KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft

No.26
November 2019

Photo: Bram Saeys

IN THIS ISSUE:

Interview with Spinoza Prize winner Ronald Hanson

With a festive ceremony, the Spinoza Prize was awarded to Prof. dr. ir. Ronald Hanson on Wednesday the 2nd of October. The Spinoza Prize is the highest scientific award in the Netherlands, and is granted to researchers for their outstanding, pioneering and inspiring work. Ronald Hanson was one of four researchers who received the Spinoza Prize in 2019.

Ronald Hanson (1976) obtained his MSc in Applied Physics at the University of Groningen in 1999 and his PhD at TU Delft in 2005 in the field of quantum technology. Since then, he has played an pivotal role in boosting the field of quantum science and enabled the TU Delft to become one of the key players in this field worldwide. Hanson is a pioneer in the area of entangled electrons and a global leader in quantum networks based on entanglement. In his relatively short career so far, Hanson has already received several prestigious prizes, such as the Ammodo KNAW Award and the Huibregtsen Award for Excellence in Science and Society. He was also the youngest laureate to receive the John Stewart Bell prize, and in 2019, he was elected a member of the Royal Netherlands Academy of Arts and Sciences.

Ronald Hanson is one of the founding members of QuTech, a collaboration between TU Delft and TNO aimed at exploring future applications of quantum science, and currently its Scientific Director.

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FROM THE DIRECTORS

A major highlight in this newsletter is the interview with Ronald Hanson on this page. Ronald recently received the Spinoza prize, the most prestigious science prize in the Netherlands (see this page). Harold Hwang, a true pioneer in quantum materials and a highly inspiring speaker, will give the Kavli colloquium on November 14, 2019. Read the interview on page 3. Several Kavli scientists received prestigious grants, including an ERC Starting Grant for Tim Taminiau, Menno Veldhorst and Arjen Jakobi. Last but not least, we are very excited to welcome a new faculty member in our Kavli Institute, Gijsje Koenderink. Get to know Gijsje through her self-interview on page 8. And don't miss the two thought provoking columns, an account of life of a PhD candidate in Kavli (on page 10) and the many publications, events and additional grants and awards.

Lieven Vandersypen

COLUMN

Sharing with the world

One of the books I had the pleasure of reading this summer was *Nobel Streven* by Utrecht history professor and Spinoza laureate Frits van Oostrom. The book is a biography of the colorful but little-known lord-turned monk-turned mercenary Jan van Brederode. Van Oostrom has approached his topic as a scientist, and the book reads like a well researched (and also very well-written) paper. Although the topic was not 'new' to historians, Van Oostrom managed to bring significant new insights. He's not boasting about those, but rather admits failure on behalf of the entire field, because they didn't do something very obvious: look up the relevant archives both in the Hague (the administrative center of Holland, where Jan van Brederode was a lord) and in Brussels (the capital of Brabant where he was a monk).

One particularly striking find was a declaration of travel expenses. This document allowed Van Oostrom to trace Jan's steps quite precisely for a year in which he was previously thought to have stayed in a single place. Van Oostrom is not afraid to admit that more such documents might exist, but instead is actively looking for them, even though they'd force him to change his interpretation of events further.

What struck me most in the story though was something that happened later in Jan's life. He had become a monk not (primarily) out of piety, but to escape his creditors, chief among them his father-in-law. When that father-in-law died five years later, Jan couldn't wait to drop the habit and resume his secular life, hoping to claim the rather substantial inheritance. Naturally that led to court cases (there were other would-be heirs). Neither the count nor the bishop saw a way out, and they decided to put the case to the authority they both trusted. That wasn't the emperor or the pope; it was the university of Paris. It's Eppo Bruins' ideal come true, with a vengeance.

History partially repeated itself a century later when English king Henry VIII (the one with the six wives) consulted the Paris university on his plans for divorce. However, when the university told him that he couldn't legally do that, Henry showed his Trumpish side and simply ignored the advice. In some sense, we've never recovered. Scientists have been co-opted by governments to build bombs or rewrite history, but universities have not held the position of ultimate authority for seven hundred years.

That may change though. Not thanks to us. It's thanks to the climate activists who point out that to save the planet, politicians should listen to science. That gives us scientists a great responsibility: to make sure that science is heard, and that the voice of science is truly scientific. As individual scientists or as a collective we may be wrong or miss something obvious, but like the biography of Van Oostrom, what we investigate is real. It is our job not just to figure out what that reality is, but also to share it with the world, in just the way this historian has done.

