KAVLI NEWSLETTER

Kavli Institute of Nanoscience Delft

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IN THIS ISSUE:

Interview with Spinoza Prize winner Lieven Vandersypen

By Violet van Houwelingen

Lieven Vandersypen, Professor in Quantum Nanoscience and scientific director of Qu-Tech, has been awarded a Spinoza Prize for his pioneering work on quantum computation, which holds great promise for global problems in health, climate and energy. With his prize Vandersypen also intends to encourage girls to go into the field of technical sciences, as well as help people tell the difference between facts and fabrications. "The first time I heard about quantum computers I thought: how are these things possible?"

Q: What is your reaction to receiving this prize?

A: "I'm very honoured. It's the highest scientific recognition you can get in the Netherlands, to receive it is really fantastic. Of course it's a personal prize but all the work we do is really team work. So I also want to express my thanks to the many collaborators over the years within our Kavli institute and from abroad, especially my mentors Hans Mooij and Leo Kouwenhoven. I see this prize as a carte blanche from the Dutch Research Council: they have the confidence that you will do good things with the prize money. That flexibility is unusual, which makes it extra valuable."

"The nature of the Spinoza prize is quite similar actually to what Fred Kavli had in mind with the Kavli Foundation: through this organization he selected a number of institutions, endowed them with significant sums of money, trusting that they would do good things with them to advance nanoscience, neuroscience, astrophysics and so forth. The foundation looks carefully who has done excellent work and deserves to get this flexible money, who knows how to best to use it to advance the science in their institute. With the Spinoza prize and also with Kavli funds we as scientists have the freedom to say: we are going to do this because we believe it's worthwhile."

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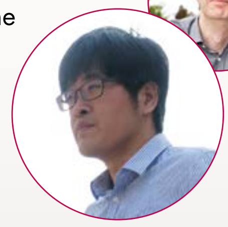
FROM THE DIRECTORS

For the fourth time since 2018, we have a Spinoza Winner in our Kavli! The former director, Lieven Vandersypen, received the award for his outstanding work on quantum computing. As we are coming out of the pandemic, this Newsletter highlights the revival of in-person activities. Check out photos from our Kavli Day in September. Our colloquium will be back on campus in November. We will celebrate it with cake with the face of Alexander van Oudenaarden, the director of the Hubrecht Institute, printed on. And don't miss the self-interview of Lukas Splitthoff.



Chirlmin Joo

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Interview with Spinoza Prize winner Lieven Vandersypen

Q: What is the promise of quantum computing?

A: "One reason why you don't see many concrete promises, is because I don't want to add to the height of the inflated expectations in this field. On the other hand: quantum computers can have a strong impact. These computers work on different principles than computers we work with today, offering much faster solutions – meaning the difference between millions of years in a practical time scale and an hour, or minutes. We know that quantum computers can offer a speed up for important classes of problems, and not in others."

"In the first category where it is possible to get a quantum speed-up, the most firmly established methods are able to compute efficiently the properties of molecules and materials. This can have societal implications. Because if you can efficiently compute the properties of molecules and materials – todays super computers cannot, it's too hard for them – it can speed up the design of new drugs, new catalysts that make chemical plants efficient for example, lead to better fertilizers or batteries... This can ultimately can contribute to health, climate, the energy transition etc."

"The reason why it's difficult to compute the properties of molecules and certain materials, is because these properties are directly influenced by interacting quantum systems, interacting electrons. When that happens the complexity of behaviour grows exponentially with the size of the system. However, the quantum computer already has that same exponential complexity build into it, so it's uniquely fitted to the properties of molecules and materials."

Q: Can you describe the focus of your work?

A: "My expertise is in building quantum computers and quantum bits that we can program, control and take through the steps of algorithms; what we call quantum hardware. Our mindset is: the more, the better, the easier. As we increase the number of qubits and the degree of control, in addition we should make things easier over time. For instance, going from 10 to 11 qubits should be easier than going from 2 to 3 – if not, we are on a bad trajectory. Quantum simulation is a parallel line of our research: building a system that very much resembles a different system which we would like to understand better."

Q: Do you have a specific mission in mind with this prize?

A: "I will apply the Spinoza award to support these two research lines in the coming years. In addition to this, I also want to find ways to support two causes that are closely connected to what we do here and which I care about a lot. The first is to encourage girls at the high school level to go into the field of physics or other technical sciences. I think girls are underrepresented and it's not because they are uninterested: its often because they think incorrectly that physics just for boys or that they are not smart enough. This is a missed opportunity for the progress of science and the people involved."

"The second cause I want to support I consider the most important thing for our society these days: to help people tell the difference between scientifically proven or investigated facts and simple fabrications that somebody came up with. Many find this distinction difficult, which is a problem for our society. For example, I understand people being afraid of getting a corona vaccine; what I have difficulty with, is the people who are merely spreading lies and fabrications. Even for smart people it's difficult to understand why they should believe an expert in virology more than a random dance teacher. I want to use this prize to disseminate science in non-scientific venues - 'Spinoza te Paard' by Leo Kouwenhoven is a great example of this."

