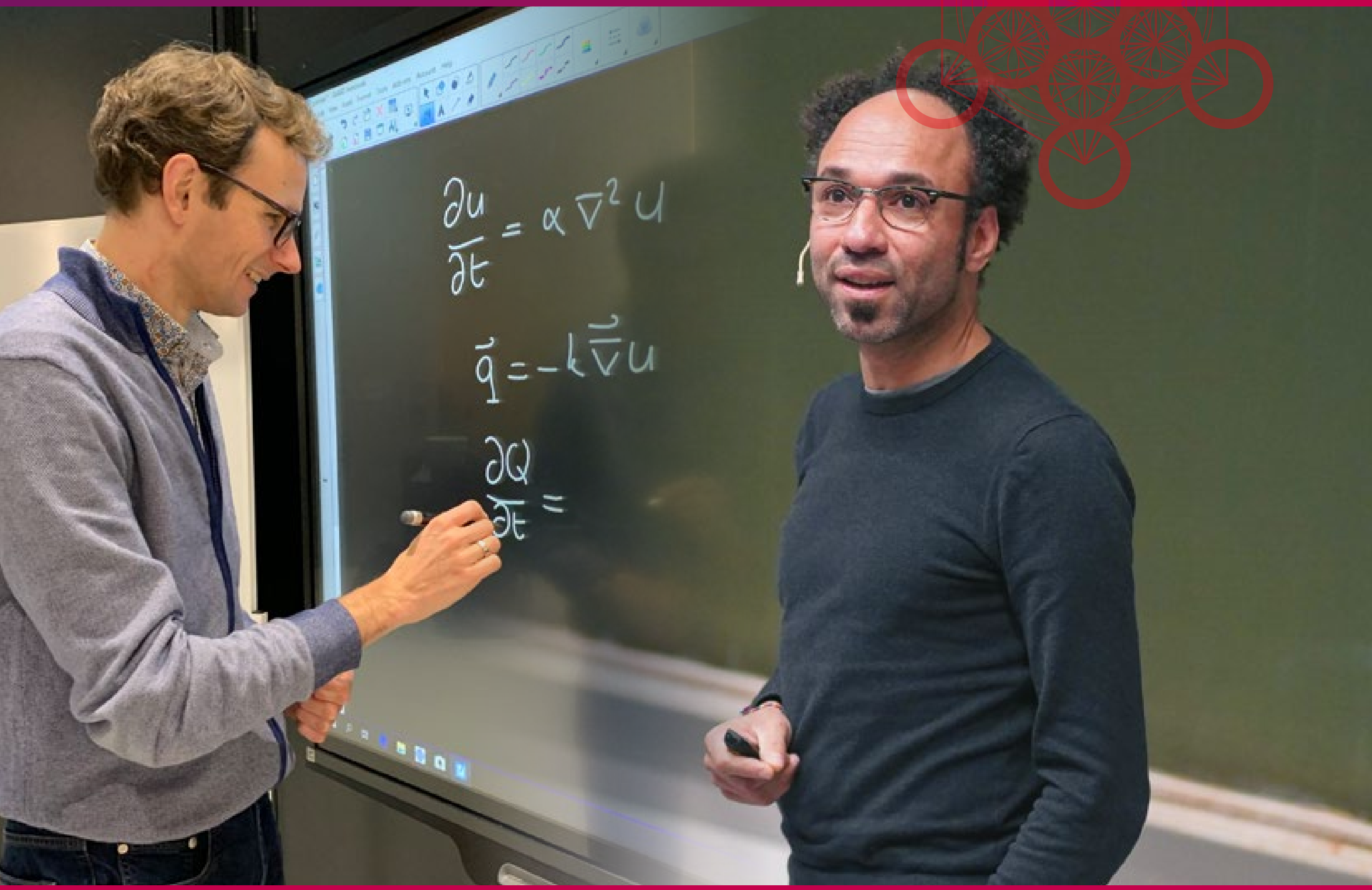
KAVLI NEWSLETTER

Kavli Institute of Nanoscience Delft

No.27
Januari 2020



IN THIS ISSUE:

Increasing the reach and depth of education

By Bertus Beaumont

As a teacher, I try to inspire students to actively explore how life works. Central to my approach is that I offer a unified framework to help students deal with the complexity of biology, and that I interact with them in a very open and personal manner. I teach biology courses in both bio- and non-bio study programs because innovation is not bound by the classical academic disciplines. This is particularly true for nanoscience: nanotechnology provides tools to study life at the nanoscale, which in return uncovers new engineering principles of use in nanotechnology. I envisage two ways in which Kavli Delft can contribute to education and give back to society: (i) by actively advancing the public understanding of nanoscience and (ii) by empowering excellent high-school students from challenging social backgrounds to aspire a career in nanoscience.

Nanotech that actually works

I teach three biology courses. In the Nanobiology BSc program, I treat the fundamentals of evolutionary theory. For the Applied Physics MSc program, together with Greg Bokinsky, I teach a course on the evolution and engineering of living systems. My third course is BioLogic, a TU-wide MSc elective that teaches biology for bio-inspired design and engineering. At the core of all three courses is the idea that biocomplexity can be navigated efficiently

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FROM THE DIRECTORS

Kavli's ambition goes beyond the excellence in research. In particular, this Newsletter covers the stories from Teachers of the Year about how to educate prospective scientists. Bertus Beaumont talks about what nanotechnology can learn from biology. Timon Idema underscores the importance of interaction with students and fellow lecturers.

This issue contains the self-interview with the very first Artist-in-Residence, Simon(e) van Saarloos. She talks about how it felt to work in Kavli and what was surprising.

You can find the interview with the upcoming colloquium speaker, Taekjip Ha from Johns Hopkins University. Ha has pioneered single-molecule techniques and has worked on many exciting topics over the years.

Finally, don't miss the columns by Anton Akhmerov and Timon Idema, and a PhD student profile from Axel Dahlberg!

Chirlmin Joo

COLUMN

As you probably noticed, the Dutch in our institute are quite proud of their cultural heritage, and will find excuses to introduce it to those of you coming from abroad. For example, during the QN Christmas party people were competing in some old-school Dutch games, while the people in the Cees Dekker lab in BN celebrated Sinterklaas complete with putting their shoes at the (fake) fireplace, and by making *surprises* (fancy wrappings) for each other. Of course, Cees himself got one too, an effigy of the Nobel peace prize, "for successfully leading a lab of 18 nationalities + an Irishman".

Science doesn't have a very good reputation when it comes to furthering world peace – partly due to the sadly real reason that physicist helped build atomic weapons, and partly due to the portrayal of mad scientists in movies. What is overlooked in both is the capability of science to bring people together, as evidenced in many of our labs, where we collaborate independent of nationality. This practice has strong precedent; a well-known example is the unifying role played by Lorentz after World War I, when he quickly re-established relations between scientists from countries that were fighting each other a few years earlier, culminating in the return of German scientists to the famous Solvay conferences.

Until recently, it seemed that global affairs were moving towards the breakdown of borders, much to the benefit of everyone involved. The high point was the 2015 deal between Iran and (essentially) the rest of the world, normalizing relationships, with the promise to the Iranian people that they could join the global community. We all know what happened next, with new borders being drawn up isolating both the US and the UK. Moreover (and perhaps even worse), the populist movements that favor this kind of isolationism also publicly denounce science and scientific results when they don't fit their agenda.

