KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft

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Interview with Kobus Kuipers, the new Kavli director

How would you describe yourself as a leader?
'I try to connect people and steer towards consensus. In meetings, I am always very active and extroverted without wanting to be directive. Although it may be true that, because of my active presence, I actually steer the discussion very much without really meaning to do so. Apart from that, I react from the gut and I wear my heart on my sleeve. That sometimes makes me blurt things out and fire from the hip. Of course, doing so has its advantages and disadvantages. Sometimes it might be better to think a bit longer before reacting. On the other hand, you immediately know where I stand.'

You're also the head of a department. Do you have the time to take on an additional role?
'I think so. Look, ideally, a Kavli director shouldn't also be head of department. Before you know it, you're wearing too many hats. But after putting up a little resistance, I said yes. I think it's a very interesting job and I was honored to be asked. I also thought it was important that someone from Quantum Nanoscience took on the role. And really, it's not a very difficult job in terms of the amount of time it takes. As director, you're not a supervisor.'

How do you see your role as director?
'Kavli's a beautiful institute, so just looking after the store isn't good enough for me. If that had been my angle, I shouldn't have said yes. I think it's especially important that an institute such as this is more than the sum of its parts. The question that comes with that is: how can you maintain and strengthen the connections that exists, in order to maintain this seal of excellence that we have? As a director you have to keep making new plans to keep the Kavli Institute strong.'

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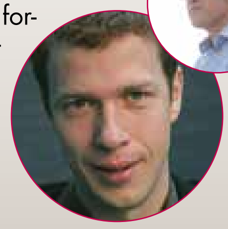
FROM THE DIRECTORS

What an exciting and amazing news that for the third time in a row, one of our Kavli faculty members will be honored with the most prestigious science prize in the Netherlands, the Spinoza Award! We will cover Nynke Dekker and her work in the next newsletter, after the prize ceremony is held.

While the Covid-19 situation forced us to postpone colloquia and the visit of our Kavli Chair, research goes on in (almost) full force. No less than 7 publications from our institute appeared in Nature and Science from December through April 2020! Members of our institute received multiple honors and awards. And we are delighted to welcome two new faculty members to our institute, Eliska Greplova and Johannes Borregard (see their self-interviews).

On September 1st, 2020, I will pass on the torch to Kobus Kuipers as Co-Director of our Kavli Institute, alongside Chirlmin Joo. I look back with pride and gratitude on all the new activities that we have launched over the past four years, and look forward with great expectations to the coming years!



Lieven Vandersypen

COLUMN

A new plan

Writing two weeks into the ersatz-lockdown, my strongly restricted view of the world suggests that people have been divided along demarcation lines never considered before. One of the most striking ones is that circumstances have either forced you into a super-busy mode (for which risk factors are having a 'vital' job and having children that suddenly need home schooling) or have left you super-bored. I find myself in the first category, somewhat envious of the second; for those in the second though, I can well imagine being envious of the first. Of course, the internet is still running, so you can find things to do. Academic twitter already predicts a wave of review articles coming out in nine months or so, along with the likely waves of babies (first children only) and divorces.

I'm an introvert and a theorist, so in a sense I am the lucky one. But I hate this. I think you do too – and that's an encouraging thought. Misery loves company.

Not that I see misery in the company I keep. In all my online meetings, people remain to be of good cheer, and I'm grateful for that. Yet, I think it's ok to be frustrated, and to say that you are. This is no time for photoshopped, instagrammable pictures of ourselves. It is a time for mutual support instead, which begins by acknowledging that we need that support.

Apart from moral support though, there is frustratingly little that we seem to be able to help each other with. The way we divide labor under normal circumstances (putting, for example, our kids in groups with qualified teachers) simply doesn't work anymore. As I write this, it seems that will still be true by the time you'll be reading it. I try not to dwell on that perspective too much.

So what do we take from all this? First, we should be willing to admit that under different circumstances, expectations should be different. We cannot expect anyone to function as they normally would. Second, when things go back to normal, we should remember how it was, and be grateful to the people who allow us to do our work. Only they can create the circumstances necessary for those who are bored to get going again, and those who are overburdened to share some of the load. Third, while the crisis lasts, we need a plan. Not the reactive plans we've implemented so far (necessary as they may be), but a real plan, with us in control, not the virus. The best plan will bridge the new division lines, like good plans of old that brought people together across divisions of gender, social class, or nationality. Neither sticking to the old routines nor defeatism will do. Let's get cracking.

Timon Idema

› **Continued from page 1**

Do you have any concrete new plans?
'I have been thinking about some things, yes. Something I find very exciting, for example, is that our world is changing. DORA, the Declaration on Research Assessment, has made its way to Europe from San Francisco. It's a movement aimed at weighing scientific quality differently than just looking at the number of kilograms of publications, or just counting the number of citations or Nature and Science papers, like a bean counter. As a movement, DORA is now also gaining traction in the Netherlands, within NWO. Everyone embraces it. But at the same time, no one really knows what a good new way of working would be. Since we as an institute are so diverse and have a lot of extremely smart and creative people within our ranks, I think we are well positioned to contribute to something that could become the benchmark. If we could indeed do so, that would be fantastic.'

You just said you care about connecting people. Can you elaborate upon that?
'One of the things the Kavli Foundation finds very exciting, but which they also say we should keep working on, is the fact that we have two different tracks. Keeping the tracks scientifically connected, keeping that cross-pollination, doesn't happen naturally. Nano used to be the link and everyone needed the cleanroom. They don't anymore. The cleanroom remains very important to us, but it no longer has the natural bridge function it used to have. It is now much more of a hammer that we use to do a chunk of science with. And precisely because we have those two tracks, we no longer meet each other by chance at conferences, and then go for a beer or a glass of wine and come up with a fantastic plan for cooperation. If you don't put effort into it, nothing happens. That's why the directors have to put in more energy in order to maintain the feeling of unity.'

What has happened in the past year to strengthen that connection?
'The fellowships are a good example. Excellent postdocs can submit a research proposal that links the two branches of the Kavli Institute. This works well, but if I'm honest it's often because it's the techniques that are being shared. For example: an optical technique in my group connected to a biological question in the group of Marie-Eve. Or the joint use of electron microscopy. It would be much more exciting if we actually had a scientific question that lies exactly between bio and quantum. We have been looking for this for a very long time, and in the past attempts were made to recruit people in that intermediate area. Unfortunately, this failed at the time. The first time we were recruiting, the right people weren't there yet. And when they were they were very popular elsewhere as well. But we will keep on searching.'

Have you already identified other areas you want to contribute to?
'I think training our talent is extremely important. Whether it's PhD students, postdocs, tenure trackers or greybeards like me, we must continue to make full use of the talent we have within our organisation. That's why we've been changing the tenure track reviews over the last year. In the past, at the end of their tenure track period, someone would be weighed by the staff of Kavli. That process was actually a bit of a formality, although of course it was not without meaning. We have now changed the procedure so that we do it in the middle of the tenure track period, also inspired by DORA. Now, it's less of a weighing moment and more of an advisory moment. We are all very much in favour of this, but at the same time we are still a bit too used to the old system. I want to help people adjust to this new approach.'

What else can we expect from you?
'That I'm going to be supporting Chirlmin, especially in the beginning. He's the senior co-director, I have to learn all kinds of things I don't even know I have to learn. How finances work, what initiatives are already underway, and so on. I am sure that in the course of time activities will come our way that are more up my alley than that of Chirlmin and vice versa. Finally, what I want to say is that people can always call on me. It doesn't matter whether that's through an e-mail or a phone call in this corona-era.'

Interview by: Jerwin de Graaf

INTERVIEW

Interview with Claire Wyman

about the 'convergence' between TU Delft, Erasmus MC and Erasmus University Rotterdam

Complex issues in health and technology require a stronger cooperation between technical sciences, medicine and social and economic sciences. For this reason, the boards of TU Delft, Erasmus University Rotterdam and the Erasmus University Medical Center agreed to structurally strengthen their collaboration in 2019. Claire Wyman, a molecular biologist and the director of the Nanobiology programme, was a member of the core group that explored what the pillars of this 'convergence' should be. We interviewed her about the value of the convergence agenda and the first steps that are being taken to tighten the bonds between Delft and Rotterdam.

Q: What does this 'convergence' entail?

A: 'TU Delft and Erasmus MC have been working together in projects involving many departments in Delft and a lot of faculties at Erasmus MC. By formalizing these existing contacts, we want to expand upon that cooperation and leverage it to do even greater things. It's all about blending our activities in ways we haven't done before to make our cooperation more efficient, to work faster and to move into new areas. Erasmus MC is a medical institute aimed at understanding health(care) and advancing medicine. Delft, of course, is world-renowned in technology fields aimed to improve society. Coming from different directions both institutes have strong interest in fundamental biology. The current plans have expanded to include the social sciences and business oriented expertise of the Erasmus University. The goal is to have a more holistic view of problem solving, especially in the field of health and healthcare.'

Q: What is your role in the convergence?

A: 'The deans have committed to this convergence on the basis of a relatively short document that was produced earlier this year. The document describes our vision, and I was involved in the content side of it. I was a member of the core group that explored what the initial flagships of the convergence should be. Specifically, I helped shape the nanobiology and molecular medicine flagship. I contacted people who are working in that broadly defined field to try and figure out what the topics were that could benefit from convergence. After that I became a member of the advisory board, as did many of my colleagues who helped draft that initial document.'

Q: Can you tell us something about the plans for the near future?

A: 'There are a lot of ideas already. Expanding joint appointments is one. Whether or not there need to be a physical place where people can work together temporarily or permanently is another big question. I personally believe that there will be such a place. Another priority is expanding educational programmes and bringing people together. There is a movement at Erasmus MC to include more quantitative and computational skills, as well as data science, in the bachelor of medicine, for instance. On the Delft side, a number of programmes now include aspects of healthcare development or applications. It's not necessarily about developing new things, you see, but about integrating what we already have in order to make it better.'