Q: Which aspect fascinates you most about your work?

A: "The fact that some of the deepest aspect of quantum physics, which are very counter intuitive but also fascinating, can be applied to build a computer that works in a completely different way than computers that currently exist, and which is also extremely powerful. That's such a fantastic combination, right? The most fascinating deep properties of nature coming together with a potential for technology that can be really impactful. This combination inspires me a lot. The first time I heard about quantum computers, I almost couldn't sleep from excitement: how are these things possible?"

"Still, if you think about what we are doing it continues to be remarkable. In our case we can hold onto one electron – almost unimaginable! – and we can actually read out the spin of the electron: that one is spin up, that one is spin down. All at the level of individual electrons. And we can actually control their states, and couple them together, and make them go through the steps of a computation. That fascination, which I've had for almost 25 years now, hasn't diminished. It keeps me motivated and working in this field."

Q: In the future, do you imagine we will be seeing more of quantum computers in daily life?

A: "That's hard to say. I think the mental picture I have today of a future quantum computer is a very expensive machine in a large, specialized facility, that will be used by companies, institutions or government agencies to solve important problems that they cannot solve even with super computers. So my mental picture of a quantum computer is more similar to what a super computer looks like today, rather than what a laptop or a cellphone looks like today, which are available almost in any household these days."

"Of course it's hard to predict the future of quantum computing. Certainly when the first computers were built decades ago, I think nobody imagined that a machine orders of magnitude more powerful than they were building then, now fits in our pockets. When you ask me today 'would a laymen person need a quantum computer?' I would say no, a normal laptop is fine. But I have to admit, when Steve Jobs gave his famous speech 15 years ago "And here it is, the iPhone" my first thought was: that's stupid I don't need that, why would anybody care?"

Q: Do you foresee ethical or philosophical implications of quantum computing in the future?

A: "We have a vision team at TU Delft on quantum computing which is now composing its conclusion: we reflect on the possible applications of this new technology together with all kinds of people, from industry, and governments to advocacy groups and privacy experts. Once you are conscious of ethical implications, there are ways to build this into the technology: so that positive outcomes are landing more easily than negative outcomes. As a scientist we cannot say; 'We do the science and develop the technology, let somebody else think about implications.' We can't stay on the sidelines. I don't pretend that I will have complete control over it, but it starts at least with caring and participating."

KAVLI COLLOQUIUM

"Novel single-cell sequencing tools to explore cells in space and time"

Prof. dr. ir. Alexander van Oudenaarden

Hubrecht Institute and Utrecht University

November 25, 2021 will feature a Kavli colloquium by Alexander van Oudenaarden:

Prof. dr. ir. Alexander van Oudenaarden is director and group leader at the Hubrecht Institute (KNAW) and professor of quantitative biology of gene regulation at the Faculty of Science and the Faculty of Medicine at Utrecht University. His research group works with advanced (light) microscopy and sequencing technologies in order to study individual cells. Van Oudenaarden studied materials science and physics at Delft, where he also obtained his PhD in solid state physics. As a postdoc he worked at Stanford University collaborating with Steven Boxer and Julie Theriot. He was professor of physics and biology at the Massachusetts Institute of Technology (MIT). In 2012 he moved to the Hubrecht Institute after 15 years in the USA. His group combines techniques – in part developed by themselves – from developmental biology, molecular biology, physics, mathematics and computer science. He was awarded the 2011 and 2016 ERC Advanced Investigator grant and in 2017 van Oudenaarden won the Spinoza Award.

What are you currently working on?

The goal of our lab at the Hubrecht Institute is to develop single-cell sequencing methods. For example, you can use this technology to take one cell, open it up, and sequence the RNA molecules. This allows you to determine, in an unbiased way, which of the thousands of the genes in the genome are ON and which genes are OFF in individual cells. This technology has recently been used, for example, to determine all the cell types in a developing mouse embryo. After dissociating the embryo into individual cells, hundred thousand to millions of single cells can be analyzed. This is really exciting, because often new cell types are discovered, which were previously missed by microscopy-based methods.

You worked on the stochasticity of gene expression. I wanted to translate that to real life, how much do you think luck plays a role in the trajectory and accomplishments of each researcher?

This is indeed how I started in my lab in 2000. We studied stochastic gene expression and asked the question: "Can two cells that have identical genomes and are exposed to identical environments, end up with different phenotypes?" For individual cells the answer to this question turned out to be "Yes". Now, I think it is too difficult to link that to the behavior of billions of interacting cells in a multi-cellular organisms like us. However, I completely believe that luck is really important when you do science. We ran into several of our breakthroughs by serendipity. The key thing is that you have to realize when you are lucky and therefore can make use of this insight. Many of the projects that we started had a certain goal and then we ran into something else which was more interesting. Biology is so complex and still many things are unknown and have to discovered. The chances are high that you will run into something unexpected and interesting. We experienced this already many times and I am sure it will happen again. I feel we are explorers in a space of hidden biological discoveries.