We should not stand idly by when these things happen. We should support our fellow scientists in countries where their voices are not heard, or where there is a strong possibility that they will be ignored. Likewise, we should continue supporting scientist in countries that our governments don't like. By working together we can not only do better science, but also contribute to building mutual understanding. Moreover, we should go outside, and show (rather than tell) the government and the people not just what we discovered, but also how we got there. The university employs people specialized in writing up press releases, but those only highlight our Nature papers – not that we worked on them with people from nineteen different countries. By showing the world how we can work across borders without having to give up our cultural identity we can give much more than simply the results of our experiments, while at the same time making our results more credible though increased transparency.

Timon Idema

INTERVIEW

Interview with Taekjip Ha

Q: You are famous for your work in the field of biophysics and in particular the development of single-molecule FRET. However, you initially started out as a physicist. What was your start in biophysics like?

A: When I was a graduate student I worked in a lab that used lasers to study semiconductor physics. In that lab I initially worked on semiconductor optics. My boss then suggested for me to build a new instrument that can perform semiconductor optics at a resolution better than the diffraction limit – we wanted to do semiconductor physics at a resolution of 50 nm, using an instrument that was invented by a lab in Cornell university. It was called near-field optical microscopy. Once I built it we quickly realized it is not useful for semiconductor physics, because the electron-hole pairs will diffuse so quickly at room temperature that we weren't able to capture anything, so it was quite depressing. But Eric Betzig, who invented the microscope, had managed to image single molecules for the first time in around 1994 (he later got the Nobel Prize for the invention of PALM). So after we failed to use the microscope on semiconductors we decided to use it to observe single-molecule fluorescence instead. But I knew if I do the same thing, I won't get my PhD. I came across a handbook about dyes and decided to observe single-molecule FRET between two dyes, because that was new. My initial experiments failed because I did not have a direct way of making sure the dyes were close enough. A colleague of mine knew how to use DNA to bring the dyes close together and as doing bulk FRET measurements. He made me a sample, and in 1996 we reported the first single-molecule observation of FRET. So I became an expert overnight.

Q: So you started with DNA purely to be able to observe FRET, but not to investigate its properties?

A: Correct. I often joke when I give talks, that when my bosses mentioned in the abstract that this could be used to measure conformational dynamics of biological molecules, I thought it was something you have to say to get your paper published. In the end I published more than 200 papers using the method and made a career out of it.

Q: You studied many biological systems, molecular motors, other molecular mechanisms. What aspect of your physics training was the most helpful in trying to understand biological systems?

A: I have never taken a course in biology in college or later on, so I had to learn everything from textbooks, seminars and papers. I do think that it is good to come from outside, because you can question the assumptions implicit in the field. I think this helped at the beginning of my research. But I think by now I don't have the advantage anymore.

Q: You yourself have a physics background and in Bionanoscience department here in KIND, most people come with either physics or biology background to do biophysics and very few universities actually teach biophysics as a degree program, as opposed to, for example, biochemistry. Why do you think that is?

A: Maybe one could argue that biophysics as a field is developing so rapidly and it is harder to pin down what should constitute a curriculum of biophysics. I think biochemistry is easier to imagine. People joke that biophysics is more of a state of mind than a biological subject. It really depends on how you divide biology into sub-disciplines.

Q: You started single-molecule FRET in the late 90s. How do you think the field of single-molecule biophysics has changed over the years?

A: It has become a lot bigger. Now you go to a biophysical society meeting which has around 6000 people, about a third of the posters are about using a single-molecule method of some kind. So it's very very popular. I also think that technology is now quite mature, so that many people are now focusing on applications. There's also less interest from traditional physics departments – it has become a lot more biological. Now there are so many people doing similar experiments – when I was a

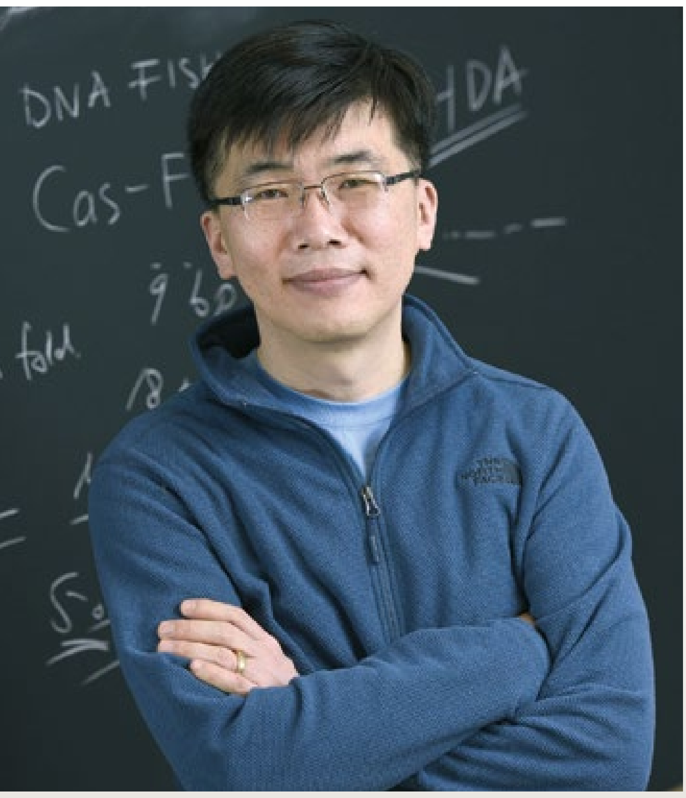
KAVLI COLLOQUIUM

“CRISPR and DNA repair”

Taekjip Ha

Johns Hopkins University

February 6, 2020 will feature a Kavli colloquium by Taekjip Ha:



Double strand breaks (DSB) are frequently generated, and researchers have discovered many proteins and processes needed to repair the breaks. However, relative timing of sub-stages of DNA repair or even their ordering has been difficult to determine due to the lack of method to synchronize the generation of well-defined breaks in living cells. Exposing cells to X-ray and UV can produce massive DNA damages at a defined time point, but the nature of the damage is ill-defined, and damages are made randomly. CRISPR-Cas systems allow the generation of breaks at specifically defined genome locations, but despite many attempts to develop ligand- or light-inducible CRISPR-Cas systems, the cleavage kinetics remains slow, leading to unsynchronized repair. We developed a very fast CRISPR-Cas9 can generate a DNA break at a defined locus at a well-define (within seconds) time point, allowing us to reveal the mechanisms of break recognition and study DSB repair and other cellular processes with an unprecedented spatiotemporal control.

15.30 hr	Coffee and cake
16.00 hr	Kavli colloquium by Taekjip Ha: “CRISPR and DNA repair”
17.00 hr	Drinks & time to meet

Dr. Taekjip Ha is a Bloomberg Distinguished Professor of Biophysics and Biophysical Chemistry, Biophysics, and Biomedical Engineering at Johns Hopkins University School of Medicine. He is also an investigator with the Howard Hughes Medical Institute. He uses sophisticated physical techniques to manipulate and visualize the movements of single molecules to understand basic biological processes involving DNA and other molecules. His study is focused on pushing the limits of single-molecule detection methods to study protein–nucleic acid and protein-protein complexes and the mechanical basis of their interactions and functions – both in vitro and in vivo – that are important for genome maintenance.