Q: What about research?

A: 'Our institutes have committed to fund 17 joint research projects consisting of 34 postdoc positions. The projects are a healthy mixture of the fundamental and applied research that is being done at our institutes. In Delft, this involves a couple of departments that you might not think are necessarily connected to healthcare. But it's not all technical. Some of the questions have to do with the implementation of healthcare innovations, for example, or the way in which people in a specific communities behave when it comes to such innovations. There are about three projects per flagship, and ethics postdocs who are connected to several of the projects.'

Q: So ethics is an important theme?

A: 'It is. We defined five pillars of the convergence: nanobiology and molecular medicine, health data science, biomedical imaging, smart instruments and interventions, and ethics. Ethics runs through all of the other pillars. One of the most important elements of this initiative is implementation: how do you bring new knowledge to practical applications? In healthcare and technology development in general, there are important ethical considerations to take into account. So very early in this process, people who think about the ethical implications for healthcare and technology application were brought on board. That's another element that makes this convergence stronger than just another collaboration.'

Q: Do you agree that QuTech and Quantum Nanoscience will benefit less from these plans than Bionanoscience?

A: 'I would say that that's the wrong attitude. One of my friends in this process is Ton van der Steen, who works at the intersection of medical and technical sciences. He put it this way: "People shouldn't ask what convergence can do for them, but what they can do for convergence." I think that there are really fascinating things going on at QuTech and Quantum Nanoscience that are extremely relevant. Certainly, a lot of biology and healthcare depends on enormous amounts of data, most of it sparse. Coming up with understanding from that data is really, really hard. The other side of it is that while people's particular tasks might not be exactly what you need, their insights and skills in looking at a problem in a different way can be extremely useful. A lot of expertise can be applied to medicine in ways we haven't yet thought about.'

Q: How much of this plan is about making new connections?

A: 'That's a very important aspect, of course. At the events and workshops we've organized, I met people I would have never thought of connecting to. I have an appointment at the department of Bionanoscience and I know most of the people there. Over the years, worked together with many of them on various research projects. I also know a number of people from the other departments of the Faculty of Applied Sciences. But I didn't know anyone in Industrial Design, or Aerospace Engineering. I do now, and when you talk to these people you start to see the things you have in common, the things you can learn from each other. I think that's extremely valuable.'

EXIT INTERVIEW WITH LIEVEN VANDERSYPEN

After four years Lieven Vandersypen will complete his term as Co-director of our Kavli Institute on August 31st, 2020. In this interview he reflects on the challenges and successes of his time as Co-director, and on the unique spirit of the Kavli Institute.

What was the best thing about your directorship?
The nice thing about being a Kavli director is that you have free resources available to really add something to the nanoscience community in Delft. You can play Sinterklaas, as it were, and make people happy with high-profile events, funding opportunities and other initiatives. And what you don't have is hassle. There has always been a very positive atmosphere. And it is important to keep it that way.

Did you have a specific mission in mind when you started as Co-director in 2016?
One mission was, and still is, to promote the unity of the Kavli institute. The second mission is to exploit the opportunities that exist on the interface between quantum- and bioscience. This is a very exciting interface, and while many things have started, I think there is room for much more. If breakthroughs occur in this area anywhere in the world, we would like them to come from the Kavli Institute in Delft. Thirdly, my mission was to set up new activities with a third donation from the Kavli Foundation that had just arrived."

Can you tell us what kind of activities you started in these past four years?
We started with the **Kavli Postdoc fellowships**, in which Postdoc candidates submit their own application at the interface between quantum and bioscience and with the involvement of PIs from both sides. We now have 3 Kavli Postdoc fellows. Also, we started the **Kavli Chair**: a multi-month visit from an absolute top scientist in the field of nanoscience. We have now had three of them, the fourth should have been here by now…. The **Artist in Residence** is also a new program that has started. Furthermore, we have set up **Parents in Kind**: a PI who expects or has just had a child can receive financial compensation to be replaced part-time so she or he can take time to be at home. This fund is available for women and for men.

And we have just launched a new program, known to the PIs but not yet in the large Kavli community: a **seed funding program to stimulate synergy**. In this program two PIs can apply for up to 50,000 Euros to set up a new collaboration. The idea is that they can get a fast start and gain momentum without waiting for a larger application to follow up the initial seed funding.
Those are programs that I helped to get started. In summary, my mission was to stimulate and promote the synergy and unity between quantum and bioscience, and to setup new programs with the newly available donations.

Did you also succeed in bringing unity between quantum and bio departments within the Kavli Institute?
That remains a challenge. This has to do with a few things: quantum and bioscience researchers are two different blood groups. I noticed that 10 years ago it was easier to find the overlap, for example with the Nanofront program. The fact that the bio-nano science department is located in the south campus and the quantum activities in the old TNW building is really an additional barrier. For instance, if we have a colloquium at one location, this has an immediate impact on how many people join from the other building. And it is also a challenge if parts of the Kavli Institute have a strong urge or need to profile themselves strongly. This is particularly the case with QuTech.

Kavli is a strong brand, especially in the Netherlands. People know that there is something special going on in "Kavli from Delft". It is really very unique that an American philanthropist (with a Norwegian background), who has founded an American foundation, gives such strong support to an institute in the Netherlands, in Delft. That is very unusual in NL, it is a special recognition that we are really very proud of. And so of course we would like to propagate that and make use of it.

Can you tell us a bit about how QuTech fits into Kavli and how these two cultures compare?
If I were to describe the Kavli culture then it is innovative, ambitious and adventurous in the new research directions we are taking and for instance with initiatives such as the Artist in Residence. The Kavli culture is also characterized by Out of the Box and creative thinking.

At QuTech you see a number of the same elements, such as ambition, creativity and innovation, but the QuTech culture also includes other aspects such as entrepreneurship, the translation to demonstrators, the cooperation with engineers. So we have overlap in aspects such as ambition, innovation and creativity, but there are also aspects where it varies.

But that could complement each other very well?
Yes absolutely. That is why QuTech has largely become part of the Kavli Institute. But in QuTech in particular, there are strong efforts to promote the idea of one QuTech. This is also necessary, because we also have two blood types in QuTech: TNO and TU Delft. But if you are both in QuTech and Kavli, it is not automatic to feel strongly connected with both. And how many BBQs can you go to? So that's a challenge. But the fact that the cultures overlap in many areas does help. We really find each other at the (international) ambition level, the creativity, the innovation. That is good to emphasize.

Another question: is there a Kavli event from the last years that really stands out for you?
I have been very happy with the program of the Kavli days in which, unlike usual, we do not just have a scientific colloquium. Instead we have had the founders of startups come by, we have discussed the role of science in politics and policy, we have talked about fraud in science. Those are good memories. And I also have the idea that these discussions and exchanges of ideas linger with people.

How do you see the Kavli Institute in the future?
My long-term dream for Kavli is that it is able to hold on to that unique Kavli spirit and culture for many decades to come. It has been a place with a lot of dynamics. In 2020 it is really very different from the nanoscience department that we started with. For me that is a sign of innovation. Not only scientific, but also organizational. In 2004 our Kavli Institute was the Department of Nanoscience, a few years later the bio-nanoscience department was founded. 10 years later QuTech was formed. So it is already very dynamic in the organization. And that does not happen automatically! It means that we always have to attract the right people to become part of that culture. I hope the Kavli Institute will look very different in 10 and certainly 15 years from now. Because if not, we have not renewed!

What are your own plans?
I will become QuTech's scientific director. Again a great challenge with a lot of responsibility. In addition, I look forward to simply participating in the Kavli events without having to take care of them, that I can just watch and enjoy them carefree. I'm really looking forward to that.

Any final words of advice?
What I hope to convey to the young generation, and in general, is that Kavli is unique and special, offering something sparkling for them to enjoy and contribute to. Advice to my successor would be to maintain the positive atmosphere in Kavli and thus uphold the Kavli culture. Kavli is supposed to be something sparkling, it can add something extra! But most of all: follow your instinct!

NWO recently decides to fund two 'groot' projects where Cees Dekker is participating in a major way:

Resolving the fundamental building principles of the genome (headed by Remus Dame from Leiden)
It is becoming clear that the spatial structure of DNA within a cell is of crucial importance for its function. All DNA-based processes are tightly interconnected with the three-dimensional organization of chromosomes. Here, we will investigate the basic fundamentals of chromosome structure across all domains of life, as well as the interrelation between the chromosomal structure and gene activity. Among other goals, these studies aim to uncover how genome architecture can impact the establishment of transcriptional programs in health and disease.

Guardians of protein disorder
(headed by Liesbeth Veenhoff from UMC Groningen)
Intrinsically disordered proteins are ones that lack persistent structure. Some of them are involved in aggregation pathologies such as Parkinson's disease and ALS. Intrinsically disordered proteins can exist in different phases, such as a liquid droplet, a gel or an aggregate. The goal of this research is to reveal what mechanisms exist to ensure these proteins exist in the right phase state to perform their biological function. By studying how these transitions are guarded, we aim to contribute to a better understanding of aggregation pathologies.

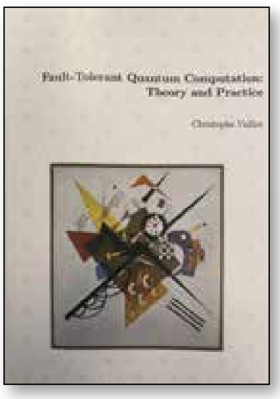
Gijsje Koenderink is co-recipient of an ENW-Groot grant from NWO:

The Active Matter Physics of Collective Metastasis
(headed by Dr E.H.J. Danen, Leiden University)
During the early stages of metastasis, clusters of tumor cells combat a series of hurdles to dissociate from the primary tumor, navigate surrounding tissues, and enter the circulation to reach distant organs. In this program, we map this journey by integrating theoretical models with experimental cell biology, biophysics, and tumor biology. We aim to identify the physical/mechanical parameters that regulate collective behavior of tumor cells during these first steps of the metastatic cascade, and deliver insights for rational design of new therapeutic intervention strategies.