The reproduction number of COVID19 is estimated to be around 2.87. We can also define the same thing in regard to the average number of PhDs that every professor delivers, which is around 7.8. So if you think about the exponential growth, it is just really crazy. This together with the publish or perish phenomenon creates a lot of competition and stress for PhDs and postdocs. Some statistics show that around half of them experienced some sort of anxiety and depression. What would you recommend to your PhDs and postdocs, or in general to other researchers to keep going and stay motivated?

My experience is that it depends on who is the person and who is having a hard time. Perhaps this is not an answer to your question, but what I always feel is that if you want to continue an academic career, you really have to love science. Because I feel science is one of the places where you have to fight and work very hard for a very long time to, for example, get a permanent position. It is probably the job where the delay between your first job and the permanent job is the longest.
So only go that way if you are completely pasionate about it. Because there are many other jobs where you can do great science in a nonacademic context, which are very interesting and are more secure. Going into science is one of the most difficult paths. I think this has always been the case. But it might be that there is more competition now.

What motivated you to go into science?

I was a PhD student, like you, in Delft. When I was young, I was very interested in science. When I was around 12, I bought a microscope, I remember it was quite expensive for me at that time. I was delivering newspapers to accumulate enough money to buy a microscope. I somehow figured out which brand was really good. It was a Russian microscope called Mbu4, I remember this exactly. I was completely crazy about it, already at that time. I do not know where this interest came from. It is probably something in my genes.

What do you think will become the most important topics in your field? Where are the big challenges?

We are working with very complex single-cell data sets. For example, we accumulate single-cell data-sets on genome properties, transcription and translation. We have to start thinking about how to integrate all these datasets and systematically determine which part of data is consistent with the biology we know today and which part is inconsistent with it. This will allow us to discover new biology. These data sets are very quantitatively and therefore we can start to compare the experimental data to theoretical predictions. This is very common in physics but still quite new in biology, at least for these large single-cell sequencing data sets. Recently, Paul Nurse said in an interview in Nature that we have all this data, but that we need more ideas. I agree with this, but I also think that, if we properly integrate and analyze these new data, we can generate novel ideas and insights directly from the data. I think these are two very complementary ways to do science.

By Jean-Paul van Soest and Ali Nick Maleki

KAVLI COLLOQUIUM

Date: November 25, 2021
Location: Kronigzaal, building 58

15.30 hr	Coffee and cake
16.00 hr	Kavli colloquium by Alexander van Oudenaarden: "Novel single-cell sequencing tools to explore cells in space and time"
17.00 hr	Drinks & time to meet

ONLINE VIA ZOOM

https://tudelft.zoom.us/j/96081570790?pwd=UFdydUEvdFhQMEtZUDBWU2VmeXVUZz09

Meeting ID: 960 8157 0790
Passcode: 717139

SELF-INTERVIEW WITH LUKAS SPLITTHOFF - PHD CANDIDATE IN THE KOUWENHOVEN LAB

Lukas Splitthoff is a 3rd year PhD student in the Kouwenhoven lab at QuTech and implements hybrid superconducting-semiconducting nanowires in superconducting circuits.

Hey Lukas, why did you follow up on my request for this self-interview?
Moving myself into the spotlight was not an immediate decision, I went a bit back and forth on the idea of a self-interview. After all, I concluded that as long as I do not hear, somewhat half hallucinating, voices talking to me, a self-interview would be a good way to create awareness with myself. And if someone reads it, they might be inspired, or shocked. Similar to this self-interview, I highly recommend you keeping a diary while trying to be honest to yourself. I could bet that you'll find it extremely hard!

I understand you keep a diary yourself. What was your last diary entry about?
About my summer vacation: Lately, I cycled 2500km equipped with tent and gravel bike to Stockholm and back to see where I could pick up my Nobel prize, when the time comes. But there were also two other goals to this mission. First, I desperately needed some active recreation after being confined to Delft for two years. I promise you, such a tour deliberates your mind, and you'll find inner peace. Second, I wanted to compare a long-distance bike ride with my PhD trajectory. Here is what I learned: (1) Be able to read the good old paper maps, and study them well, since it happens that you must take a sudden detour, or you are off the grid. (2) Even after three days of constant rain, the sun will come back and dry all your soaked clothes.

If you leaf through your memory to the prologue of your PhD, why did you choose to come to Delft?
Well, I thought it was a good idea to return "de fiets van oma" to the Netherlands. And so, I did. I brought the two old Batavus from our garage in Germany to Delft. However, one after the other they fell apart on the bad pavement of some cycle paths. Now, I'm already riding my fourth bike since my arrival in Delft two years ago.