Dr. Ha received his undergraduate degree in Physics, from Seoul National University, Seoul, Republic of Korea in 1990. He earned his Ph.D. in Physics from the University of Berkeley in 1996. After postdoctoral training at Stanford University, he was a Physics professor at University of Illinois at Urbana-Champaign for fifteen years until 2015.

Dr. Ha serves as a member of Editorial Boards for Science, Cell, eLife, PRX, Structure, PCCP, Physical Biology and Cancer Convergence. He is a member of the National Academy of Science and an elected fellow of the American Academy of Arts and Sciences.

HOT TOPICS

“Measuring DNA mechanics on the genome scale”

Please register on casimir.researchschool.nl
Date: February 7, 2020
Time: 10.30h
Location: A1.100

KAVLI COLLOQUIUM

Date: February 6, 2019
Location: Kronigzaal, building 58

graduate student I knew that no one was doing anything similar, but that is not the case anymore. If you want to make your research more unique you need to be good at more than one thing.

Q: Single-molecule FRET was a huge breakthrough for biophysics. You also worked on such topics of CRISPR, which is one of the most famous discoveries of the decade. What do you think will be the next big development in biophysics or overall science will be in the next years?

A: In my opinion the next big thing in biophysics will be what PhD students are excited about. My prediction is that the most exciting thing in the next five years will be a biophysical analysis of human tissue samples.

Q: What do you think are the biggest challenges for scientists nowadays?

A: Time. There are always distractions. Emails, social media. Those things can be quite distracting and give you less time to think. There’s hardly a moment where I’m not doing anything. That’s a big problem. You have to be more disciplined. So much new development in every direction, it is quite overwhelming. Time is the most precious asset.

Q: Do you have any advice for young aspiring scientists?

A: I have one suggestion. It is about how to choose a project. I think you want to choose a project where your anticipated contribution will be unique. So that if you don’t do it maybe no one will do it for the next couple of years. But on the other hand you don’t want to work on things that no one cares about. You want to have impact – I do not mean impact factor, I mean that people will read your work and will maybe change the way they do research or think about something. You want to work on things that many people care about, but how do you make your work unique? You want to pick a project or a situation where you have an unfair advantage compare to others in the field.

That is a great piece of advice. Thank you for the interview!

Viktorija Globyte

Great teaching requires time and interaction

By Timon Idema

In Nanobiology, we apply principles from physics to biological systems, mostly at the cellular scale and below. The various physics courses in the Nanobiology curriculum are designed to support this goal: teaching students the physical concepts they will encounter both in the lab and in the modeling of cellular processes. I teach three of these courses. In my first-year course, students learn the basics of mechanics of both particles and continuum systems. In the third year, I teach an elective on quantum mechanics, where we make a direct connection to chemistry. In the MSc program, I teach a course on soft matter, the physics of all the squishy stuff inside cells, which is also an elective for physics students. Especially in the last course, we can directly connect to ongoing research, in e.g. the study of DNA shapes, cytoskeletal network formation, or interactions between proteins and the cellular membrane. Frequently, what we've discussed in class in the morning comes back during a scientific seminar in the afternoon, and at the end of the course students can pick up a recent article and explain to me what's in it.
How I teach depends a lot on which teaching activity I'm involved in. As I learned from science-journalist Diederik Jekel, I can't do anything about how the audience listens to what I'm saying, but I can change the way I speak. Moreover, I can make the audience do something else than just listening. Therefore, especially in the first-year course, I add interactive elements: live demonstrations and feedback questions (multiple-choice on student's phones) replace long derivations. Also, the teaching doesn't stop at the end of my lecture – essentially any interaction with a student has an element of teaching, in particular when they come to do projects in my group. However, the learning goals get completely turned around. Instead of teaching students how to solve problems to which we know the answer, in these projects the main thing I have to convince them of is that I don't know the answer either, and that that's what makes research interesting.

Teaching well is hard, but improving your teaching may be even harder. Giving a lecture for the second time, it is tempting to simply re-use what you did the year before. Improving requires an extra investment of time, a commodity that we're all desperately short of. Yet if we are serious about becoming as excellent in teaching as we are in research, there is no way around it: we need to invest time in attending each other's lectures (both to learn from each other and to give feedback), to reflect on our learning material and teaching methods, to further develop some of that material, and to talk to the students so we can learn from them what works and what does not. There is an upshot though: where research is impossible to plan, these teaching-related activities can be planned. Facilitating that people take time for them would be a great way to further excellence in teaching.

› **Continued from page 1**

by viewing life as a single phenomenon that emerges from interacting components at multiple levels of organisation. An American biotechnologist once provocatively said "biology is nanotechnology that works". Regardless of your opinion on this, biology offers a mind-blowing sneak-preview of what can potentially be achieved by nanotechnology. Although bionanoscience is still in the exploration phase—figuring out how the molecular machines inside cells work and interact—research that will one day allow us to build nanodevices from the amino-acid building blocks of life is ongoing.

A gap in TU Delft education

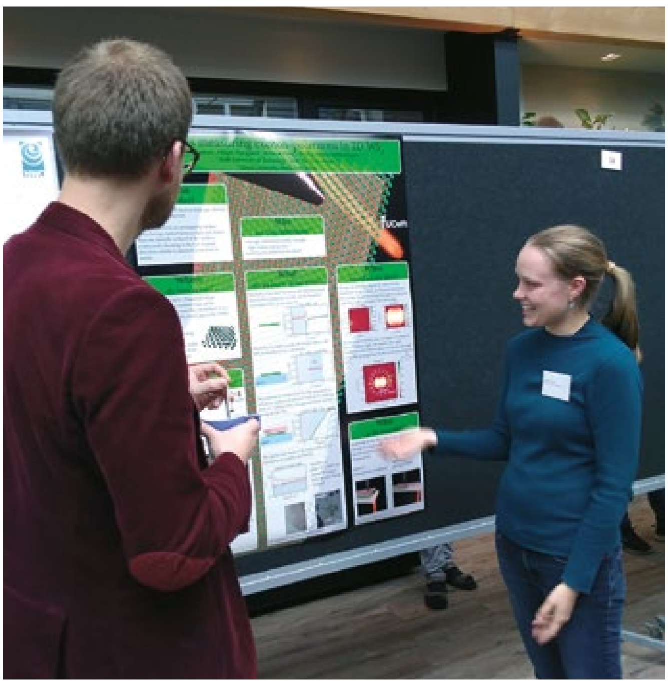
One simple method I use to connect with students is to learn their names using photos—which is much easier than it sounds—and to use this to interact with them during lectures. When I started teaching, I was surprised by how often the barriers to learning are personal rather than related to the task at hand: from procrastination and fear of exams to full blown burn-out. Given how common these minor and major issues are among student and professionals, and considering the lack of training of personal leadership skills in our curricula, this represents a major opportunity to improve the education we offer. Inspired by this, I am currently developing a TU Delft-wide course (working title 'TYou Delft') and a teacher community to address this. If you are interested in participating in this network, please send me an email for more information (h.j.e.beaumont@tudelft.nl).

Kavli Delft education for all!?