Timon Idema

INTERVIEW

Interview with Prof. Harold Y. Hwang

Q: What initially drove you to pick the topic of your PhD research and pursue it? And during those early years, did you meet an influential scientific mentor?

A: As a young student, I was rather naïve and broadly interested in many things. While an undergraduate at MIT, I changed my major quite a few times – starting out in political science and economics, then biology, and eventually electrical engineering and physics. I cannot claim there was a coherent evolution in my thinking, but key for me was my first exposure to scientific research. This was in the laboratory of Prof. Joel Goodman, at the University of Texas Southwestern Medical Center, where I spent three summers. Although his science, in cell and molecular biology, is quite different from what I do now, he introduced me to the joy and freedom of research – how to formulate clear questions and try to experimentally answer them. He has been a fantastic mentor for me. Approaching graduate school, I gravitated to what I do now, materials physics. This is largely because it has an interesting mix of both analyzing interesting problems – many questions on how interacting electron systems behave, as well as a synthetic degree of freedom – to design and potentially discover new phenomena.

Q: During your globetrotter's research carrier, from Bell Labs to Stanford, via Tokyo University, how would you summarize what has been the common thread of your research so far?

A: I have been very fortunate as you say to travel the world while enjoying my work. The Dutch people seem to intrinsically understand how valuable it is, both professionally and personally, to see and experience different cultures and perspectives. Certainly I am a big believer that such experiences can help you to be more creative in research. All of the places I have worked are characterized by institutional commitment to, and excellence in, the interdisciplinary arena mixing physics and materials science, fundamental studies and applications. This is the type of work we like to do. We also like the back and forth of developing new methods to atomically control materials and therefore study them, as well as using these methods to create new artificial systems and structures.

Q: Which 'Eureka' moment in your career was a particularly memorable, important one?

A: This may be a boring answer, but I can't really isolate a single moment that was so unique. Breakthroughs come rarely, so it is difficult to rely on them! Rather, I like the daily pace of looking at new data, and trying to add to a fuzzy picture of what is going on – similar to the joys and frustrations of working on a complex puzzle.

Q: Which would you say is currently the topic of research you're the most excited about in your group?

A: A theme we have been working on lately is the incorporation of 'soft chemistry' techniques in our research. We have traditionally been using high temperature, ultra-high vacuum growth techniques to synthesize thin films and heterostructures of oxide quantum materials. However, there is a parallel world developed by creative chemists over the years, allowing for low temperature chemical reactions that can be used to create and stabilize new materials and structures that were not previously possible. We are finding that the combination of these approaches is a very rich playground that is only beginning to be explored. For example, we can now create freestanding oxide nanomembranes that are nanometers thick and millimeters wide, which can be stretched and poked to give interesting nanoelectromechanical response. We have recently discovered superconductivity in a new layered nickelate, which is interesting in part because it shares key similarities and dif-

KAVLI COLLOQUIUM

"Soft Chemistry Approaches to Two-Dimensional Oxide Quantum Materials"

Harold Y. Hwang

Stanford University

November 14, 2019 will feature a Kavli colloquium by Harold Y. Hwang:

Complex oxides are fascinating systems which host a vast array of unique phenomena, such as high temperature (and unconventional) superconductivity, 'colossal' magnetoresistance, all forms of magnetism and ferroelectricity, as well as (quantum) phase transitions and couplings between these states. Thin film growth techniques have now developed to the level of controlling oxide heterostructures with atomic precision, enabling the epitaxial integration of these phases, as well as new emergent phenomena at their interfaces. Recently, we have been incorporating soft chemistry techniques to further manipulate such heterostructures in previously inaccessible ways. First, we present a general method to create freestanding complex oxide membranes and heterostructures with millimeter-scale lateral dimensions and nanometer-scale thickness. This unusual geometry enables the stabilization of extreme strain states, which can be used to drive a wide range of phase transitions. Second, we show how topotactic reactions can be used to synthesize superconducting infinite layer nickelates. This newly discovered system is of particular interest due to its close relationship with the cuprate superconductors.

15.00 hr	Pre-programme: Introduction of a new faculty member Gijsje Koenderink
15.30 hr	Break
16.00 hr	Kavli colloquium by Harold Y. Hwang: "Soft Chemistry Approaches to Two-Dimensional Oxide Quantum Materials"
17.00 hr	Drinks & time to meet

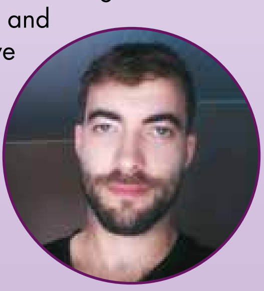
KAVLI COLLOQUIUM

Date: November 14, 2019
Location: Aula, Lectureroom D

ferences from the famous cuprate superconductors. Both of these examples combine thin films and soft chemistry approaches, and will be the subject of my talk.