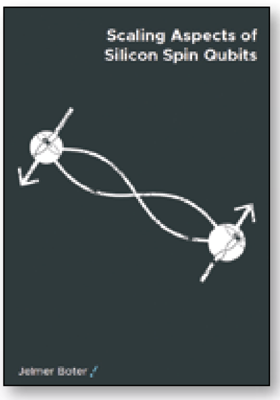
NEW EMPLOYEES

Name	Date of employment	Title	Lab
Victoria Shalabaeva	01-01-2020	PD	Caviglia Lab
Remon Berrevoets	02-01-2020	Researcher	Tittel Lab
Anastasiia Varentcova	03-01-2020	PhD	Akhmerov Group
Guido van de Stolpe	05-01-2020	PhD	Taminiau Lab
Jurgen Dijkema	05-01-2020	PhD	Vandersypen Lab
David van Driel	06-01-2020	PhD	Kouwenhoven Lab
Yannick Hermann	08-01-2020	PhD	Hanson Lab
Damian Kwiatkowski	08-01-2020	PhD	Taminiau Lab
Madvey Finkel	08-01-2020	Fabrication Engineer	Di Carlo Lab
Roel Smit	08-01-2020	PI	Smit Lab
Nina Codreanu	08-01-2020	PhD	Hanson/Groeblacher lab
David Maier	09-01-2020	PhD	Wehner Group
Matt Skrypynsky	09-01-2020	PhD	Wehner Group
Gayene Varoyan	09-01-2020	Postdoc	Wehner Group
Pablo Cova Farina	10-01-2020	PhD	Vandersypen Lab
Yash Jawale	16-01-2020	PhD	Marileen Dogterom Lab
Sam van Beljouw	01-02-2020	PhD	Stan Brouns Lab
Ilina Bareja	01-02-2020	Postdoc	Marileen Dogterom Lab
Roman Barth	01-02-2020	PhD	Cees Dekker Lab
Remon Berrevoets	01-02-2020	Researcher	Tittel Lab
Jiarui Mo	01-02-2020	Researcher	Zandbergen Lab
Tanmoy Chakraborty	15-02-2020	Postdoc	Tittel Lab
Felix Frey	01-03-2020	Postdoc	Timon Idema Lab
Jacob Koenig	01-03-2020	PhD	Steele Lab
Parsa Zivari	15-03-2020	PhD	Groeblacher Lab
Alok Bharadwaj	15-04-2020	PhD	Arjen Jakobi Lab
Samer Kurdi	16-04-2020	Postdoc	Van der Sar Lab
Dorian Oser	01-05-2020	Postdoc	Tittel Lab
Rachel Los	01-05-2020	PhD	Timon Idema Lab
Alejandro Martin Gonzalez	01-06-2020	Postdoc	Cees Dekker Lab
Violet van Houwelingen	01-06-2020	Communicationsadvisor SynCellEU	Bionanoscience
Edo van Veen	01-06-2020	Programmer and data analyst	Nynke Dekker Lab
May-An van de Pol	15-06-2020	PhD	Vandersypen Lab

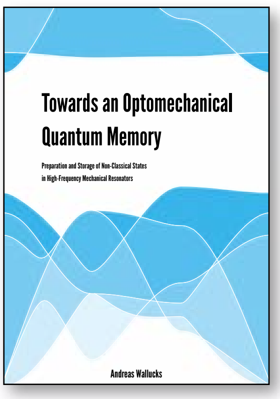
RECENT PHD THESES



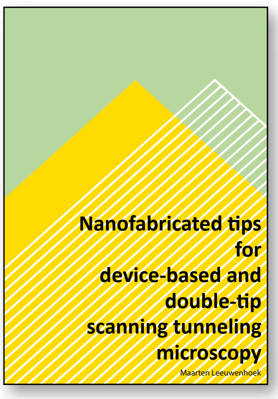
Christophe Vuillot
20 January 2020



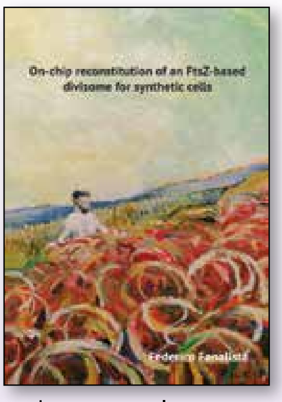
Jelmer Boter
23 January 2020



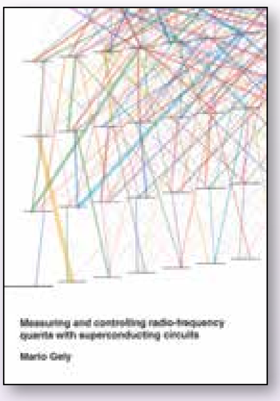
Andreas Wallucks
10 February 2020



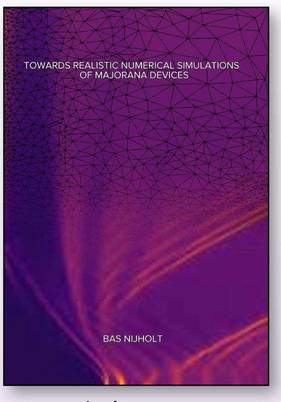
Maarten Leeuwenhoek
20 February 2020



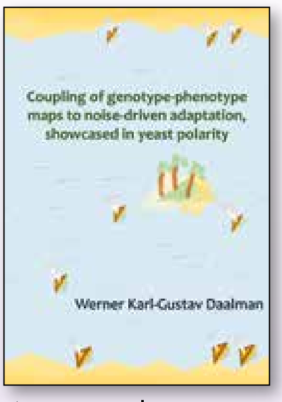
Federico Fanalista
21 February 2020



Mario Gely
09 April 2020

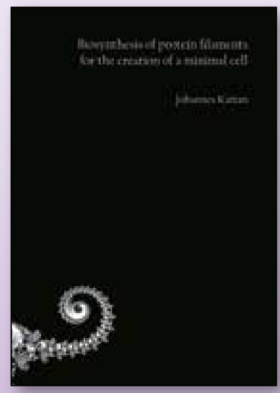


Bas Nijholt
11 May 2020

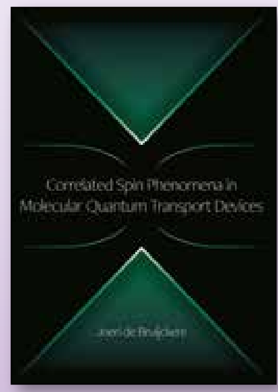


Werner Daalman
13 May 2020

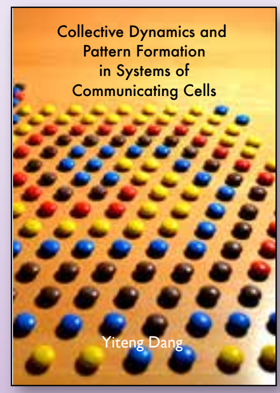
Sumit Deb Roy
03 June 2020



Johannes Kattan
12 June 2020



Joeri de Bruijckere
15 June 2020



Yiteng Dang
27 August 2020

QuTech news

Cryo-chip overcomes obstacle to large-scale quantum computers

QuTech has resolved a major issue on the road towards a working large-scale quantum computer. QuTech, together with Intel, has designed and fabricated an integrated circuit that can operate at extremely low temperatures when controlling qubits, the essential building blocks of a quantum computer. This paves the way for the crucial integration of qubits and their controlling electronics in the same chip. The scientists have presented their research during the ISSCC Conference in San Francisco.

Lieven Vandersypen appointed as Director Research at QuTech

Professor Lieven Vandersypen has been appointed as Director Research at QuTech from 1 September 2020. As Director Research he will chair the management board of QuTech. He will succeed professor Ronald Hanson, who has been Director Research at QuTech since the end of 2016.

Guoji Zheng and Nico Hendricks win best article prize in the Dutch Journal of Physics competition

Guoji Zheng (PhD student in Vandersypen lab) and Nico Hendrickx (PhD student in Veldhorst lab) have been awarded first and third place respectively in this year's Dutch Journal of Physics (NTvN) competition. The PhD students and postdocs that participated in the competition were asked to write a clear article on their physics research. The latest April edition of the NTvN magazine focuses on the price-winning articles, for which Zheng and Hendricks were granted prices of 1000 euros and 500 euros respectively.

Europe's first quantum computing platform launched

On April 20th 2020, Minister Ingrid van Engelshoven and European Commissioner Mariya Gabriel launched Europe's first public quantum computing platform: 'Quantum Inspire'. The platform was developed by QuTech, a collaboration between TU Delft and TNO. Quantum Inspire makes the quantum computer accessible to everyone and is the first in the world to use a quantum processor made of scalable 'spin qubits'.

Professor Barbara Terhal appointed as new member of the KNAW

Professor Barbara Terhal, group leader at QuTech and the Faculty of Electrical Engineering, Mathematics & Computer Science of TU Delft, has been appointed as new member of the Royal Netherlands Academy of Arts and Sciences (KNAW). In the Netherlands, membership of KNAW is a significant accolade for an academic career. A total of 18 new members have been appointed.

New software brings quantum network design to users around the world

NetSquid, a specialized simulator for quantum networks has been made freely available for non-commercial users. In development by QuTech since 2017, the software is the first of its kind to model timing effects using discrete events. NetSquid allows researchers around the world to accurately predict the performance of quantum networks and modular quantum computing systems. Such simulations are essential to design scalable quantum systems, and exploit them for radically new types of computation and communication technologies.

Single Molecule Biophysics meeting

The first edition of the Single Molecule Biophysics meeting in Europe was held in Les Houches, France, inspired by the successful Single Molecule Biophysics meetings in Aspen run by Steve Block and Tom Perkins. It was co-organized by Nynke Dekker (BN, TU Delft) and David Rueda (Imperial College) and hosted by the Ecole de Physique. There was exciting new science presented with lots of preliminary data. Participants from all over the world actively discussed single-molecule technology as well as biological discoveries, even while skiing together on the slopes of Les Houches and Chamonix! Thanks to Filip Asscher and Louis Kuijpers of the Nynke Dekker Lab for helping out, and we look forward to a second edition in two years' time!