Haha, but all jokes aside! Why Delft?
In previous research internships, I had studied high-harmonic generation in laser induced plasma, high-quality superconducting resonators and Tantalum pentoxide based nanophotonics. When it was time to choose a research group for my PhD, I was about to set out for a personal challenge. I asked myself: Among the previously studied subjects, what do I know least about so far? Eventually, my choice fell on superconductors in conjunction with semiconductors (Delft I, others 0). Then, a new city was needed, I wanted to stay in Europe, and I knew how life in Muenster and Paris was like (Delft II, others 0). Also, rumours said, people in Delft are working hard, they are aiming high and striving for the best. Sounds like a good place to be, I thought (Delft III, others 0).

In your current project you work on hybrid superconducting-semiconducting nanowires. What's so special about them?
It's the interface that makes them special. Bring a slice of a superconductor in proximity to a semiconductor. Then naively think of Cooper pairs penetrating a semiconductor, or reversely excitons in a superconductor. How do they survive? I find is matter of fact super intriguing. To probe the properties of this hybrid system and its response to an external electromagnetic field, we in our research team embed the nanowires in superconducting circuits, which we can read out employing microwave techniques. Down to the present day, we have not fully captured the rich physics encapsulated by these nanowires. But already our current understanding allows us to build novel types of superconducting qubits based on this material platform.

Sounds like you have a good time at QuTech. But would you come to Delft again?
Probably yes. In QuTech, I especially appreciate the collaborative spirit between research groups of the same faculty. Thanks to the great support staff, we can base on a well-organized infrastructure. But there are two things: Food and housing are simply miserable. *Dear Dutch government, please reconnoitre the excellent student restaurants on any German or French campus and be inspired by the affordable and healthy food they have on offer.* Let me even say: I hate the junk food on campus. *Dear Dutch government, please start of an immediate initiative for the construction of more public housing and provide a proper room to every student.* In the meantime, I have a provocative suggestion: Let's found the new QuTech division "quantum housing", that rents out properly furnished apartments to their own students and employees in the spirit of paternalistic company towns.

Last question: What lesson did you learn during your PhD career, that you would like to share with your fellow students?
Sleep well! All my life I had underrated the value of a good night rest driven by peer pressure in our modern society. But only now I understand the bad consequences of sleep-deprivation on my physical and mental well-being. If you are not convinced yet, please read the book "Why we sleep?". For all the others: Sleep well!

Thanks for the interview!
Yeah, it was fun. If you have more questions, then knock on my door.

Other things
After PhD: German Bakery
Why physics: Michelson interferometer 8th grade
Corona activity: rail road system

SURF and QuTech collaborate on quantum technology

QuTech and SURF agreed to collaborate on quantum technology. The collaboration recognises current activities and commits to future activities, like supporting the backend of QuTech's demonstrators with the SURF supercomputer, jointly developing and enabling hybrid quantum computations, developing an orchestrator for quantum networks and partnering in various projects.

Physik-Preis Dresden award for Gijsje Koenderink

On 6 July 2021, the "Physik-Preis Dresden" of TU Dresden and the Max Planck Institute for Physics of Complex Systems (MPI-PKS) was awarded to Professor Gijsje Koenderink from Bionanoscience. Gijsje Koenderink is an outstanding experimental biophysicist with a series of groundbreaking papers on cell mechanics and cellular force generation.

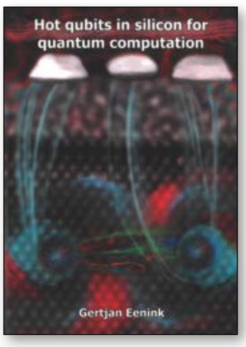
Koenderink's research is of great interest to a number of research groups in Dresden in the fields of polymer physics, soft condensed matter, biophysics and cell biology, especially within the Cluster of Excellence "Physics of Life". Physik-Preis Dresden has been established with a prize money of EUR 5.000.