Q: Do you have a fundamental question you'd personally like to answer/tackle in the future?

A: I think in general we are revisiting the longstanding notion of 'materials by design'. This is not a new concept, but one that has been cyclically discussed over the decades, both in terms of theory and experiment. As our community gets ever more sophisticated in the ability to create materials controlled on the atomic scale, it again raises the question whether complex emergent phenomena, such as superconductivity or magnetism, can be predictively designed. This is not entirely a good thing for me, as I rather like the path of using intuition and serendipity to find new materials and properties. On the other hand, we seem close to the opportunity to fundamentally change the way we develop new complex materials and devices, which is quite exciting.



Edouard Lesne

Congratulations to Menno Veldhorst and Giordano Scappucci for receiving tenure

QuTech congratulates its two PI's Menno Veldhorst and Giordano Scappucci for receiving tenure per 1 October. Based on their excellent performance at QuTech and supported by the positive advice from the Kavli career committee, the Directors Team of QuTech offered them a permanent contract and promotion to Group Leader. We wish them and their groups lots of success.

Kavli Delft Thesis Prize 2019

On the Kavli Day, the 2019 Kavli Delft thesis prize was awarded to Afshin Vahid Berlarghou for his thesis "Assembly of Membrane-deforming Objects in Tubular and Vesicular Membranes". Afshin's thesis, which he defended cum laude in October 2018 was of exceptional quality, both in terms of productivity and quality.

The Kavli Delft thesis prize is for the best PhD thesis written by a graduate student at our Kavli Institute of Nanoscience at Delft in the previous two years.

NWO ORC Grant for Toeno van der Sar

Quantum microscopy: A new tool for future technologies

Quantum technology has the potential to transform global industries and markets. This revolution requires the ability to image how electrons behave in quantum systems. Collaborating with industry, we will develop a 'quantum microscope' that uses diamond sensors to image electrons with nanometer resolution, from near absolute-zero to above room temperature.
Participating institutions: TNO Delft, Leiden University, QuTech, Applied Nanolayers BV, Leiden Spin Imaging BV

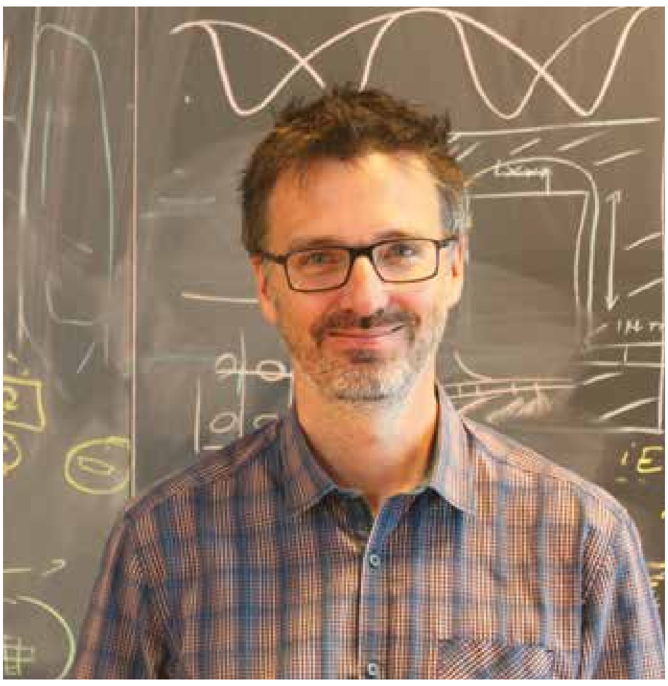
Veni grant for Paola De Magistris

The Dutch Research Council (NWO) has awarded a Veni grant worth up to 250,000 euros to twelve highly promising young scientists from TU Delft including our colleague Paola de Magistris. The grant provides the laureates with the opportunity to further elaborate their own ideas during a period of three years. Paola De Magistris (Cees Dekker Lab) will set up the first minimal system of mRNA export through biomimetic nuclear pore complexes (NPCs).