IRIS-lab one of the eight new TU Delft AI Labs

TU Delft is setting up eight new AI Labs to investigate how artificial intelligence (AI) can accelerate scientific progress. With the IRIS-lab (Intelligent & Reliable Imaging Systems) the involved researchers David Maresca, Arjen Jakobi and Carlas Smith want to open the "black box" of AI and develop methodologies for context-independent, knowledge-based learning of imaging systems that will address fundamental challenges in all quantitative imaging applications.

Artificial intelligence (AI) concepts are propelling nearly all computer vision-intensive applications in life science, biomedical research, space exploration, high-tech manufacturing, and security technology. While traditional image processing methods are based on linear space-invariant assumptions, neural networks are inherently non-linear and have the potential to outperform these methods.

Neural networks are trained to perform a certain task using very large sets of data. The feature of adapting to data by extracting the essential information and using it to form decisions or make predictions in a "black box" is what makes this approach so useful for many applications. For scientific applications, however, this black box causes a serious dilemma: what is gained in performance is lost in interpretability of the solution. Also lost is the ability to integrate existing physical knowledge of the system.

AI labs & talent recruitment

We have a university-wide talent programme, involving both faculty members and PhD students, with which we attract and support new talent in AI, Data & Digitalisation. The aim of this programme is to accelerate research in all relevant scientific disciplines and to increase the available educational capacity.

At our TU Delft AI-labs we unite experts in 'the fundamentals of AI technology' with experts in 'AI challenges' to address current and prominent (societal) research questions and to provide domain specific education. Each of these labs consists of at least two academic members of staff (new talents from the talent programme or young academics already on board) and four joint PhD students.

The aim of the IRIS lab is to open the black box of AI and develop methodologies for context-independent, knowledge-based learning of imaging systems that will address fundamental challenges in all quantitative imaging applications. The proposed AI-technology will be applied to electron, optical, and ultrasound imaging to unravel dynamic molecular processes in living organisms: conformational ensembles of proteins, single-molecule dynamics in thick tissue and super-resolved vasculature mapping in real-time.

ERC Advanced Grant for Cees Dekker and Lieven Vandersypen

Two researchers of our Kavli Institute have been awarded an ERC Advanced Grant. Cees Dekker (Bionanoscience) and Lieven Vandersypen (Quantum Nanoscience/QuTech) will receive this European grant, which is awarded to five-year projects conducted by internationally established research leaders.

Cees Dekker - Building a chromosome from the bottom up

How is DNA organized in our cells? In 2018, Cees Dekker had a breakthrough that made headlines. His research group recorded on video how a protein complex extrudes loops in the DNA to pack the genetic material into compact chromosomes. Early this year, he discovered a new kind of DNA loops, called 'Z-loops'. The next five years the group will research how our DNA is organised into chromosomes, which change shape all the time during a cell's life cycle. Cees Dekker will, among other things, build a chromosome from the bottom up - an approach that the group calls 'genome-in-a-box'. "The idea is to add all kinds of essential, DNA-organising proteins to a very long piece of bare DNA that is the size of an entire genome under controlled conditions", explains Dekker. "Indeed, by building it step by step, we can learn a lot. Genome-in-a-box is a unique way to learn which protein systems and physical conditions are needed for the formation of chromosomes."

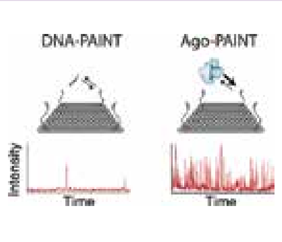
Lieven Vandersypen - Performing quantum simulations with an experimental model system

Aristotle's phrase 'The whole is greater than the sum of its parts' applies perfectly to Lieven Vandersypen's research on so-called 'quantum many body systems'. In these systems, quantum particles interact with one another, leading to phenomena such as quantum magnetism and superconductivity. The complexity of these systems makes them very difficult to model on conventional computers. Instead of using a computer, Vandersypen therefore uses a model quantum system. Vandersypen: "By constructing experimental model systems, we hope to get new insight into some of the biggest open problems in condensed matter physics, and to reveal new physics."

HIGHLIGHT PAPERS

High-Speed Super-Resolution Imaging Using Protein-Assisted DNA-PAINT

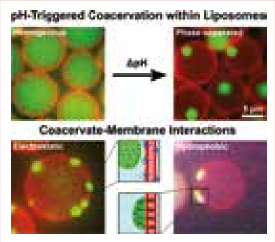
Single-molecule localization microscopy allows for imaging structures beyond the diffraction limit. We have developed a protein-assisted DNA-PAINT which reduces the imaging time by a factor of 10. This new method can speed up many currently existing super-resolution imaging techniques.



M. Filius, T.J. Cui, A.N. Ananth, M.W. Docter, J.W. Hegge, J. van der Oost, C. Joo.
Nano Letters 2020 Apr 8;20(4):2264-2270

pH-Controlled Coacervate–Membrane Interactions within Liposomes

Here, we use an on-chip microfluidic method to study the formation of membraneless organelles within liposomes, using pH as the control parameter and induce interactions between the organelles and the liposomal membrane.



M.G.F. Last, S. Deshpande, C. Dekker
ACS Nano, 2020, 14, 4, 4487-4498

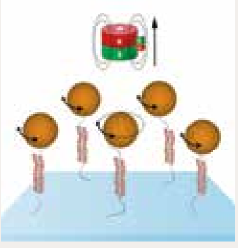
Detecting motion using quantum interference

In this work, we have demonstrated the detection of mechanical motion using quantum interference. The proof of concept device is already competitive with the state of art and there are clear prospects to reach even higher single-photon coupling strengths in the near future.

Coupling microwave photons to a mechanical resonator using quantum interference
I. C. Rodrigues, D. Bothner, G. A. Steele
Nature Communications 10, 5359 (2019)

Chromatin fibers stabilize nucleosomes under torsional stress

Here we employed novel magnetic tweezers approaches to measure the extension of chromatin fibers under tension and torsion. The results revealed that positive twist was absorbed by the chromatin fiber and stabilized nucleosome stacking. This study highlights the importance of chromatin 3D organization in switching gene expression on and off.

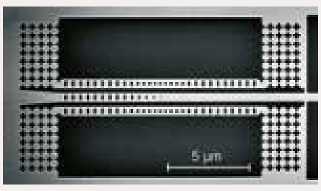


The image shows many chromatin fibers tethered in parallel in the magnetic torque tweezers instrument that is used to perform the measurements.

A. Kaczmarczyk, H. Meng, O. Ordu, J.van Noort & N.H. Dekker
Nature Communications volume 11, Article number: 126 (2020)

A quantum memory at telecom wavelengths

Here, we demonstrate a Duan–Lukin–Cirac–Zoller-type mechanical quantum memory with an energy decay time of $T1 \approx 2$ ms, which is controlled through an optical interface, engineered to natively operate at telecom wavelengths. In addition, we further investigate the coherence of the memory.



A.Wallucks , I. Marinković, B. Hensen, R. Stockill and S.Gröblacher
Nature Physics 16, pages772–777 (18-05-2020)

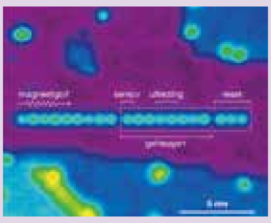
Magnetic and electronic phase transitions probed by nanomechanical resonators

Here, we demonstrate that phase transitions in thin membranes of 2D antiferromagnetic FePS3, MnPS3 and NiPS^3 can be probed mechanically via the temperature-dependent resonance frequency and quality factor. This has the potential to characterize phase transitions in a wide variety of materials.

Makars Šiškins, Martin Lee, Samuel Mañas-Valero, Eugenio coronado, Yaroslav M. Blanter, Herre S.J. van der Zant and Peter G. Steeneken
Nature Communications 11, 2698 (1 June 2020)

Remote detection and recording of atomic-scale spin dynamics

Here, we present a device composed of individual Fe atoms that allows for remote detection of spin dynamics. We have characterized the device and used it to detect the presence of spin waves originating from an excitation induced by the STM tip several nanometres away; this may be extended to much longer distances.



Robbie Elbertse, David Coffey, J. Gobeil and Sander Otte
Communication Physics 3, 94, 2020

Yeasts collectively extend the limits of habitable temperatures by secreting glutathione

We discovered that yeast cells work together to survive and replicate at high temperatures, thereby avoiding population extinction at high temperatures. This revises a textbook view of microbes autonomously fighting heat damages.

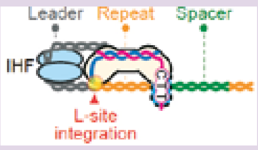
D.S. Laman Trip & H. Youk
Nature Microbiology 5:943-954 (April 2020)

Protecting quantum entanglement from leakage and qubit errors via repetitive parity measurements

Protecting quantum information from errors is essential for large-scale quantum computation. Quantum error correction (QEC) encodes information in entangled states of many qubits and performs parity measurements to identify errors without destroying the encoded information. We show the stabilization of Bell states over up to 26 parity measurements by mitigating leakage using post-selection and correcting qubit errors using Pauli-frame transformations.

C. Bultink, T. E. O'Brien, R. Vollmer, N. Muthusubramanian, M. W. Beekman, M. A. Rol, X. Fu, B. Tarasinski, V. Ostroukh, B. Varbanov, A. Bruno, and L. DiCarlo
Science Advances 6, No. 12 (2020)

Selective loading and processing of prespacers for precise CRISPR adaptation



This publication demonstrates how the memory of bacteria is kept to up to date to protect them from constantly evolving viruses. The system has a potential for biotechnology applications by converting it to kind of biological logbook that keeps track of what happens in a cell.