NEW EMPLOYEES

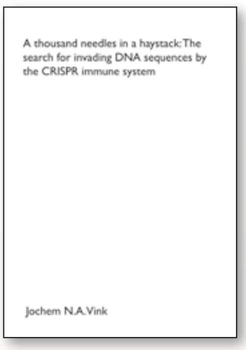
Name	Date of employment	Title	Lab
Antonio Manesco Rigotti	01-07-2021	Postdoc	Quantum Tinkerer
Mert Bozkurt	01-08-2021	Postdoc	Wimmer group
Mert Bozkurt	01-08-2021	Postdoc	Quantum Tinkerer
Jelger Esser	01-08-2021	Technician	Brouns Lab
Catalina IJspeert	15-08-2021	Researcher	Dogterom Lab
Isidora Araya Day	01-09-2021	PhD	Wimmer group
Siddhart Singh	01-09-2021	PhD	Andersen lab
Vicky Tubio Dominguez	01-09-2021	PhD	Borregaard Group
Bethany Davies	01-09-2021	PhD	Wehner group
Ravisankar Ashok Kumar Vattekkat	01-09-2021	Phd	Wehner group
Gaia Da Prato	01-09-2021	PhD	Groeblacher Lab
Koen Bastiaans	01-09-2021	Postdoc	Otte Lab
Hester Vennema	01-09-2021	PhD	Otte Lab
Isadora Araya Day	01-09-2021	PhD	Anton Akhmerov
Talieh Sadat Ghiasi	01-09-2021	Postdoc	Van der Zant lab
Agathe Henocq	01-09-2021	PhD	Dogterom Lab
Hidde Offerhaus	01-09-2021	PhD	Dogterom Lab
Lucas Stehouwer	15-09-2021	PhD	Scappucci lab
Corentin Déprez	15-09-2021	PD	Veldhorst Lab
Maxim De Smet	15-09-2021	PhD	Vandersypen Lab
Robin Dekker	15-09-2021	PhD	Gary Steele
Evert Stolte	15-09-2021	PhD	Otte Lab
Moritz Lukas Konstantin Engelhardt	15-09-2021	PhD	Grußmayer Lab
Andreea Stan	15-09-2021	PhD	Danelon Lab
Aswin Muralidharan	15-09-2021	Postdoc	Brouns Lab
Santiago Valles Sanclemente	01-10-2021	PhD	Di Carlo Lab
Aishwarya Gunaputi Sreenivasulu	01-10-2021	Research assistant	Sebastiano Lab
Mariagrazia Iuliano	01-10-2021	PhD	Hanson Lab
Christopher Waas	01-10-2021	PhD	Hanson Lab
Taryn Stefanski	01-10-2021	Guest PhD	Andersen lab
Vinicius Fonseca Hernandes	01-10-2021	PhD	Eliska Greplova
Daan van der Berg	01-10-2021	PhD	Brouns Lab
Selina Teurlings	01-10-2021	Technician	Meyer Lab
Valentin John	15-10-2021	PhD	Veldhorst Lab
Alejandro Rodriguez-Pardo Montblanch	15-10-2021	Postdoc	Hanson Lab
Justas Ritmejeris	15-10-2021	PhD	Cees Dekker Lab
Sean van der Meer	01-11-2021	PhD	Di Carlo Lab
Brennan Undseth	01-11-2021	PhD	Vandersypen Lab
Praneetha Sannidhanam	01-11-2021	Research assistant	Sebastiano Lab
lennart de Jong	01-11-2021	Research assistant	Sebastiano Lab
Benjamin van Ommen	01-11-2021	PhD	Taminiau Lab
Figen Yilmaz	01-11-2021	PhD	Andersen lab
Eva Bertosin	01-11-2021	Postdoc	Cees Dekker Lab
Nynke Hettema	01-11-2021	PhD	Laan Lab
Marieke Glazenburg	15-11-2021	PhD	Laan Lab
Ian Nova	01-01-2022	Postdoc	Cees Dekker Lab
Carlos de Lannoy	01-01-2022	Postdoc	Joo Lab
Ran Huo	15-01-2022	PhD	Grußmayer Lab
Moon Hyeok Choi	01-03-2022	PhD	Joo Lab