NEW EMPLOYEES

Name	Date of employment	Title	Lab
Ashmiani van den Berg	01-06-19	Technician	Marileen Dogterom lab/Cees Dekker lab
Nikos Papadopoulos	01-06-19	Postdoc	Goswami lab
Grzegorz Mazur	01-07-19	Postdoc	Kouwenhoven lab
Kostas Viskelis	01-08-19	PhD	Wimmer/Akhmerov lab
Sung Hyun Kim	01-10-19	Postdoc	Chirlmin Joo lab
Jie, Li	15-08-19	Postdoc	Groeblacher lab
Kasper Spoelstra	23-08-19	PhD	Dimphna Meijer lab
Matteo Pasini	26-08-19	PhD	Hanson lab
Esther Bruining-Fransen	01-09-19	Management Assistent	Bionanoscience
Tom Dvir	01-09-19	Postdoc	Kouwenhoven lab
Blah, Patrick	01-09-19	PhD	Caviglia lab
Mattias Matthiessen	01-09-19	PhD	Caviglia lab
Niccolo Fiashi	01-09-19	PhD	Groeblacher lab
Gijsje Koenderink	01-09-19	Professor	Bionanoscience
Celine Alkemade	01-09-19	PhD	Gijsje Koenderink lab/Marileen Dogterom lab
Lennard van Buren	01-09-19	PhD	Gijsje Koenderink lab
Lucia Baldauf	01-09-19	PhD	Gijsje Koenderink lab
Christina Martinez Torres	01-09-19	PhD	Gijsje Koenderink lab
Gerard Castro Linares	01-09-19	PhD	Gijsje Koenderink lab
Jeffrey de Haan	01-09-19	PhD	Gijsje Koenderink lab
Lukas Splitthoff	09-09-19	PhD	Kouwenhoven lab
Bouwmeester, Damian	15-09-19	PhD	Van der Zant lab
Milos Tisma	16-09-19	PhD	Cees Dekker lab
Ivan Kulesh	16-09-19	PhD	Goswami lab
Ramon Overwater	23-09-19	PhD	Charbon lab
Pinyao He	01-10-19	PhD	Cees Dekker lab
Daniel Ramirez	01-10-19	PhD	Nynke Dekker lab
Lukas Grunhaupt	15-10-19	Postdoc	Kouwenhoven lab
Ana Marie Restrepo Sierra	15-10-19	PhD	Christophe Danelon lab
Alessia Di Maggio	15-10-19	Technician	Chirlmin Joo lab
Irene Isturiz	15-10-19	PhD	Gijsje Koenderink lab
Christian Prosko	01-11-19	PhD	Kouwenhoven lab
Sabrina Meindlhumer	01-11-19	PhD	Cees Dekker lab
Martin Holub	15-11-19	PhD	Cees Dekker lab
Medina Bandic	16-11-19	PhD	Grazia Almudever lab
Marcel Meyver	16-11-19	PhD	Veldhorst lab

Teacher of the Year Gary Steele learns from his own lectures

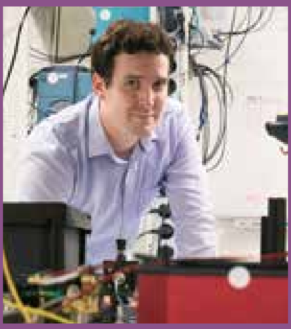


His infectious enthusiasm, clarity and good examples are just a few of the reasons for his election as TNW's Teacher of the Year (TN/AP). Gary Steele is pleasantly surprised. "This is great feedback. It is important to know how students experience their education, so that you can make the lectures better and better."

4 ERC Grants awarded to our Institute

Four Kavli researchers have been awarded an ERC Grant.

ERC Starting grant for **Arjen Jakobi**



ERC Starting grant for **Tim Taminiau**

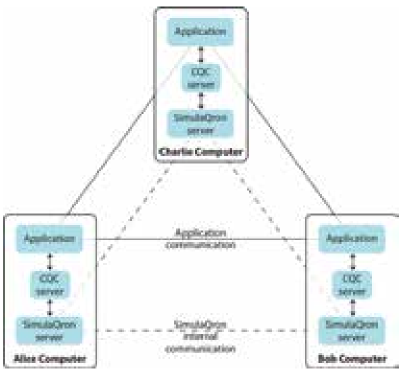
ERC Proof of concept for **Andrea Caviglia**

ERC Starting grant for **Menno Veldhorst**

Open source software

SimulaQron - a simulator for developing quantum internet software

SimulaQron is an open-source quantum internet simulator intended to be used for software development. The simulator can be run on one or more classical computers, connected in the background to simulate the effect of entanglement between remote processors. Programming SimulaQron is done using an universal interface, which will be compatible with the demo quantum network currently under development in the Netherlands, such that applications developed today can be run on a real network in the near future with minimal modification.