S. Kim, L. Loeff, S. Colombo, S. Jergic,
S.J.J. Brouns, C. Joo
Nature 579, pages 141–145 (Feb 2020),
published online

Charge-dependent interactions of monomeric and filamentous actin with lipid bilayers

As part of the BaSyC team effort to build a synthetic cell, we combined experiments (Koenderink group) with simulations (Siewert-Jan Marrink group) to reveal how cytoskeletal actin filaments interact with the membrane lipids, which is important for the construction of a synthetic cell.

Press release: https://www.rug.nl/sciencelinx/nieuws/2020/03simulations-show-fundamental- interactions-inside-the-cell

C.F.E. Schroer, L. Baldauf, L. van Buren, T.A. Wassenaar,
M.N. Melo, G.H. Koenderink, S.J. Marrink
PNAS, (March 2020)

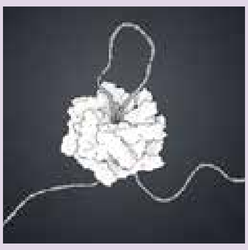
Mechanisms of motor-independent membrane remodeling driven by dynamic microtubules

This work of the groups of Dogterom and Koenderink (Delft) and A. Akhmanova (Utrecht) shows that microtubules can organize membranous organelles by coupling microtubule dynamics to membrane remodeling via proteins that associate with the tips of growing microtubules, disproving previous hypotheses.

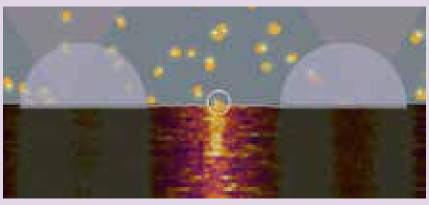
R. Rodriguez-Garcia, V.A. Volkov, C.-Yi Chen, E.A. Katrukha, N. Olieric, A. Aher, I. Grigoriev, M.P. Lopez, M.O. Steinmetz, L.C. Kapitein, G.H. Koenderink, M. Dogterom, A. Akhmanova
Current Biology (Feb 2020), published online

Processive extrusion of polypeptide loops by a Hsp100 disaggregase

We show how protein aggregates are broken down. Ring-shaped disaggregase proteins can thread polypeptide loops through their central pore, forcibly extracting them from aggregates and allowing their refolding. These findings are key to elucidating how cells combat dementia and ageing.



ClpB extruding a polypeptide loop. Credits: Avellaneda/Tans

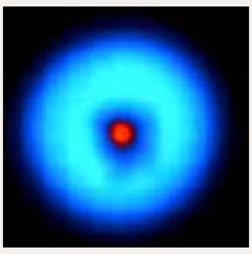


Combined optical tweezers and fluorescence shows disaggregase action. Credits: Avellaneda/Tans

M.J. Avellaneda, K.B. Franke, V. Sunderlikova,
B. Bukau, A. Mogk, S.J. Tans
Nature 578 (2020): 317-320

Bacterial coexistence driven by motility and spatial competition

We report a novel mechanism how bacterial species coexist. Mere differences in moving and growing yield a complex dynamic when colonizing new nutrients. This helps explain the diverse microbiome in our intestine, and enables study of the role of movement in ecosystems and antibiotic resistance.



Red and blue bacterial populations spatially excluding each other. Credits: Gude/Tans.

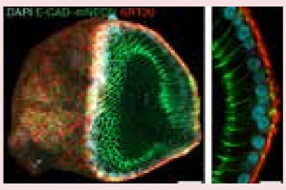
S. Gude, E. Pinçe, K.M. Taute, A.B. Seinen,
T.S. Shimizu, and S.J. Tans. "."
Nature 578 (2020): 1-5

Predicting Evolution Using Regulatory Architecture

In this article we review how we can now begin to predict the evolution of regulatory networks, driven by a new wave of novel quantitative experiments and theoretical concepts.

P. Nghe, M.G.J. de Vos, E. Kingma, M. Kogenaru,
F.J. Poelwijk, L. Laan,S.J. Tans.
Annual Review of Biophysics 49 (2020)

Fast and efficient generation of knock-in human organoids using homology-independent CRISPR–Cas9 precision genome editing



This paper reports on a novel and highly efficient CRISPR-Cas9-mediated gene engineering approach for mini-organs called organoids. The power of this method is illustrated with various applications, and for instance revealed a remarkable dynamic of cells that define bile duct networks in the liver.

CRISPR-HOT engineered intestinal organoids. Credits: Artegiani/Hendriks

B. Artegiani, D. Hendriks, J. Beumer, R. Kok, X. Zheng, I. Joore, S. Chuva de Sousa Lopes, J.van Zon, S.J. Tans, H. Clevers
Nature Cell Biology 22, 321–331 (2020)

Nagaoka ferromagnetism observed in a quantum dot plaquette.

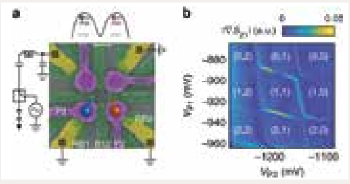
In 1966, Japanese physicist Yosuke Nagaoka predicted the existence of a rather striking phenomenon: Nagaoka's ferromagnetism. His rigorous theory explains how materials can become magnetic, with one caveat: the specific conditions he described do not arise naturally in any material. Researchers from QuTech have now observed experimental signatures of Nagaoka ferromagnetism using an engineered quantum system.

J.P. Dehollain, U. Mukhopadhyay, V.P. Michal, Y. Wang, B. Wunsch, C. Reichl, W. Wegscheider, M.S. Rudner, E. Demler, and L.M.K. Vandersypen
Nature 579, 528–533(2020)

Marie Curie European Fellowship for Henry Brinkerhoff

Congratulations to Henry Brinkerhoff. He received a Marie Skłodowska Curie (MSC) European Fellowship 2020. He will use this fellowship to work on methods for single-molecule protein sequencing.

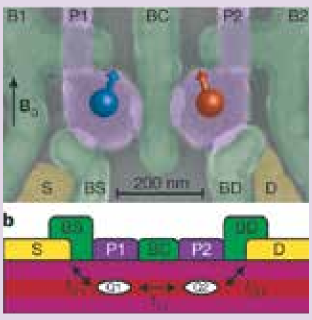
A single-hole spin qubit



One of the key challenges in building the much coveted and very powerful quantum computer is the building of qubits (quantum bits) that can be scaled to large numbers. Using only standard semiconductor manufacturing techniques, researchers from QuTech have now demonstrated that a single hole, trapped in a germanium quantum dot, can be effectively used as a qubit.

W. Hendrickx, W. I. L. Lawrie, L. Petit, A. Sammak, G. Scappucci & M. Veldhorst
Nature Communications 11, Article number: 3478 (2020)

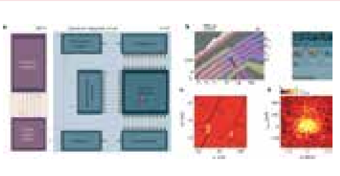
Fast two-qubit logic with holes in germanium



Transistors based on germanium can perform calculations for the future quantum computer. We demonstrate a fast universal quantum gate set composed of single-qubit gates with a fidelity of 99.3 per cent and a gate time of 20 nanoseconds, and two-qubit logic operations executed within 75 nanoseconds. Planar germanium has thus matured within a year from a material that can host quantum dots to a platform enabling two-qubit logic, positioning itself as an excellent material for use in quantum information applications.

N.W. Hendrickx, D.P. Franke, A. Sammak, G. Scappucci, M. Veldhorst
Nature 577, 487-491 (2020)

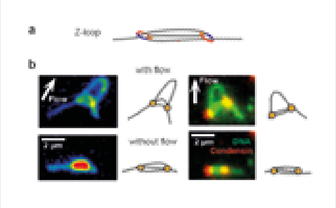
Universal quantum logic in hot silicon qubits



In this paper we show that silicon quantum dots can have sufficient thermal robustness to enable the execution of a universal gate set at temperatures greater than one kelvin, over 50 times higher than previously and a crucial leap towards a functional quantum computer. We obtain single-qubit control via electron spin resonance and readout using Pauli spin blockade. In addition, we show individual coherent control of two qubits and measure single-qubit fidelities of up to 99.3 per cent.

L. Petit, H.G.J. Eenink, M. Russ, W.I.L. Lawrie, N.W. Hendrickx, S.G.J. Philips, J.S. Clarke, L.M.K. Vandersypen, and M. Veldhorst
Nature 580, 355–359(2020)

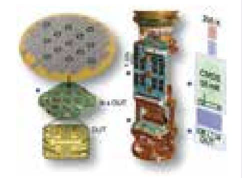
DNA-loop extruding condensin complexes can traverse one another



We show how condensin proteins , which individually extrude DNA in one direction, can pass each other and form a 'Z-loop' structure that gathers DNA from both sides, indicating that condensin may achieve efficient chromosomal compaction using a variety of looping structures.

E. Kim, J. Kerssemakers, I.A. Shaltiel, C.H. Haering, C. Dekker
Nature volume 579, pages 438–442 (2020)

Multiplexed quantum transport using commercial off-the-shelf CMOS at sub-kelvin temperatures

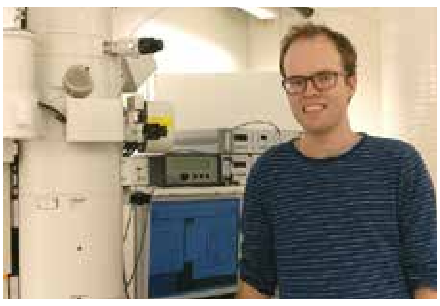


One of the major challenges in scaling toward large-scale solid-state systems is the limited input/output (I/O) connectors present in cryostats operating at sub-kelvin temperatures required to execute quantum logic with high fidelity. This interconnect bottleneck is equally present in the device fabrication-measurement cycle, which requires high-throughput and cryogenic characterization to develop quantum processors. In this article we multiplex quantum transport of two-dimensional electron gases at sub-kelvin temperatures.