NEWS

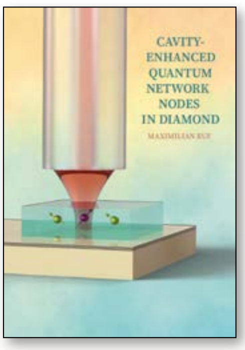
RECENT PHD THESES



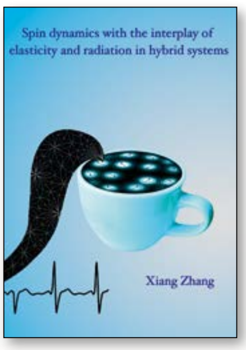
Gertjan Eenink
09 September 2021



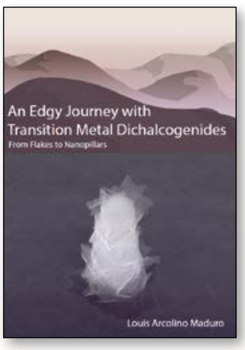
Jochem Vink
20 September 2021



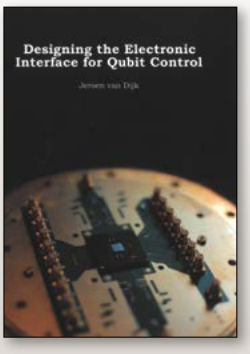
Maximilian Ruf
21 September 2021



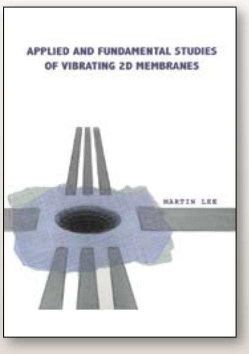
Xiang Zhang
27 September 2021



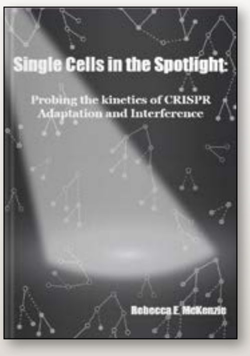
Louis Arcolino Maduro
30 September 2021



Jeroen van Dijk
5 October 2021



Martin Lee
6 October 2021



Rebecca McKenzie
15 October 2021

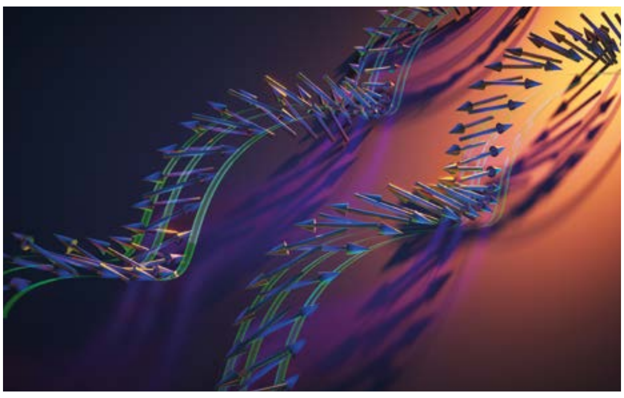
Hirad Daneshpour Aryadi
29 October 2021

NEWS

Untappable quantum cryptography becomes practical with MDI-QKD

Engineers from QuTech can provide untappable communication that is cost-scaling to many users by using measurement-device independent (MDI) quantum key distribution (QKD). A notable side-feature is that, courtesy of Cisco, conventional internet operates in parallel, on the same optical fibre from Dutch telecom provider KPN. MDI-QKD is an important step towards an accessible quantum internet.

Kick-starting supersonic waves in antiferromagnets



A team of researchers led by the Caviglia Lab has demonstrated a new technique to generate magnetic waves in antiferromagnets that propagate through the material at a speed much larger than the speed of sound. These so-called spin waves produce a lot less heat than conventional electric currents, making them promising candidates for future electronic devices with significantly reduced power consumption.
https://www.tudelft.nl/en/2021/tnw/kick-starting-supersonic-waves-in-antiferromagnets

Mohamed Abobeih receives Rubicon grant for quantum computing research at Harvard

NWO announced that QuTech's Mohamed Abobeih will receive a Rubicon grant. The Rubicon programme gives young, highly promising researchers the opportunity to gain international research experience.

Quantum computers are prone to errors because their building blocks, qubits, are extremely fragile. Mohamed Abobeih will go to Harvard to realize fault-tolerant qubits using programmable arrays of trapped atoms. The key idea to overcome errors is to encode quantum states in multiple entangled qubits forming an error-corrected logical qubit with topological protection.

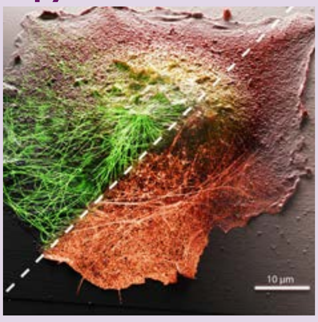
Abobeih: "Demonstrating a fault-tolerant logical qubit is a major challenge towards building large-scale quantum computers. During my PhD at QuTech I have extensively studied fault-tolerance using spin qubits in diamond. Now I would like to extend this research line into a different promising experimental platform (which comes with a different set of challenges and opportunities) in order to demonstrate such a fault-tolerant logical qubit."

Two Casimir scholarships!

Isidora Araya Day and Lucas Stehouwer have been granted a Casimir PhD scholarship. That means 4 years of funding for a PhD position, that they will both fulfill at QuTech, in the quantumtinkerer group (M. Wimmer and A. Akhmerov) and the group of G. Scappucci, respectively.

The Casimir Research School is a joint research school (Delft & Leiden) in physics and brings together over 270 PhD students, 130 postdocs and 100 faculty members. It has a yearly internal competition where aspiring PhD students can submit research proposals. Ultimately five proposals are granted.

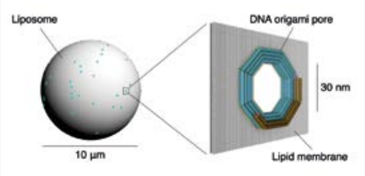
Correlative 3D microscopy of single cells using super-resolution and scanning ion-conductance microscopy



High-resolution live-cell imaging is necessary to study complex biological phenomena. Here, we combine 2D & 3D molecule-specific super-resolution optical fluctuation imaging with a complementary, label-free technique to put the fluorescence information into the cellular context. We use scanning ion-conductance microscopy (SICM) as a non-contact approach for high axial resolution topographical imaging of soft biological samples. Both techniques chosen for our correlative imaging are well suited for live-cell imaging.