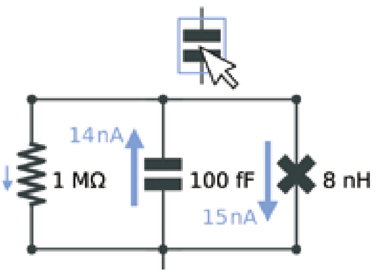


A. Dahlberg and S. Wehner
URL: http://www.simulaqron.org

QuCAT

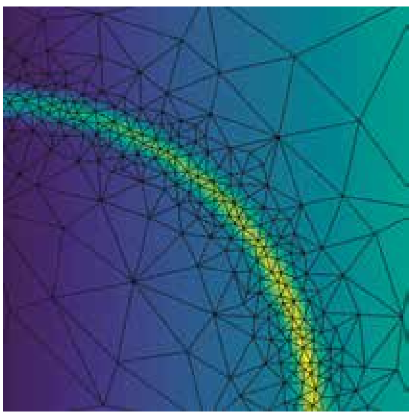
Electrical circuits which behave in a quantum mechanical way are key to many experiments, notably for quantum computing. We have developped a tool to help in their design: after drawing a circuit with mouse and keyboard, the software automatically generates the corresponding Hamiltonian.

M.F. Gely, G.A. Steele
URL: QuCAT.org



Adaptive

Adaptive is an open-source Python library designed to make adaptive parallel function evaluation simple. You supply a function with its bounds and it will be evaluated at the optimal points in parameter space by analyzing existing data and planning ahead on the fly. With just a few lines of code, you can evaluate functions on a computing cluster, live-plot the data as it returns, and benefit from a significant speedup.



B. Nijholt, J. Weston, J. Hoofwijk, and A. Akhmerov
URL: https://adaptive.readthedocs.io

INTERVIEW WITH RONALD HANSON

› Continued from page 1

Can you briefly describe the focus of your research?

"My research centres around the quantum phenomenon of entanglement, in which two entangled particles in a sense behave as one, even when separated by a large distance. This entanglement is a crucial ingredient for the working of a future quantum internet and quantum computers. "

With his group, Ronald Hanson has conducted several important experiments that have brought a quantum internet a step closer. He has demonstrated how fragile electronic quantum states can be retained for a long period, discovered how individual spins of electrons or atomic nuclei can be controlled, and has developed a new set of tools to control quantum particles in solids. In 2014 his team teleported information from chip to another. In a ground breaking and sensational experiment in 2015, he was able to entangle particles over more than a kilometre apart.

In a more recent experiment in 2018 Ronald Hanson and his group have been able to realize quantum entanglement 'on demand', generating the entanglement faster than the entanglement is lost. This is an key prerequisite for realizing multi-node quantum networks.

What is the most fascinating about this research?

"A physical phenomenon becomes tangible when you see it happen with your own eyes. And the unique thing about the current times is that we can actually fully control the effects of quantum physics. For a long time, we were limited to passive observation of the consequences of the laws of quantum, but now we are able to actively determine what happens, and use the principles of quantum mechanics to make actual devices. This means that not only can we perform fundamental experiments that were not previously possible, but we can also explore practical applications."

What are the next frontiers to tackle in your research?

"My ambition is to realise the world's first quantum internet based on entanglement, by linking small quantum processors in a quantum network. The first fundamental frontier is to realize a quantum connection between multiple nodes. All experiments thus far have been limited to two entangled nodes. The challenge is that on the one hand we need to get in and make the quantum particles do what we want, while on the other hand they need to be isolated well from the environment to maintain the desired "quantumness". To meet this challenge we need to understand exactly what happens at the quantum level. A more applied frontier lies in taking the networks out of the lab into the "real world". To enable this we are collaborating with industrial partners like KPN. The first big step that we are now working on is to create a quantum link between Delft and The Hague."

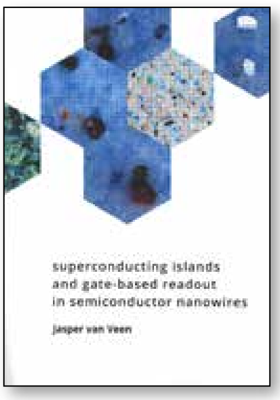
The Spinoza prize is 2.5 ME to be used for scientific research and activities to utilize this knowledge. Do you already know what you will use the money for?

"I have no concrete plans yet, but I do have a number of ideas. Of course, I will use a large part of the prize to continue research on quantum phenomena as well as on the development of quantum networks. Furthermore, I would like to reserve part of the prize for societal issues in science. For instance, the number of women that study physics, not to mention continue with a PhD or further an academic carrier, is still very limited. When I heard that I had won the prize, I launched a challenge within QuTech to come up with good ideas for projects to tackle these and other issues in science. I have received many good ideas, and will soon follow up on the most promising ones!"