B.P. Wuetz, P.L. Bavdaz, L.A. Yeoh, R. Schouten, H. van der Does, M. Tiggelman, D. Sabbagh, A. Sammak, C.G. Almudever, F. Sebastiano, J.S. Clarke, M. Veldhorst, and G. Scappucci
npj Quantum Information 6, Article nr: 43 (2020)

Automated electron diffraction for nanocrystallography

Stef Smeets



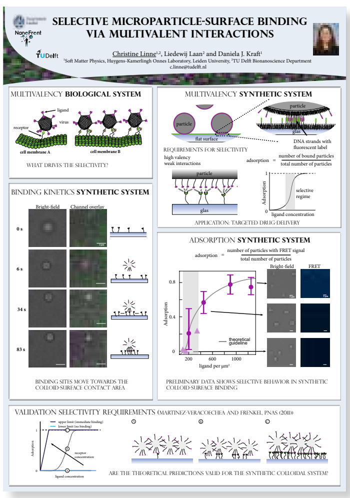
Knowledge of the atomic structure is essential to develop a fundamental insight of how a material forms or functions. Yet, crystals of many materials of biological, pharmaceutical, or industrial interest are too small (<1 μm) for routine X-ray diffraction (XRD) analysis. During the past decade, 3D electron diffraction (ED) has flourished into a powerful technique for crystal structure analysis using a transmission electron microscope (TEM), allowing access to structural information down to nanometre-sized crystalline volumes. However, data acquisition requires significant expertise and revolves around ad-hoc protocols that are manually laborious and often poorly reproducible. Model accuracy depends on finding the best crystal among thousands, which may not be representative.

Five years ago, I started to develop my own software to address these issues: instamatic (github.com/stefsmeets/instamatic). Instamatic is a flexible Python toolbox for automating electron diffraction data collection. Over the last 1.5 years at the Kavli Institute, I focused on establishing automated protocols to minimize exposure of the sample. This makes instamatic suitable for collecting data for materials sensitive to radiation, such as organic and biological materials. During his MEP project, Arent Kievits helped out to establish a pipeline to segment low magnification images and identify suitable particles using supervised machine learning. The result is a method that can collect and process data from thousands of crystals, using cluster analysis algorithms to combine all these data into a single coherent model.

Automated data collection implies that the method is reproducible, minimizing the risk of error. This not only makes the method more accessible for novice or irregular users, it also enables high-throughput large-scale crystal screening and data collection in the lab, which are typically reserved for large-scale synchrotron facilities. One could think of parallel setups to screen for new phases and polymorphs, or to study ligand binding interactions. Just as XRD has provided us with many new ground-breaking studies into structure-property relations over the last century, we can now look forward to similar insights coming from ED.

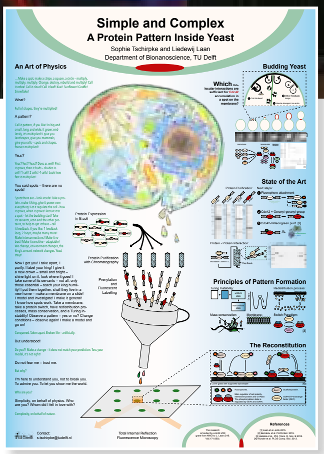
Minerva Prize for Federica Burla

During the Physics@Veldhoven 2020 meeting, Federica Burla, PhD student with Gijsje Koenderink, received the Minerva Prize, an NWO Prize for the best scientific publication by a female physicist. This prize recognized her publication in Nature Physics (2019) where she explains how human tissues achieve their remarkably adaptive mechanics from the collaboration between collagen and hyaluronic acid.



Christine Linne won the second prize at Biophysics at Veldhoven with her poster "Selective microparticle-surface binding via multivalent interactions".

Poster Prize for Sophie Tschirpke



Sophie Tschirpke (BN) won the communication poster prize at Physics at Veldhoven with her poster "Simple and Complex, A Protein Pattern Inside Yeast".

Spinoza Prize for Nynke Dekker

Nynke Dekker has been awarded an NWO Spinoza Prize. The Spinoza and Stevin Prizes are the most prestigious awards in Dutch science. Each of the laureates will receive 2.5 million euros to spend on scientific research and related activities. The researchers receive these prizes for their outstanding, pioneering and inspiring work. The Spinoza Prize focuses on the quality of the researcher: the emphasis is on the scientific work and fundamental questions.

Nynke Dekker is internationally renowned due to her pioneering research into individual DNA and RNA molecules and their interactions with proteins in bacteria, viruses and eukaryotes (organisms whose cells contain cell nuclei).

COLUMN

"Post"-covid impressions

This is my first column for the Kavli newsletter and I want to start it with honesty. I had hoped this writing would happen a few months back. I must have thought at length at an interesting topic to write about. I even had one in my mind. Then, one morning, our lives suddenly changed, and the nice things I wanted to write about suddenly lost interest and got forgotten. So here I am, typing from a plane with a mask on the face, looking forward to a well-deserved holiday. In our European context things are slowly coming back to a "new normal"- whatever this new expression fancied by our media means. Covid updates do not take necessarily the headlines, which signals that the time has come to stop and reflect.

The first thought that comes to my mind is diversity. During the lockdown, I experienced COVID as a zoom lens into our diversity. Confronted with an emergency, we are all affected and we all react differently based on our background, age, marital status, work-related responsibility- you name it. We have been asked several times and in official settings about our impressions on Covid. Has it impacted your work? How is your work-life balance going? I asked the beautiful people I have the fortune to work with day-by day the following: Close your eyes, think Covid, and write about it while following their stream of consciousness. No long and professionally-designed questionnaire, but simply: What did you miss? What do you want to keep with you? Here below I summarize these impressions, which you should take from now on as collective writing. Quite interestingly, much more was said about the future than the past, which is great.

The rigid restrictions that Covid has imposed, accelerated the transition to a more flexible, objective and goal oriented working environment. Working remotely has forced us to improve our clarity on data organization and data sharing. The limited time for discussion has shifted the focus of our discussions towards results, leaving less space to sometimes inconclusive conversations. The absence of interruptions in a less crowded environment have led to a more focused work-flow. Online meetings have proven to be much efficient and productive. Daily communications are in written format and it has brought more accuracy and transparency in all aspects of our work. We are forced to plan ahead our days in the lab, bringing more focus. Running measurements from home has been surprisingly straightforward. Online conference are not so bad: environmentally friendly, cheaper, and more accessible.

So far so good. We see the glass half full. But what about the other half? Nothing could replace a fruitful real-time chat over an ongoing measurement. The lack of an environment where spontaneous conversation happens results in a loss of those insights and inputs that in the long term can actually make a difference in somebody's research. To fail fast is a great path to successful research. Discussing day to day failures and seemingly irrelevant details is an ongoing learning process that Covid has temporarily paused. And we all regret this. Most importantly, we all paid a high emotional toll: limited visit to family abroad, limited interactions with colleagues, stress at home to name a few.

Looking beyond Covid, we know that the large part of this transition will not reverse and we hope that it will bring to a new balance where agile and focused work creates more space for enriching interactions.

Giordano Scappucci

Rebuilding biology

By Lennard van Buren

Life is extremely diverse. There are small bacteria and big mammals like ourselves, birds that yearly cross oceans and plants which inhabit the same square meter for their entire life, small prokaryotes living in environments from the freezing Arctic to boiling hot vents at the ocean floor.

Despite the vast diversity of life, all living matter is made up of the same building blocks: cells (except for viruses, but let's take this opportunity to not talk about viruses). And although cells of different organisms, and even within an organism, may appear and behave very differently, the physical boundary separating the cell from its surrounding is strongly conserved. A thin layer, which we call the cell membrane, acts as a selective barrier that keeps the cell material and nutrients inside, while shielding the cell content from foreign molecules and invasive pathogens. It creates a cosy, ambient biochemical environment in which cell activity flourishes.

The membrane is a very thin, supramolecular sheet, composed of a double layer of neatly oriented lipid molecules that is filled with membrane proteins, which act as cell fuel pumps, transporters or receptors. Essential for their function is that these proteins can easily spatially rearrange. Therefore, the membrane has to be of fluid nature, so that proteins and lipids can be continuously reorganized in this two-dimensional sea.

Throughout their life cycle, cells often have to deform their membrane. For example, during cell division, the membrane has to be constricted at the cell mid-pole, to give birth to two daughter cells. Considering their molecular thickness and fluid nature, membranes are typically easily deformable.

While ensuring fluidity and deformability, the membrane at the same time has to provide mechanical integrity to the cell container. The cell should not be damaged or permanently deformed by shear flows or compressive or extensional forces. If you think of the high blood pressure in our veins, or the numerously repeated extension and compression of our lungs, cells need to operate in mechanically stressful environments.

A key challenge for all cell membranes is thus to combine fluidity with robustness. From a physical perspective, these requirements are usually mutually exclusive. Upon applying a stress, fluids typically flow, having no memory of their shape. Soft solids, on the other hand, are elastic, and will deform back when stress is released. So how do living cells combine membrane fluidity with mechanical integrity?

Interestingly, organisms have found unique and versatile ways to cope with this challenge. Eukaryotes possess a cytoskeleton, an internal elastic framework made up of protein fibres that supports the cellular membrane and adds shape memory to the cell boundary. Bacteria have a rigid cell wall enclosing the soft and fluid membrane, that acts as a protective shell. Archaea, the long-forgotten other class of prokaryotes, thrive in extreme environments. These organisms ensure membrane integrity and functionality at their optimal growth temperature of 90 °C (!) by a very specialized lipid content.

Although the biomolecular actors in cell shaping and mechanoprotection have been identified decades ago, little is still known about how these actors together give rise to the agile mechanical behaviour of the cell. Disentangling the role of building blocks is very challenging in biological systems, due to the enormous complexity of cellular life: typically, a cell consists of thousands of different components, which all have interactions and show redundancy.