I see two ways in which Kavli Delft could contribute to education while also making a direct contribution to society. The first involves organising public lectures in which Kavli-Delft scientists present and discuss their work in an enlightening and accessible manner. I believe that all science can be communicated in this way provided the proper format. The second opportunity involves reaching out to excellent high-school students from challenging social backgrounds. At present, the educational opportunity landscape is uneven, causing some talented high-school students to underaspire and fail to reach their full potential. Consider, for example, what the likelihood of an academic career looks like from the perspective of someone who never interacted with a higher education-trained person aside from their school teachers? Kavli Delft can collaborate with organisations already targeting this group to help empower a limited number of excellent students with an interest in nanoscience to increase their chances of academic success.

Irina Komen wins AMO poster prize

Irina Komen (QN, Kuiperslab) was awarded the poster prize at the conference of the Division of Atomic, Molecular and Optical Physics (NNV AMO), held this October in Lunteren, the Netherlands. She presented her work towards measuring exciton-polaritons in 2D WS2 using a near-field microscope. Runner-up for the prize was Thijs van Gogh (QN, Kuiperslab) presenting his work on flow-field singularities in random waves.



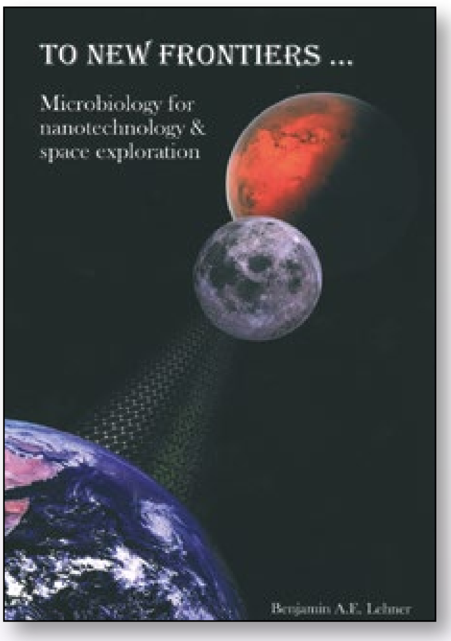
Marta Pita Vidal has been nominated for TU Delft Best Graduate 2019

During her graduation project at QuTech, Marta worked on the development of a hybrid fluxonium, a device that combines two of the main approaches to quantum computation: superconducting qubits and topological qubits. She is now a PhD student at the Kouwenhoven lab.

NEW EMPLOYEES

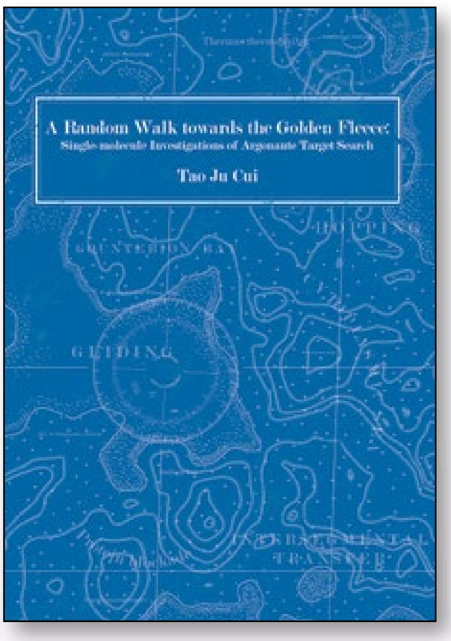
Name	Date of employment	Title	Lab
Pinakin Padalia	23-09-19	Research assistant	Charbon Lab
Kars Huisman	15-10-19	PhD	Jos Thijssen Lab
Medina Bandic	16-10-19	PhD	Carmina Garcia Almudever Lab
Minxing Xu	01-11-19	PhD	Groeblacher Lab
Assunta Scognamillo	01-11-19	PhD	Conesa Boj Lab
Helene Spring	01-11-19	PhD	Anton Akhmerov Lab
Jasper Franse	01-11-19	PhD	Steele Lab
Thomas Baum	01-11-19	PhD	Van der Zant Lab
Kian van der Enden	01-11-19	PhD	Hanson Lab
Sjoerd Loenen	01-11-19	PhD	Taminiau Lab
Stefanos Andreou	15-11-19	Postdoc	Groeblacher Lab
Alexandre Artaud	01-12-19	Postdoc	Otte Lab
Michal Shemesh	15-12-19	Postdoc	Gijsje Koenderink Lab
Nikiforos Paraskevopoulos	01-01-20	PhD	Carmina Garcia Almudever Lab
Sander de Snoo	01-01-20	Software engineer	Vandersypen Lab
Razvan Nane	15-01-20	Postdoc	Carmina Garcia Almudever Lab
Yash Jawale	16-01-20	PhD	Marileen Dogterom Lab
Ilina Bareja	01-02-20	Postdoc	Marileen Dogterom Lab
Matt Steinberg	01-02-20	PhD	Carmina Garcia Almudever Lab
Nir Alfasi	01-02-20	Postdoc	Tittel Group
Hridya Meppully Sasidharan	01-02-20	PhD	Tittel Group
Tanmoy Chakraborty	01-02-20	Postdoc	Tittel Group
Benjamin Pingault	01-02-20	Postdoc	Vandersypen Lab
Chien-An Wang	01-03-20	PhD	Veldhorst Lab
Hans Beukers	01-03-20	PhD	Hanson Lab
Lorenzo de Santis	16-03-20	Postdoc	Hanson Lab
Matheuz Madzik	01-05-20	PhD	Vandersypen Lab
Florian Unseld	01-05-20	PhD	Vandersypen Lab

RECENT PHD THESES



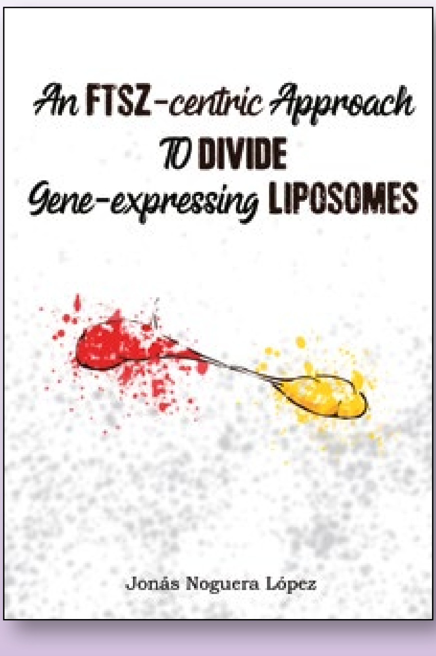
Benjamin Lehner
22 September 2019

Mohsen Falamarzi Askarani
27 November 2019

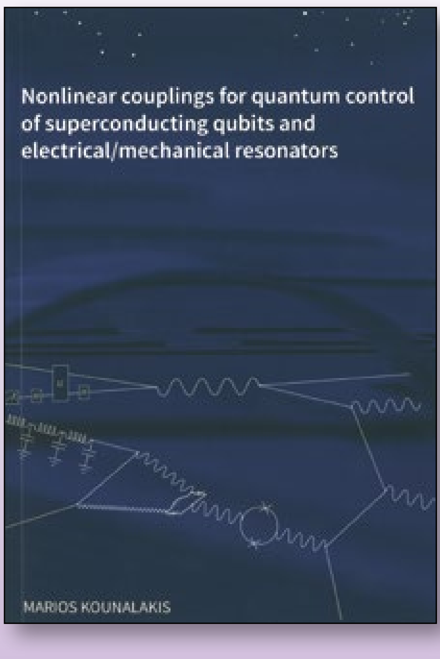


Thijs Cui
12 December 2019

Misha Klein
13 December 2019



Jonás Noguera López
16 December 2019



Marios Kounalakis
19 December 2019

Master student Hans Beukers wins one of the three Young Talent Shell graduation prizes for Physics

Hans Beukers performed his research project on the quantum properties of electrons and atoms in diamond under supervision of Prof. Hanson (QuTech) and Prof. Van der Wal (Zernike Institute for Advanced Materials, RUG). He presented his results in his prize winning thesis: *"Improving coherence of quantum memory during entanglement creation between nitrogen vacancy centres in diamond – The cure for quantum Alzheimer"*. He will start in March 2020 as PhD student Hanson Lab.