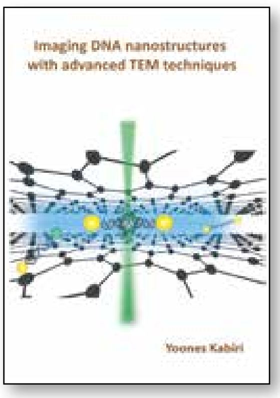
Ingrid Romijn

RECENT PHD THESES

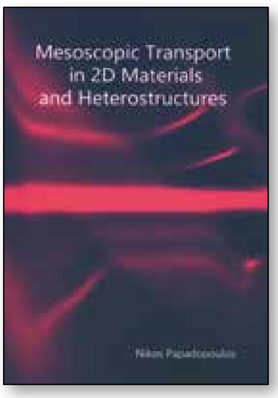
Jonas Helsen
05 June 2019



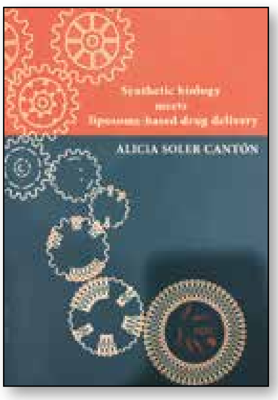
Jasper van Veen
06 June 2019



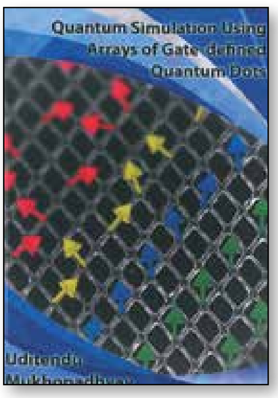
Yoones Kabiri
25 June 2019



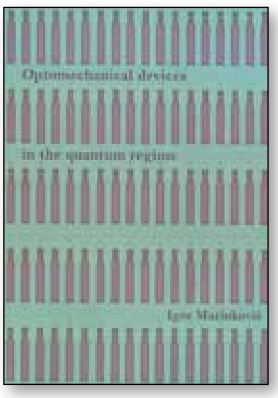
Nikos Papadopoulos
15 July 2019



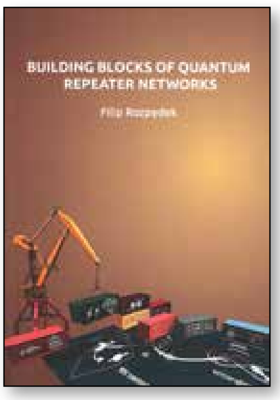
Alica Soler Cantón
07 October 2019



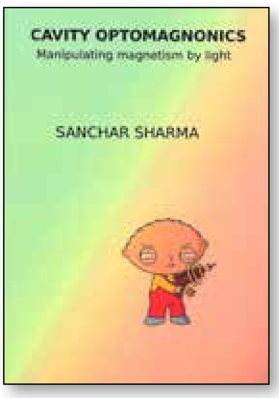
Uditendu Mukhopadhyay
03 October 2019



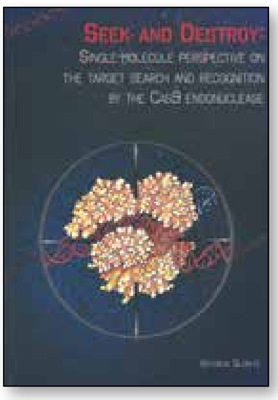
Igor Marinković
14 June 2019



Filip Rozpędek
19 June 2019



Sanchar Sharma
12 September 2019



Viktorija Globyte
26 September 2019


KAVLI DAY 2019
UNGY BU
Welkom
TU Delft
KAVLi
Dag

SELF-INTERVIEW GIJSJE KOENDERINK

What brought you here?

"Why did you decide to move?" This was the foremost question that my colleagues and friends asked me during the past months. Understandably, since I have had a fantastic time at the NWO Institute AMOLF during the 13 years since I started my lab there. And as psychologists tell us, moving is rated one of the most stress-full experiences in life. Nevertheless, I took the plunge in September. The main driver for me was that I always strive to keep growing and my experience is that growth only occurs when I challenge myself to step out of my comfort zone. Over the years at AMOLF, I have had the pleasure to take on many exciting new challenges. However, with one's own growth, the comfort zone expands as well. Now felt like the right moment to seek out a new challenge in a new environment. There were many additional arguments, of course: the Bionanoscience Department offers a scientifically highly stimulating environment, great infrastructure, and many tantalizing opportunities for new cross-disciplinary collaborations within the TU Delft and with the nearby Erasmus and Leiden Universities. I was fortunate that my entire team (Jeffrey, Lennard, Lucia, Cristina, Gerard, Celine and Federica) dared to take the plunge with me.