Instead, in the lab of Gijsje Koenderink (Biological Soft Matter group), we study the mechanical properties of living matter mainly by 'rebuilding' biological systems from a minimal set of components. This bottom-up reconstitution approach allows control over the experimental system in a way unprecedented by 'classic' biological research, and enables the physicist in the biologist (or vice versa) to unravel the first principles that govern cell mechanics.

More specifically, in my project I rebuild biological membranes by swelling films of purified lipids into spherical, cell-sized vesicles. By using micropipette manipulation and optical tweezers, I can exert small forces to deform the membrane on the microscale. The mechanical analysis of these simplified membranes helps me to understand better the complex role that membranes play in biology.

Ultimately, my bit of research contributes to the goal of the research consortium Building a Synthetic Cell (BaSyC), where experimental and theoretical researchers throughout the Netherlands collaborate to find how a minimal set of components can cooperate to form a 'living' cell. I believe that my project can reveal design principles to mechanically reinforce such a minimal cell.

Grant for project proposal 'Open Educational Resources in a Multidisciplinary Course' by Timon Idema

Annually the Dutch ministry of education issues grants for open & online education projects in two different pillars: the online education and the open learning materials. In the 'open resources' pillar TU Delft will receive a grant for the project proposal 'Open Educational Resources in a Multidisciplinary Course', written by Timon Idema (TNW) and Michiel de Jong (LIB). Timon will be project leader for this project, in which 12 lecturers in the multidisciplinary bachelor programme Nanobiology, offered at TU Delft and Erasmus MC, will work on replacing course literature with open educational resources, supported by the TU Delft Library's Education Support office.

PhD fellowship for Daniel Ramirez Montero

We congratulate PhD student Daniel Ramirez Montero, who has been awarded a PhD fellowship from the Boehringer-Ingelheim foundation!

John Walter is the 2020 Artist in Residence at the Kavli Institute of Nanoscience Delft

Visual artist Dr. John Walter (1978) will be the next Artist in Residence at the Kavli Institute. Walter is an artist based in London who's work includes painting, virtual reality, and performance. His work is humorous, brightly colored, and deals with transposing analogies between artistic and scientific disciplines. Walter will start at the Kavli Institute in the fall of 2020.

In residency at Delft, John Walters will work on a project entitled *Nanomemetics of the Paisley Pattern*, in which he seeks to deepen the theory of memetics. Memetics ask how ideas acquire humans rather than how humans acquire ideas. Ideas spread in equivalent ways to viruses by infecting hosts and using them as vehicles for their own propagation. Walter will use the millennia-old Paisley Pattern to demonstrate this process and he will borrow from nanoscience in order to undertake a new analysis of the Paisley Pattern and memetically re-engineer it into a new multimedia body of work that will be presented as part of an exhibition at the end of his residency.


John Walter

Previous work

John Walters' doctoral thesis project, *Alien Sex Club* in 2015 addressed a rise in HIV infections among gay men in the West as a crisis of representation within visual culture. His collaboration with clinical epidemiologist Professor Alison Rodgers of University College London engaged sexual health partners from across London and the UK. In 2018 Walter started with *CAPSID* a new collaboration with a scientist, Professor Greg Towers and his lab at University College London. Walter stayed as an artist in residence in the lab for two years attending lab meetings, running workshops and presenting his own work for discussion. He used their nanoscience research into how the capsid of HIV evades detection by the innate sensing mechanism of the host cell as inspiration to create over 250 artworks including a major new artist's moving image work *A Virus Walks Into A Bar*. The residency culminated in an exhibition at Southwark Park Galleries in London and HOME in Manchester. The Arts Council Collection acquired parts of *CAPSID* for their permanent collection.


Example of a Paisley pattern

More information on John Walter
http://www.johnwalter.net/about.html
https://wellcomecollection.org/exhibitions/XFximBAAAPkAioWn
https://youtu.be/aBJ34fwqbnA.

Local contact: dr. Martin Depken

KAVLI Delft Nature streak

Since the last issue of this Newsletter, there has been a remarkable streak of seven papers from KIND, which have been published in the Nature journal. These publications come from the labs of Tim Taminiau, Cees Dekker, Sander Tans (twice!), Chirlmin Joo, Stan Brouns, Menno Veldhorst (twice!), Giordano Scappucci, and Lieven Vandersypen (twice!). As those familiar with the aforementioned principal investigators can imagine, the publications cover a wide range of topics, such as: the mechanism of CRISPR memory formation (Joo/ Brouns), the demonstration of Nagaoka ferromagnetism (Vandersypen), the intricacies of DNA compaction by condensin proteins (Dekker), and how polypeptides are disentangled by a ClpB protein (Tans), a demonstration of fast two-qubit logic with holes in germanium (Veldhorst/ Scappucci), an atomic-scale imaging of a 27-nuclear-spin cluster using a quantum sensor (Taminiau), and how motility and spatial competition drives bacterial composition (Tans). The wide variety of topics covered in these highly impressive publications demonstrates the broad scope and the exceptional quality of the research performed here in KIND. A huge congratulations to the everyone involved in the work in these publications!

SELF-INTERVIEW ELISKA GREPLOVA

What brought you to TU Delft?

Since my PhD studies, I have sought to explore how we can efficiently gain meaningful insights from physically accessible measurements of quantum systems. This particularly applies to emerging quantum technologies that are not always easy to efficiently simulate on classical computers. During my postdoc at ETH Zurich, I have expanded on this area towards many-body systems and quantum matter. One aspect that I find particularly intriguing is how novel computer science methods like artificial intelligence can help us learn underlying physics from quantum measurements and gain insights into new quantum technologies. When I started searching for a place to start my own group I was immediately impressed by the diversity of research at the Kavli Institute of Nanoscience and the great research environment it provides. I am therefore very excited to join the department where I have an opportunity to pursue new directions of theoretical research, while being able to collaborate with groups running state-of-art quantum experiments.

What are your research plans at the Department of Quantum Nanoscience?

I would say my plans are two-fold: one direction of the research in my new group called “Quantum Matter and AI” will be concentrated on advancing quantum matter discoveries using machine learning-inspired methods. This will include the design of quantum metamaterials that will allow us to study phenomena which would be otherwise experimentally inaccessible. I will also focus on the development of new classes of machine learning algorithms which are custom-made to solve physics problems within the area of condensed matter physics. On the other hand, I am deeply interested in the development of new algorithmic solutions that will help quantum experiments to evolve and scale-up. I hope to collaborate closely with Kavli experimental groups and use AI-inspired methods to develop new control and tuning software for the amazingly complex quantum devices these groups are building. It is very exciting to be a quantum scientist at this time, when quantum devices begin to scale-up well beyond the standard algorithmic approaches typically used to control and understand them. For me, it is very encouraging to see machine learning provide great practical solutions to some of the burning problems we are facing nowadays - and I hope the “Quantum Matter and AI” group will facilitate the transition towards machine learning driven discovery of new physics and control of quantum experiments.

What is your impression of Kavli Institute of Nanoscience so far?

I am so excited for the opportunity to start my group at the Kavli Institute! I like that there is space for a razor-sharp concentration on perfecting and scaling-up quantum computers and quantum internet, and, at the same time, there is an equal emphasis on giving research groups space to test out completely new ideas and develop brand new directions of quantum research. I always wanted to be a part of an academically diverse place where there are many people doing completely different things to learn from and collaborate with, and Kavli Institute of Nanoscience seems to be just that.

What are your interests besides your research?

One thing about me that is a bit incompatible with being a theoretical physicist is my visceral hate of sitting for hours at the time. Consequently I try to make up for all the sitting time my job requires by being outside as much as possible - I love hiking, running, cycling, skiing and ice-skating - and it is often during these activities that I get my most useful ideas! I am also a big fan of sci-fi and fantasy books and I play cello.

SELF-INTERVIEW Dong Hoon SHIN

Ideas for original and innovative research are often outside the scope of a single discipline. Many scientific breakthroughs have been achieved by the application of techniques and methods originating from fields that were sometimes completely unrelated. I hope that I will be able to leverage my interdisciplinary background to achieve a breakthrough in a field almost unrelated to my previous field of study. My PhD study at the Department of Electrical Engineering focused on the quantum mechanical tunneling from one-dimensional nanotubes. As a research fellow at the Department of Physics, I have been performing research on fabrication and analysis of highly sensitive nano-electromechanical systems and in-situ characterization on physical properties of low-dimensional nanomaterials.

When Dr. Chirlmin Joo came to Ewha Womans University to give a talk on single-protein-sequencing technology on Christmas Eve in 2018, I attended without knowing anything about biotechnology. As soon as his talk was over, however, I said to myself, ‘this is it!” I was sure that single protein sequencing technology would revolutionize the world. I soon realized that linearizing entangled proteins is the first priority issue to be solved. I thought that if I could obtain a linearized protein in a confined area, then protein sequencing would be possible using various analytical methods applied during my previous research. Half a year later, I proposed to Dr. Chirlmin Joo and Prof. dr. Peter G. Steeneken my idea of developing this new protein sequencing platform and was accepted to join Kavli Institute of Nanoscience Delft (KIND). During the KIND postdoc fellowship period, my aims are to develop protein linearization techniques using a nanochannel, and to identify amino acids using simultaneous mechanical resonance, fluorescence, and electrical detection, enabling real-time and multi-physical analysis of proteins with high precision and speed. These multi-physical identification techniques can complement each other to identify the sequence of individual proteins. I believe my background in electrical engineering and physics will be linked to the single protein sequencing technology.

I often find the power of innocent curiosity through my 7-year-old son. Children are always curious about the world and love to explore it. Curiosity is a powerful driving force enabling them to understand the world. As a researcher in Korea, I have been living a stable life with my wife and son. It has been comfortable, but there have been times when I felt stuck in the same environment. I am looking forward to this new adventure in the Netherlands. It will surely be a big change from life in South Korea, however, I realize that I also have a strong curiosity for this new opportunity just as my son has for the world around him. I am delighted with this opportunity to explore a new culture and way of life, and I am especially thrilled about engaging with this fascinating research topic and breaking my own boundaries.