Save the date: Thursday 3 September 2020

Kavli day

Are we quantum computers, or merely clever robots?

The speaker will be Prof Matthew Fisher of UC Santa Barbara.

Srijit Goswami wins an NWO Klein Grant

The NWO Klein grants are intended for innovative, high quality, fundamental research. With his grant Srijit Goswami will study self-tuned topological states (Majoranas) in semiconductor quantum wells. He will use large two-dimensional systems to develop new kinds of Majoranas which are self-tuned and insensitive to microscopic influences in the environment. This will allow for the simultaneous creation of large arrays of identical Majoranas on a single chip, and will be used to perform experiments that demonstrate their practical feasibility for use in quantum computation.

Yuli Nazarov winner of the Humboldt Research Award

The award is granted in recognition of a researcher's entire achievements to date to academics whose fundamental discoveries, new theories, or insights have had a significant impact on their own discipline and who are expected to continue producing cutting-edge achievements in the future.
Award winners are invited to spend a period of up to one year cooperating on a long-term research project with specialist colleagues at a research institution in Germany. The stay may be divided up into blocks.
The Humboldt Foundation grants up to 100 Humboldt Research Awards annually. The award is valued at €60,000.

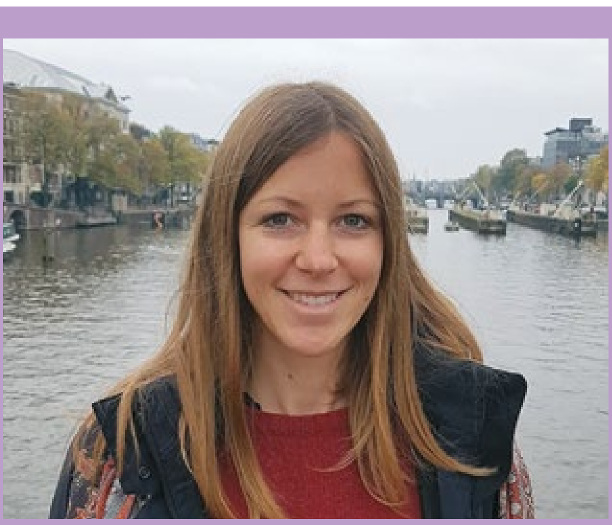
Stan Brouns on 2019 Highly Cited Researchers list

Clarivate has published its annual list of Highly Cited Researchers. Clarivate identifies scientists who have produced several papers that, based on citations, are in the top 1% in their field and in the year of publication, which shows that they have a significant influence among their peers.

Stan Brouns is fascinated by the interaction between microbes and their viruses. He conducts fundamental research into the resistance mechanisms of bacteriophages, such as CRISPR-Cas. Recently, there has been a lot of media attention for bacteriophages, because these tiny virus particles are adept at killing bacteria. We may therefore be able to use them in fighting bacterial infections. Since more and more antibiotic-resistant bacteria are emerging, the work that Stan Brouns does is as important as it is topical.

Federica Burla wins Minerva Prize physics

The Minerva prize is conferred at Physics @ Veldhoven every two years, to the best publications in the Physics domain authored by a female scientist. Federica received the prize for the publication 'Stress management in composite biopolymer networks', published in Nature Physics in October in collaboration with the group of Jasper van der Gucht in Wageningen.



You came to KAVLI for only three months. Did you feel at home?

Let me first say that I found people extremely friendly and welcoming. I really want to thank everyone who took the time to speak with me, show me around and patiently explain their daily practice in the lab. I'm also grateful to those who quietly accepted my presence: I know it can actually demand a lot of energy to share presence without explicitedly acknowledging each other. After a month or so, I wrote down in my notes: 'how will I be critical? I love everyone!' I took so many notes of one on one conversations and observing in lab meetings… when I revisit the notes at a later stage, I grow pretty attached to people without them knowing it.

As someone who usually works alone behind a desk, I didn't find it easy to accept the building as a home. It's strange to be in a space surrounded by people whom you're not expected to collaborate with. So many forms of labour and care happen to keep the building running, including cleaning staff, guards, maintenance, cafeteria personel. I understand there is limited time in a day and you cannot continuously meet and chat with everyone, but I do wonder about the way a work place is designed for efficiency, and how our bodies adjus to that.

I remember asking Bertus Beaumont whether you ever hear people singing out loud in the BioNano hallways. He said that didn't really happen: 'Not that it's not accepted, it's just: you don't really do it.' I noticed people mostly explain The Scientist's behavior as a natural personality, an inherent character trait, while I tend to think behavior is mostly shaped by cultural incentives and affordances. So: what keeps Kavli's researchers from living out loud in the lab?

And how did you behave?

It took me a while to realize how I subjected myself to an unspoken standard. For example, I like to work late nights and sleep in a bit, but even when I explicitly 'allowed' myself to stick to my own schedule, I felt lazy, a bad employee.
I felt quite aware of 'performing' presence. When I wanted to read a book to do research or follow a workshop by the Black Quantum Futurism collective in Utrecht to get inspired, I did feel like I was failing my role as an artist in residence! Presence then starts to mean 'monitored' time, 'computable' or 'visible' commitment. I distributed 'Perfomance Surveys' to play with this performance of presence (rather than trusting presence happens in many different, often illegible and invisible ways) and some people entered that they never saw me or bumped into me. Funnily enough, that hurt a little, as if I'd taken up visibility as my main responsibility. Moving between building 22 and building 58 also contributed to the feeling that I wasn't able to 'show off' my presence enough.

What surprised you?

Sometimes I refrained from asking a question because I felt it would be the most simple question I could ask. But then when I did ask, the element I assumed was a necessary building block to construct a more thorough thought, experiment or understanding, was not so evident at all.
I became quite interested in how 'not knowing' appears and functions at KAVLI. I have never seen it expressed in a form of despair, shouting or tears of frustration. Surely, me not having seen it doesn't mean it doesn't happen (there we have the illusionary pull of visibility again), but I find it super interesting that the unknown feels like a percentage, like collatoral damaged. People say: in science 95% fails. Thereby failure becomes so incorporated that it doesn't feel like failure. It rather becomes a calculated stepping stone towards succes. I fantasize about science – no, about a world – without the categories success and failure.

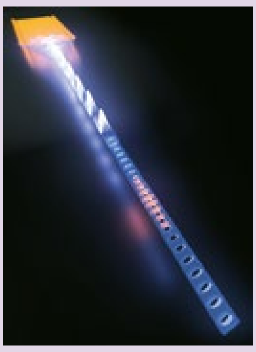

Photo: Maartje Geels

What else do you fantasize about? If you were a scientist, what would you do differently?