What are your research plans within BN?

My research revolves around the material properties of living matter. Night and day, our cells and tissues are assaulted by large mechanical forces due to muscle contraction, blood flow, gravity etc. Fortunately, cells and tissues are able to cope with this stressful world because they are supported by sturdy frameworks of protein filaments. However, living matter has the further challenge to combine mechanical strength with the ability to actively reshape, grow, and repair. Cells and tissues achieve this paradoxical combination of strength and dynamics by combining their filamentous frameworks with molecular motors and biochemical regulation networks. To understand the materials design principles of living matter, our strategy is to combine biochemical techniques to build synthetic cells and tissues with physical measurements of cell and tissue mechanics. Within the ongoing BaSyc Gravitation project led by Marileen Dogterom, my team has taken on the task to build the mechanical machinery of the synthetic cell. I am very excited about the prospects of bringing our fundamental research on living matter closer to biomedical applications such as tissue regeneration in the next years. If you're curious to know more or if you are interested in collaborating, please stop by my office or lab!

What is your first impression of the Kavli Institute of Nanoscience?

Having started only a month ago, I have not had a chance to see much of the Kavli Institute yet, but there is already an exciting colloquium coming up soon and it is clear that the Kavli scientists are without exception passionate about their science.

What goes on in your life outside the lab?

Right now, my life outside the lab is dominated by mundane activities such as unpacking boxes, mounting paintings, buying new furniture, and finding my way in the local supermarket. Last month we also moved as a family, from Utrecht (where I was born, grew up, and studied chemistry) to Ypenburg. My sons Jonas and Berend are attending a new school and new sports and music classes, so now is a period of personal growth for them as well. My husband, kids and I love the outdoors and enjoy activities such as hiking, biking and running, so we look forward to exploring the Delftse Hout and Bieslandse Polder, which are right around the corner from where we live. On rainy days, we enjoy reading, cooking, watching movies, listening music, and playing board games. (Sorry to disappoint, no surprising hobbies to mention here.)

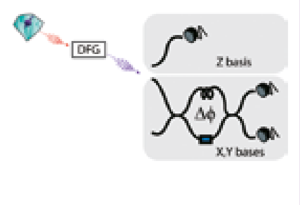
A new class of efficient randomized benchmarking protocols

An important task in quantum computing research is to quantify the reliability of the logical operations, called quantum gates. This task quickly becomes more cumbersome as the number of qubits in the computer grows. Here we develop a new class of protocols which are significantly easier to implement than existing ones.

J. Helsen, X. Xue, L.M.K. Vandersypen, and S. Wehner
npj Quantum Information 5, 71 (2019)

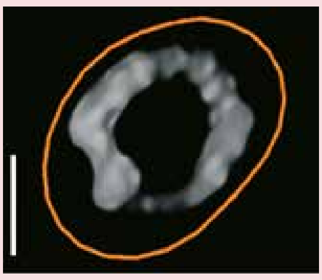
Entanglement between a Diamond Spin Qubit and a Photonic Time-Bin Qubit at Telecom Wavelength

In this research we demonstrated entanglement between a nitrogen-vacancy electron-spin in diamond and an emitted photon that has been converted to the telecom regime (1588 nm) using difference frequency generation (DFG). This is an essential step for long-distance fibre based quantum networks.



A. Tchebotareva, S.L.N. Hermans, P.C. Humphreys, D. Voigt, P.J. Harmsma, L. K. Cheng, A.L. Verlaan, N. Dijkhuizen, W. de Jong, A. Dréau, R. Hanson
PHYSICAL REVIEW LETTERS 123, 063601 (2019)

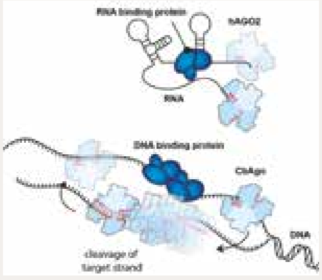
Direct imaging of the circular chromosome in a live bacterium.