V. Navikas, S.M. Leitao, K.S. Grussmayer, A. Descloux, B. Drake, K. Yserentant, P. Werther, D.P. Herten, R. Wombacher, A. Radenovic, G.E. Fantner
Nature Communications: 4565 (2021)

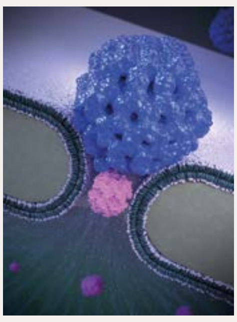
Reconstitution of ultrawide DNA origami pores in liposomes for transmembrane transport of macromolecules



Molecular transmembrane traffic is a vital cellular process that involves specialized biological pores with diameters from sub-nanometer to >30 nm. Creating artificial membrane pores with similar size and complexity will aid the understanding of transmembrane molecular transport in cells, while artificial pores are also a necessary ingredient for synthetic cells. Here, we engineer and reconstitute 30nm-wide DNA origami nanopores into the membrane of giant liposomes by using an inverted-emulsion (cDICE) technique. We show that our origami structures are size-selective as molecules with diameters up to 28 nm can enter the vesicle through the pores, while larger molecules are excluded.

A. Fragasso, N. De Franceschi, P. Stömmer, H. Dietz, C. Dekker
ACS Nano 15, 8, 12768–12779 (2021)

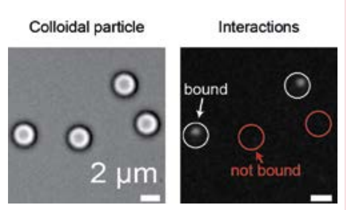
Nanopore electro-osmotic trap for the label-free study of single proteins and their conformations



Researchers from the technical universities of Delft and Munich have invented a new type of molecular trap that can hold a single protein in place for hours to study its natural behavior – a million times longer than before. The new NEOtrap technique enables scientists to use electrical currents to study the vibrant nature of proteins, which may spark innovation in biomedicine, biotechnology, and more.

S. Schmid, P. Stömmer, H.Dietz. C. Dekker
Nature Nanotechnology (2021), online 30 August 2021

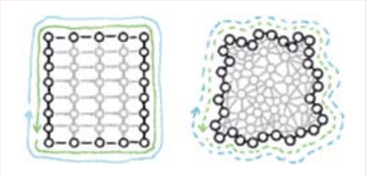
Direct visualization of superselective colloid-surface binding mediated by multivalent interactions



Biological systems often form bonds that consist of tens or hundreds of weak interactions. A characteristic property of these multivalent interactions is superselectivity: distinguishing between surfaces based on the receptor density. We studied this phenomenon using colloidal particles and DNA to mimic the interactions.

C. Linne, D. Visco, S. Angioletti-Uberti, L. Laan, D. J. Kraft
Proc Natl Acad Sci, 118: (36) e2106036118
https://doi.org/10.1073/pnas.2106036118

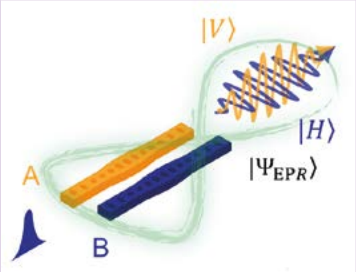
Amorphous topological phases protected by continuous rotation symmetry



Crystals have spatial symmetries: mirror, rotation and translation. These real-space symmetries shape the electronic band structure of the material. Symmetries are particularly important for topological insulators, because they are required to ensure the protection of the edge conduction. Amorphous materials on the other hand, do not have any spatial symmetries. At the same time they have an average continuous rotation symmetry impossible in a crystal. We utilise this average rotation symmetry in amorphous materials to design a topological material protected by its amorphousness.

H. Spring, A.R. Akhmerov, D. Varjas
SciPost Phys. 11, 022 (2021)

TU Delft researchers realize quantum teleportation onto mechanical motion of silicon beams

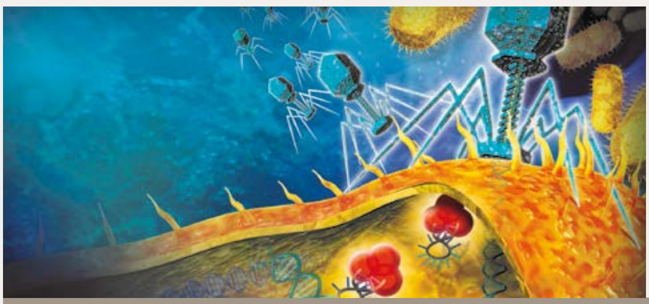


We experimentally demonstrate the ability to teleport an arbitrary qubit state from a single photon onto an optomechanical device – consisting of a mechanical structure comprising billions of atoms. This enables real-world applications such as quantum internet repeater nodes while also allowing to study the classical to quantum transition.