At TU Delft I noticed: when an engineer encounters a problem, the problem is welcomed mostly in order to coin a possible solution. A problem, I felt, is usually introduced with a (partial) solution. The lack of deep diversity in terms of who practices science, is countered with a 'we are working on it', or: 'the percentage of women is increasing'. Donna Haraway, a biologist and feminist theorist, has written a book with an advising title: *Staying with the trouble*. Sit with the pain, stay with the trouble. This could be a mode that allows for more fundamental questions than the solutionist perspective in which a problem ignites the creation of something new. Sometimes, a problem is just a problem.

Why does it seem rather unimaginable that changing the current scientist's positionality in society would also change the questions asked in science? In art, media and social science there is a question about who holds a seat at the table. Sometimes this means that you 'give up' your seat to make space for someone who's positionality historically has not been represented. I haven't encountered a scientist considering to make space by giving up their position. A scientist career is presented as a linear path, in which you struggle and struggle to get a position, to get tenure. When you do acquire some security, it must feel a bit like you deserve to hold that seat. I'd like to invite KAVLI's scientists to strike and make space. Because, why not be curious about what it opens up? As Evelynn Hammonds writes: 'The observer outside of the [black] hole sees it as a void, an empty space in space. However, it is not empty; it is a dense and full place in space.'

Microwave-to-optics conversion using a mechanical oscillator in its quantum ground state



Conversion between signals in the microwave and optical domains is of great interest, particularly for connecting future superconducting quantum computers into a global quantum network. The idea is to transduce microwaves that are usually lost after a mere few centimeters into an optical signal which does allow transmission of quantum information over tens or even hundreds of kilometers. Simon Gröblacher and his group have made two important steps in realizing such a practical device by demonstrating coherent conversion between GHz signals and the optical telecom band with minimal thermal background noise. In a separate publication, they explore GaP, a new and low-loss piezoelectric material for this process.

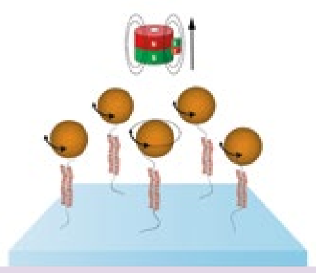
M. Forsch, R. Stockill, A. Wallucks, I. Marinković, C. Gärtner, R.A. Norte, F. van Otten, A. Fiore, K. Srinivasan, S. Gröblacher
Nature Physics.16, 69–74, (2020),
R. Stockill, M. Forsch, G. Beaudoin, K. Pantzas, I. Sagnes, R. Braive, S. Gröblacher
Physical Review Letters 123, 163602 (2019)

A 10-qubit solid-state spin register with quantum memory up to one minute

Researchers at QuTech have made an important advance towards functional quantum computers. They have demonstrated a fully controllable chip with ten qubits that can store quantum information for up to one minute. Controlling such a large number of qubits with long memory times is an important step forward for chip-based qubits and might pave the way to large multi-qubit quantum systems.

C.E. Bradley, J. Randall, M.H. Abobeih, R. C. Berrevoets, M.J. Degen, M.A. Bakker, M. Markham, D.J. Twitchen, T.H. Taminiau
Phys. Rev. X. 9, 031045, (2019)

Chromatin fibers stabilize nucleosomes under torsional stress



In eukaryotic cells, condensed chromatin fibers composed of DNA-protein spools called nucleosomes must locally unfold to render the densely packed genome more accessible. It remains unclear, however, how this process is controlled when multiple nucleosomes interact with and stack onto each other. Using magnetic tweezers, we have twisted individual chromatin fibers to mimic the torsional stress generated during DNA replication and transcription. Surprisingly, positive twist, which can destabilize individual nucleosomes, was absorbed by the chromatin fiber. This demonstrates substantial elasticity in chromatin fibers, and implies that chromatin domains can function as regulators of gene expression.

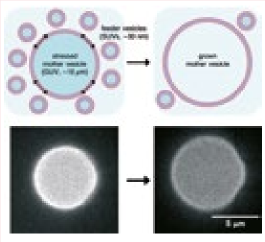
A. Kaczmarczyk, H. Meng, O. Ordu, J. van Noort, N.H. Dekker
Nature Comm, 11, 126, (2020)

De novo synthesized Min proteins drive oscillatory liposome deformation and regulate FtsA-FtsZ cytoskeletal patterns

The Min system is a set of three proteins that assist in localizing the bacterial division apparatus in the middle of the cell. With the long-term goal to build a synthetic cell in mind, we reconstituted an active Min system starting from the genes that were decoded by a minimal protein factory. The in vitro synthesized proteins were able to self-organize into dynamic surface waves and to periodically deform lipid vesicles.

E. Godino, J.N. López, D. Foschepoth, C. Cleij, A. Doerr, C.F. Castellà, C. Danelon
Nature Comm. 10 , 4969, 2019

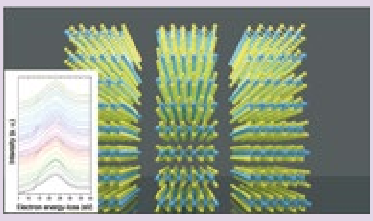
Membrane Tension–Mediated Growth of Liposomes



Using an on-chip microfluidic approach, we demonstrate membrane tension-mediated growth of cell-sized liposomes and hybrid lipid-fatty acid vesicles through fusion with many nanometer-sized feeder vesicles as a lipid source. Our results provide evidence for a minimal, protein-free way to achieve growth, which may find useful applications in creating autonomous synthetic cells.

S. Deshpande, S. Wunnava, D. Hueting, C. Dekker
Small (online), e1902898, (2019)

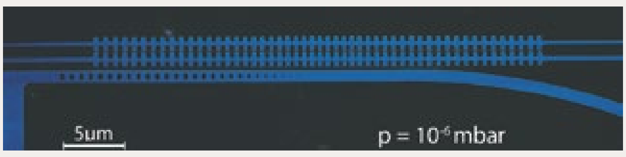
Metallic edge states in zig-zag vertically-oriented MoS_2 nanowalls



The properties of layered materials such as MoS_2 strongly depend on their dimensionality, and in particular their electronic properties can be tailored by selecting the type of edge sites exposed. Here we adopt a top-down approach to selectively pattern the exposed edge sites in MoS_2 nanostructures, and confirm the predicted metallic character of zig-zag MoS_2. Our results pave the way towards novel applications of MoS_2 nanostructures in fields such as electronics, optoelectronics, and photovoltaics.

M. Tinoco, L. Maduro, S. Conesa Boj
Sceintific Reports Oct 30;9:15602, (2019)

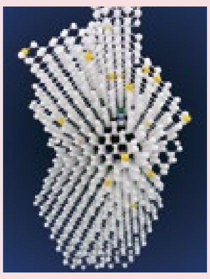
Feedback Cooling of a Room Temperature Mechanical Oscillator close to its Motional Ground State



Recent years have seen impressive progress in demonstrating quantum features of microfabricated mechanical oscillators. To date, however, all of these quantum experiments rely on cryogenic pre-cooling of the mechanical system, as classical thermal noise would otherwise overwhelm any quantum features. In a new experiment published in Phys. Rev. Lett., the group of Simon Gröblacher, in collaboration with Richard Norte at 3mE, has developed a new type of optomechanical system, based on an integrated high-stress silicon nitride nanocavity design. This new system allows them to overcome previous limitations in reaching the quantum regime of a mechanical system from room temperature. Their results are facilitated by minimizing the mechanical losses through a fishbone-like design of the photonic crystal part of the oscillator, as well as its mechanical shield, significantly reducing the typical bending losses plaguing such devices. The resonator is fully integrated on a chip, paving the way to directly using it as a quantum sensor in real-world applications.