Johannes Borregaard

A self-interview is a peculiar concept. When asked if I could provide one for this newsletter, I agreed without really knowing what it was. Luckily, I could consult the many past Kavli newsletters to see how others had approached this task before me. The conclusion I drew from this (admittedly far from exhaustive) literature search was that the format was pretty open. The important thing was to introduce yourself as a new colleague at Kavli Institute of Nanoscience Delft.

What a great opportunity! Given that no strict interview format seemed to be required, I started to think about which format I should pick for introducing myself. I ended up going for a short story.

Chapter 1: "Text me when you are on the train to Den Haag"

This text from our lovely contact in Tulip Expat Service was the first thing that lit up on my phone when I switched off flight mode after arriving in Schiphol Airport. Okay, train to Den Haag, right. A number of things had to dealt with first though. The youngest member of our caravan was at this point transitioning from hungry to hangry and nutrition had to be provided fast! His older sister needed a restroom and our extremely heavy luggage from Denmark had to be located on a conveyer belt somewhere in the arriving hall. Luckily, the past experiences with international relocation came in handy. Acting as a well-oiled machine, my wife and I quickly got the situation under control. We got on the train to Den Haag and finally arrived at our new apartment filled with moving boxes. A new chapter could begin.

Chapter 2: First day on the job

March 1st 2020 (well actually March 2nd) – first workday as an assistant professor at TU Delft. I was thrilled walking around this fantastic place that houses both the Kavli Institute of Nanoscience Delft and QuTech. Filled with inspiring and brilliant scientists and a hotspot in Europe when it comes to my own field of research. As a theoretical quantum optics physicist with an appetite for quantum information theory, I had the opportunity to hit the ground running. The question was clear: "How can we explore and unlock the potential of quantum technology?".

The first days were hectic and exiting. I went from meeting to meeting, hearing about cutting-edge research and starting up new collaborations. It was clear that a plethora of different physical hardware with great potential for quantum information processing was being researched and developed in Delft. A plan started to come into shape. Might it be possible to "mix-and-match" some of this hardware to make new opportunities? I have always found it very interesting to consider the strengths and weaknesses of different quantum hardware platforms. The tricky and really interesting part is then to find the optimal quantum system – or combination of quantum systems – for the task at hand, whether it be long distance quantum communication or quantum enhanced metrology.

Chapter 3: When a bat flaps its wings in Wuhan...

"Oh, we are not allowed to shake hands". Hearing this sentence was the first time I came across the corona virus at TU Delft. Apparently, this new virus had made its first appearance in Wuhan, China and was stating to spread across the globe. As a precaution, TU Delft banned all handshakes. Something you notice quite a few times when running around meeting new people. Well, how bad could it be – maybe just a bit of a nasty flu? Some alarming reports from Italy, however started to come in. Almost in a matter of hours, all shops closed, trains stopped running, and students were sent home. The corona lockdown had arrived.

It is a strange experience to start in a new job during a lockdown. Especially, when that new job happens to be in a new country. Conditions for doing research at home is not ideal with two kids - one of whom needs to be homeschooled in Dutch (neither me or my wife speak Dutch yet). Nonetheless, I felt lucky that I was doing theory after all. Having to set up a new lab during a lockdown seems extremely challenging at best.

Chapter 4: Light at the end of the tunnel

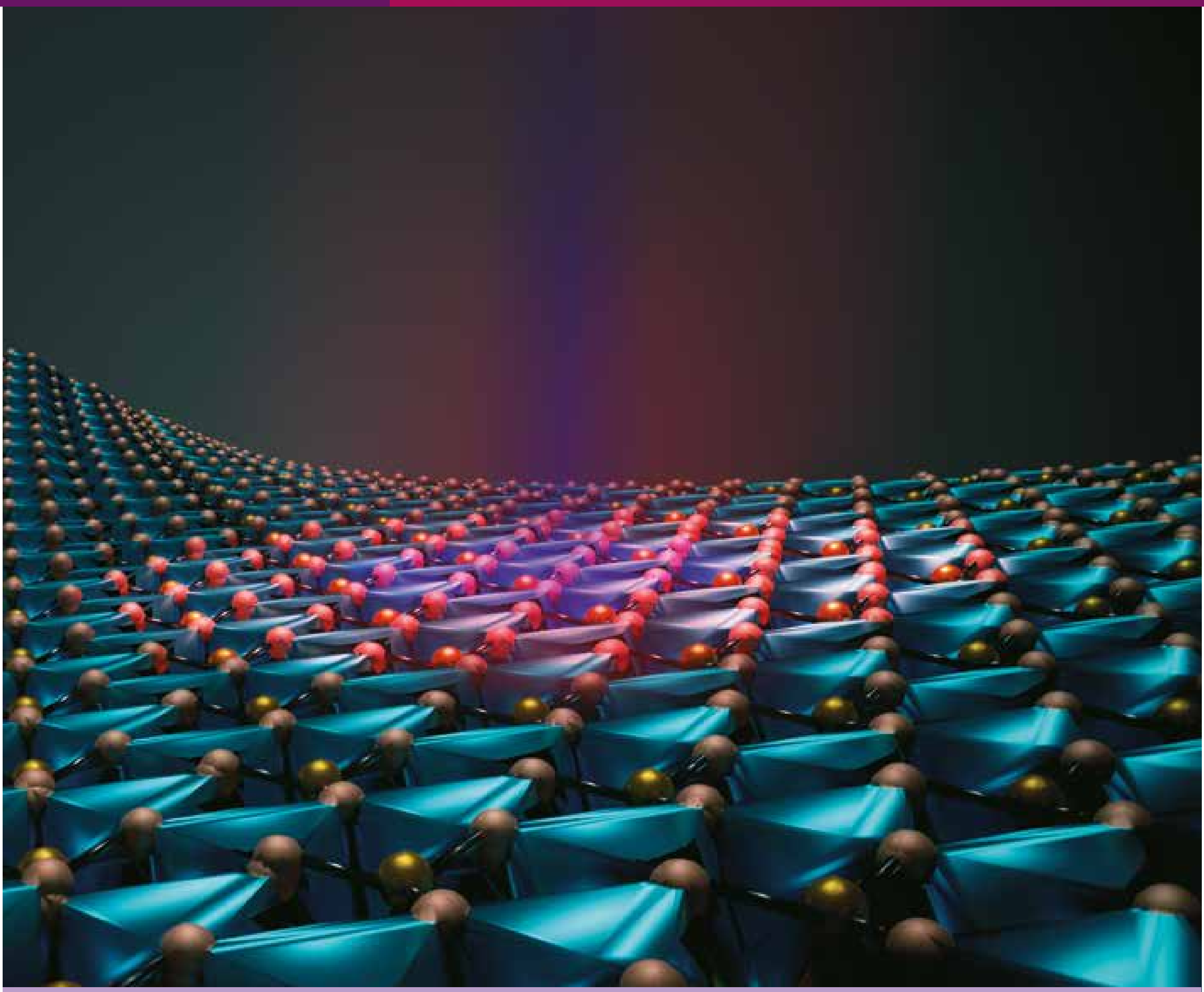
After 78 days in captivity, things started to open up. The corona outbreak in the Netherlands was under control and society could slowly start up again. People started to show up at their offices again though still working from at home as much as possible of course. When writing this, I'm eagerly awaiting the next corona-update from TU Delft. I will soon be having some additions to my newly started group and fingers crossed that they will be able to get here without too much trouble. I guess time will tell but there seems to light at the end of the tunnel.

By reading this short story, I hope that you have gotten an idea about who I am. However, I do not fancy myself as a great writer – far from it. So if nothing else, thanks for sticking out to the end of it. I hope that I will soon be able to meet even more of you in person and hear about your exiting research! Zoom is okay but sometimes it is just nice to discuss physics with a blackboard (or whiteboard) at hand.

Flagship multidisciplinary project between Erasmus MC and TU Delft on the topic of tissue generation

The Convergence initiative supports a flagship multidisciplinary project between Erasmus MC and TU Delft on the topic of tissue generation. They are looking for two self-motivated postdocs. This project joins expertise in regenerative medicine (Erasmus MC) and quantitative biophysics (TU Delft) towards the aim of generating tissue-mimetic hydrogels for human disease models and tissue regeneration. Being able to precisely engineer the cell's micro-environment holds the key for generating accurate in vitro disease models and de novo tissues. In this project, you will mimic design principles of tissues to precision-engineer the micro-environment of stem cells and direct them towards a desired tissue fate.

SCIENCE ART



"Artist impression of probing magnetic phase transition by nanomechanical resonator of $FePS_3$ using a laser interferometery technique."
Credit Ernst de Groot

Rectification of the Science art in Kavli newsletter 27 of January 2020
The credits for the photo "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)" are for **QuTech** instead of Ernst de Groot.

UPCOMING KAVLI COLLOQUIUM

Kavli Chair Prof. Michel Devoret

Date: Spring 2021

Yale University

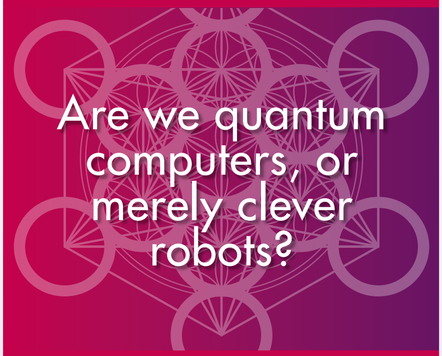
UPCOMING KAVLI COLLOQUIUM

Prof. Miriam Goodman

Date: T.B.A.

Stanford University

KAVLI DAY 2021



Speaker: Prof. Matthew Fisher of UC Santa Barbara

September 2, 2021

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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Haagsblauw

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KAVLI DAY 2020

Cancelled

September 3, 2020