N. Fiaschi, B. Hensen, A. Wallucks, R. Benevides, J. Li, T.P. M. Alegre, and S. Gröblacher, *Optomechanical quantum teleportation*, Nature Photon. (2021)
https://www.nature.com/articles/s41566-021-00866-z

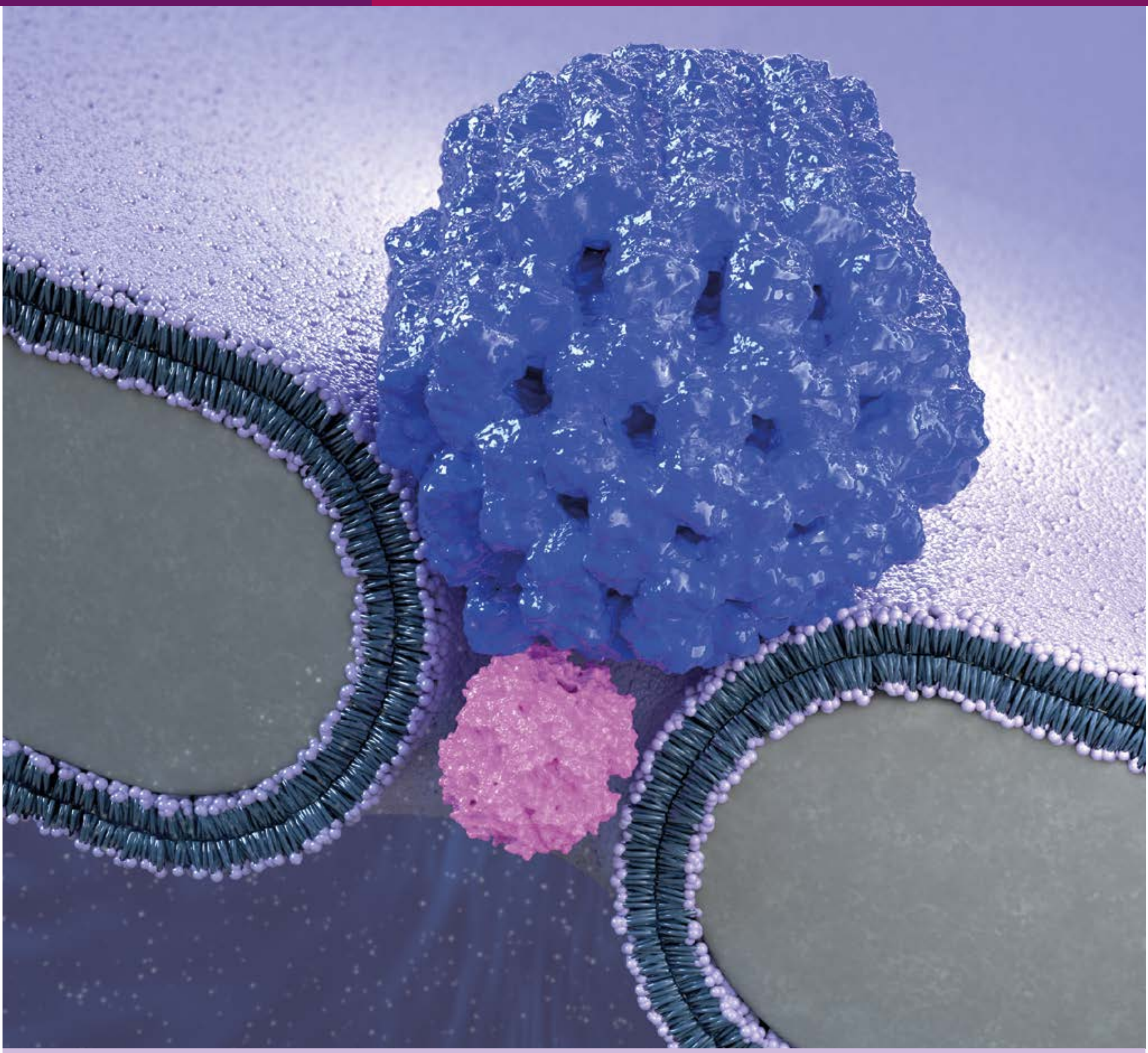
The gRAMP CRISPR-Cas effector is an RNA endonuclease complexed with a caspase-like peptidase

Many prokaryotes use CRISPR RNA–bound proteins to sense viral RNA instead of DNA to set an immune response in motion that protects from virus infection. Although these ribonucleoproteins are typically composed of many protein subunits, van Beljouw et al. discovered that CRISPR-Cas type III-E systems are formed by a large, single-component effector protein capable of double RNA cleavage. Distinct from other systems, this effector forms a complex with a peptidase from the caspase family, raising the intriguing possibility that viral RNA activates a protease activity to prevent virus propagation by host suicide.



S.P.B. van Beljouw, A.C. Haagsma, A. Rodriguez-Molina, D.F. van den Berg, J.N.A. Vink, S.J.J. Brouns
Science, 17 Sep 2021, Vol 373, Issue 6561, pp. 1349-1353

SCIENCE ART



Artist impression of the Nanopore Electro-Osmotic trap (NEOtrap), a new single-molecule method where a DNA-origami sphere docked onto a solid-state nanopore is used to create a trap for single unmodified proteins, enabling conformation-sensitive recordings up to hours. This research was published in Nature Nanotechnology, online 30 August 2021, doi: 10.1038/s41565-021-00958-5
Credit: Cees Dekker Lab / SciXel

UPCOMING KAVLI COLLOQUIUM

Alexander van Oudenaarden

November 25, 2021

Hubrecht Institute

COLOFON

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