J. Guo, R. Norte, S. Gröblacher
Physical Review Letters, 22, 123, 223602, (2019)

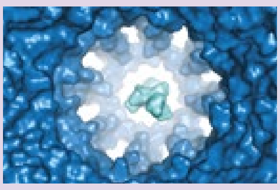
Atomic-scale imaging of a 27-nuclear-spin cluster using a single-spin quantum sensor



Researchers at QuTech, a collaboration of TU Delft and TNO, have developed a new magnetic quantum sensing technology that can image samples with atomic-scale resolution. It opens the door towards imaging individual molecules, like proteins and other complex systems, atom by atom.
To test their method, the researchers applied it to a cluster of 27 carbon-13 atoms in a highly pure diamond. This cluster of spins provides a model system for a molecule. After measuring more than 150 interactions between the nuclei and running an intense numerical reconstruction algorithm, the complete 3D structure was obtained with a spatial precision much smaller than the size of an atom.

M.H. Abobeih, J. Randall, C.E. Bradley, H.P. Bartling, M.A. Bakker, M.J. Degen, M. Markham, D.J. Twitchen, T.H. Taminiau
Nature, 576, 411-415, (2019)

Label-free detection of post-translational modifications with a nanopore



Protein post-translational modifications play a key role in a vast number of cellular processes. The authors show the detection and distinction of phosphorylation and glycosylation in a label-free manner using a nanopore.

L. Restrepo-Pérez, C. H. Wong, G. Maglia, C. Dekker*, C. Joo*
Nano Letters, 19, 7957–7964, (2019)

Towards a Quantum Internet – bridging the gap between applications and the physical quantum hardware

By Axel Dahlberg – PhD candidate

News about the development of quantum computers have been more and more frequent lately.
Such computers promise to do certain computations faster any "classical" computer. But what happens when one connects multiple (smaller) quantum computers together in a network? Networks of quantum computers, forming a "Quantum Internet" is an active field of research. Motivated by the fact that a Quantum Internet can perform tasks which are impossible in the current Internet, QuTech sets out to build the first ever prototype of a Quantum Internet in the Netherlands. What is this field of research all about and what are the main challenges to overcome?

Axel Dahlberg is a fourth-year PhD candidate in the group of Stephanie Wehner at QuTech. He comes from Sweden, where he did his bachelor in physics. Later he moved to Switzerland to do a master in theoretical physics. Since 2016, Axel works at QuTech, where he and his colleagues aim to develop a quantum network and subsequently a Quantum Internet.

What is exactly a "Quantum Internet"?
Like the "classical" (or current) Internet, a Quantum Internet will also consist of networks of connected computers which can exchange information. However, in this case, these computers will be quantum computers and the information they exchange is also quantum. In the classical Internet, information is encoded as bits, but in a Quantum Internet the smallest blocks of information are called "quantum bits", or more commonly, qubits. Qubits are different from classical bits since they can be in what is called a superposition of "0" and "1". In a way, one can then say that the qubit is a "0" and a "1" at the same time. Furthermore, qubits can be in a strongly coupled state, even when they are separated far away, which is called entanglement.

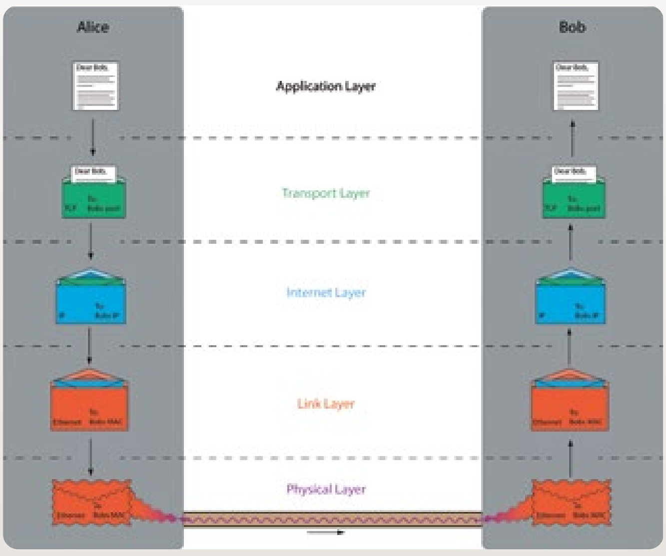
Why is this any different from current Internet?
Using superposition and entanglement of qubits, one can perform tasks which are impossible in the current Internet. The most famous of these tasks is the distribution of secure keys for secure communication. Keys are used between par-

QuTech co-organizes Quantum Internet Hackatons to engage with future users and software engineers. On a simulated version of the quantum internet the participants can already design new algorithms and applications for a future quantum internet.

ties to encode information such that it can only be read if the key is known. Given a secure key, one can easily use the current Internet to encode information and send it to a remote party. However, what cannot be done on the current Internet, with security guaranteed, is to distribute the secure key in the first place. A Quantum Internet enables Quantum key distribution, or QKD, which can already be done in the earliest stages of a quantum network. Apart from QKD, there are many more applications that a Quantum Internet enables.

What is the focus of your research?
I focus on bridging the gap between applications developed for a Quantum Internet and the physical hardware enabling these applications. The goal is to provide a certain abstraction of the hardware and its capabilities such that applications can be agnostic to the hardware. In this way, a single application can be developed for multiple hardware implementations of a quantum network, and someone writing such an application does not need to know all the complicated physics that goes on in the hardware. This task is therefore two-fold: (1) we work on developing protocols that provide certain services to higher layers, while abstraction away irrelevant details and (2) defining interfaces to these services to have a modular assortment of implementations of both physical hardware and protocols. For example, we are developing a network stack for a quantum network, with ideas inspired by the classical IP/TCP suite. If you are more interested in this, you can also have a look at my blogpost.

What motivates you in your research?
What I really like in my day-to-day research is that I have the opportunity to do a large variation of tasks in different fields of research and along the way learn a lot. My background is physics, but since the time I started my PhD I have done projects ranging from very theoretical work in mathematics/computer science to applied endeavors in networking and computer architectures. For example, I have worked on developing a link layer protocol for a quantum network, defining an instruction set architecture for the processing nodes in a quantum network and am currently focusing on compiling network applications to this instruction set. During this time, I have gained knowledge (although far from complete) on, for example, how the current Internet works, which I find amazing.



How is the interaction and collaboration with other institutions and partners?
As part of my PhD I have great opportunities to doing very exciting projects; both research projects but also other activities. For example we sometimes organize hackathons such that people with varying backgrounds can come together and develop new exciting applications and protocols for a Quantum Internet. I have also given talks at the quantum internet research group (QIRG) at IETF, and been part of collaborations with networking companies for the development of a Quantum Internet.

How do you see the future of your field?
I am very excited for what will happen in the coming years and in particular seeing the network we are currently building between four cities in The Netherlands become a reality. I encourage anyone who is interested, whether he/she has a background in physics, mathematics, computer science, electrical engineering or another field, to join our efforts.

COLUMN

Let's talk online

This Fall, together with colleagues, I spent some time designing a platform for online conferences—scientific events where all the talks and discussions happen via videoconferencing. Our effort culminated in running a trial session, which went smoothly:both the speakers and the audience were excited about the new format. My story, however, is not about the session itself, but how we organized it, and what I learned.

I had an idea of doing something along the lines of virtual conferencing after participating in an online meeting of the Jupyter developer community and being surprised by how easy it is to discuss with around fifty participants.Having enthusiastically discussed virtual conferences with pretty much everyone I knew, I wrote an online note summarizing my thoughts. In the spirit of open source, I also made the note editable by anyone, so that I could ask my friends to write their suggestions directly in the note rather than doing it myself. To properly credit their contributions I also added to the note a list of contributor names together with an invitation to add their name.

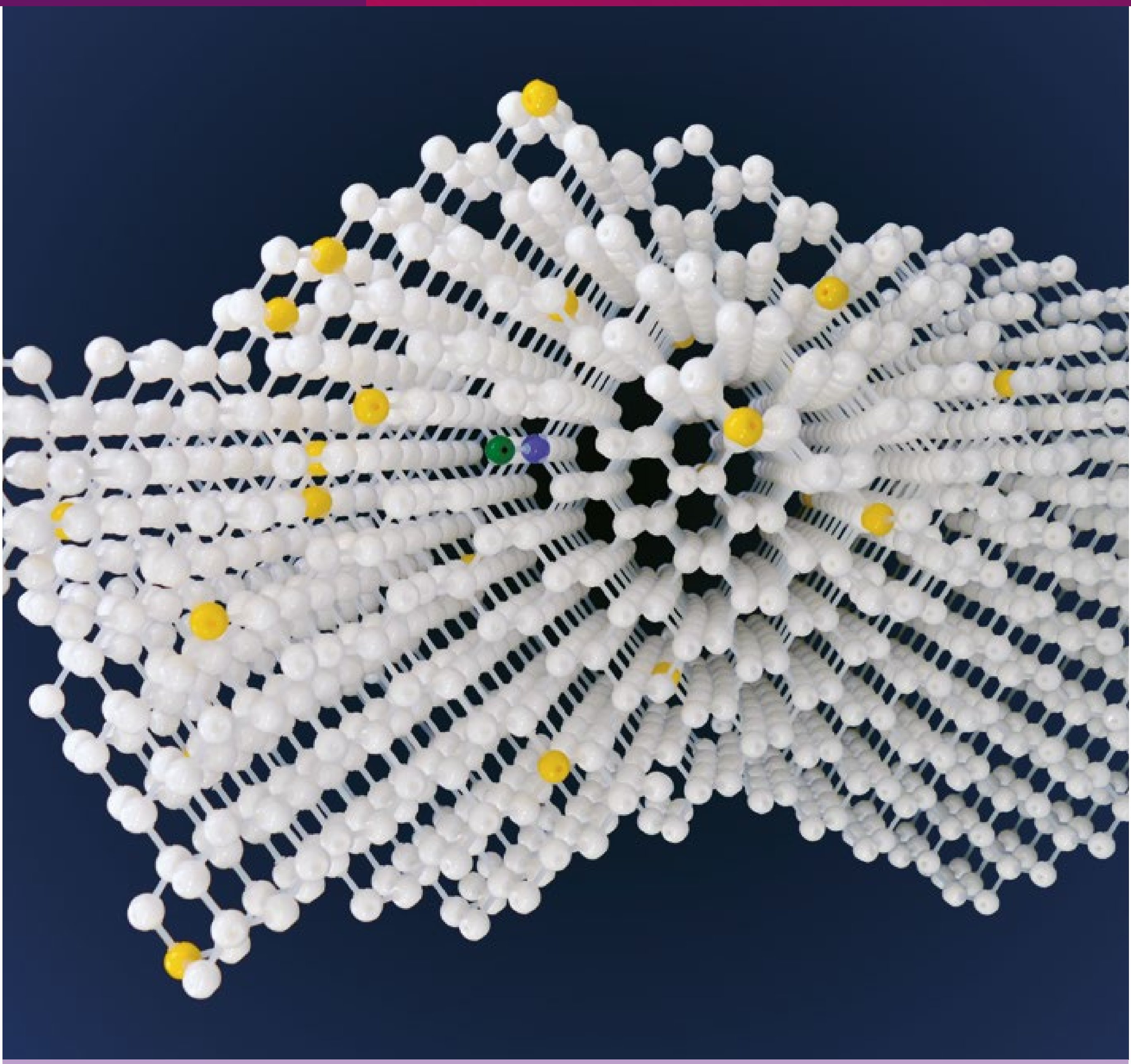
A few months before that I started a Twitter account as an outreach exercise, so using Twitter as a way of gauging the community reaction seemed a logical next step. Much to my surprise, not only did I receive an overwhelmingly positive reaction, but also several people volunteered to help to organize the event by adding themselves to the list of names in my document. Before I knew it, I assembled a dozen physicists ranging in academic age from Ph.D. students to professors and spread across nine-hour zones. A couple of them I did not even meet beforehand. Our relatively broad background turned out to be indispensable because all of us had a different perspective or expertise to contribute.

The rest was straightforward. We planned online discussions every few weeks, where we reviewed the progress and decided on the next logical steps. The different hour zones combined with an irregular academic schedule mean that there was never a meeting where every one of us can join. For those missing a meeting to still be able to follow and contribute, the meeting notes were, therefore, an absolute requirement. Very much in the spirit of the original planning, we decided to keep these notes as well all of our documents publicly available, so that anyone can follow what is going on.

Being able to work collaboratively and sharing the result of my work is an important factor attracting me to academia. By tradition several aspects of our work are competitive, and we often keep our ideas or work secret from the rest of the world in fear of being scooped. Looking back at my experience with the virtual conference, I realize how much more rewarding it can be to work in the open. I hope that in the future the ambition of doing exciting work will lose its petty competitive aspects and that the tradition of collaboration will become commonplace.

Anton Akhmerov

SCIENCE ART



Artist impression of a 3D model of the spins in a diamond structure imaged by a new magnetic quantum sensing technology developed by researchers at QuTech (scale 250.000.000 : 1).
Credit Ernst de Groot

UPCOMING KAVLI COLLOQUIUM

Taekjip Ha

Date: February 6, 2020

John Hopkins School of Medicine

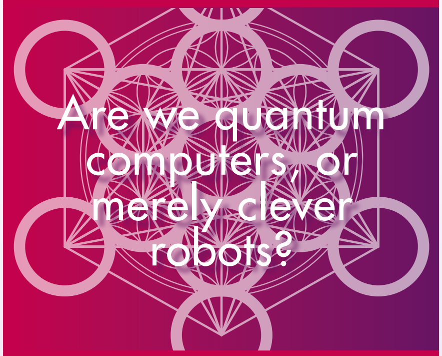
UPCOMING KAVLI COLLOQUIUM

Kavli Chair Prof. Michel Devoret

Date: T.B.A.

Yale University

KAVLI DAY 2020



Speaker: Prof. Matthew Fisher of UC Santa Barbara

September 3, 2020

Where: T.B.A.

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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