The chromosome in bacteria is highly compacted under the influence of condensing proteins, DNA supercoiling, and the cell-wall confinement. Understanding how chromosomes are organised is essential for understanding genetic regulation and cellular physiology. In this paper, we visualize, for the first time, the circular chromosome of a bacterium in its native circular shape. We manage to achieve it by slightly widening a live *E. coli* cell while keeping only one genome copy – which allows to study a single chromosome in a live cell. In doing so, we discover that the bacterial chromosome is organized into a ring-like torus topology that, unexpectedly, is highly dynamic, undergoing major dynamic rearrangements at a minute timescale. In our paper, we discuss the nature and underlying drivers of the bacterial genome organisation.

Wu Fabai, Japaridze Aleksandre, Zheng Xuan, Wiktor Jakub, Kerssemakers Jacob W.J., Dekker Cees
Nature Communications. vol. 10, 1–9 (2019)

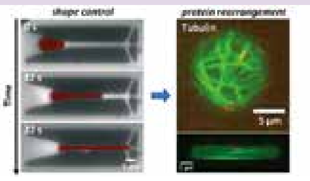
Argonaute bypasses cellular obstacles without hindrance during target search



Argonaute protein is important for cellular development in eukaryotes and host defence in prokaryotes. It scans long stretches of DNA/RNA sequences to find target sites. Using single molecule FRET and kinetic modelling, the authors showed that Argonaute binds DNA loosely and slides along the DNA during target search.

T. J. Cui, M. Klein, J. W. Hegge, S. D. Chandradoss, J. van der Oost, M. Depken, C. Joo Nature Communications, in press

Shape and Size Control of Artificial Cells for Bottom-Up Biology



Fanalista & Birnie et al developed a microfluidic platform to manipulate the shape and size of artificial cell containers. The method is based on an innovative trap design, where minimal containers, such as droplets, double emulsions and liposomes get deformed into a morphology remarkably similar to actual living cells. In the future, this platform will be useful to reconstitute and study various cellular machineries inside cell-like confinements.

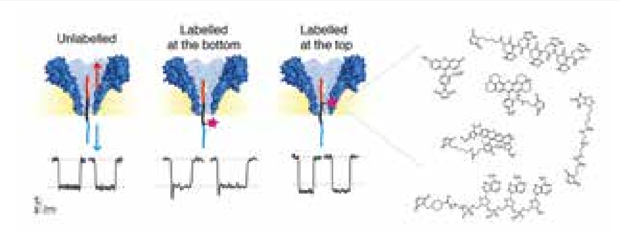
F. Fanalista,* A. Birnie,* K. Charles, G. Pawlik, R. Maan, F. Burla, S. Deshpande, G. H. Konderink, M. Dogterom, C. Dekker
ACS Nano 2019, 13, 5, 5439-5450

A full vectorial mapping of nanophotonic light fields

In nanophotonic structures all six vector components of light come into play. We present a method to map all six at the nanoscale with near-field microscopy, using only two detection channels and a single, obvious assumption: that the fields under investigation obey Maxwell's equations.

B. Le Feber, J.E. Sipe, L. Kuipers and N. Rotenberg
Light Science and Applications 8, 28 (1/7) (2019)

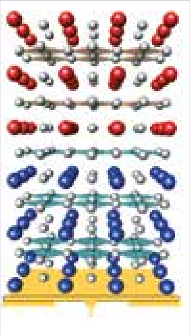
Resolving Chemical Modifications to a Single Amino Acid within a Peptide Using a Biological Nanopore



One of the main challenges of protein sequencing is differentiating 20 different amino acids. Fingerprinting schemes have been proposed, in which only a subset of amino acids is labelled and detected. In this study, we show that nanopores can sensitively and reproducibly detect chemical side-labels added to particular amino acids in a polypeptide.

L. Restrepo-Pérez , G. Huang , P.R. Bohländer ,
N. Worp , R. Eelkema , G. Maglia , C. Joo, C. Dekker
ACS Nano

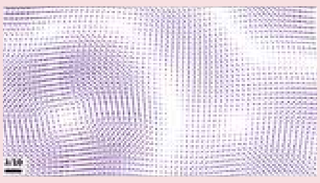
Bimodal Phase Diagram of the Superfluid Density in LaAlO3/SrTiO3 Revealed by an Interfacial Waveguide Resonator



The interface between insulating oxides LaAlO3 and SrTiO3 hosts a two-dimensional electron system with a superconducting ground state. In this work the researchers investigate the density of superconducting electrons by means of waveguide resonators. They show that the concentration of superconducting electrons is extremely low and exhibits a spontaneous nanoscale texture.

N. Manca, D. Bothner, A.M.R.V.L. Monteiro, D. Davidovikj, Y. G. Sağlam, M. Jenkins, M. Gabay, G. Steele, A. D. Caviglia
Physical Review Letters 122, 036801 (2019)

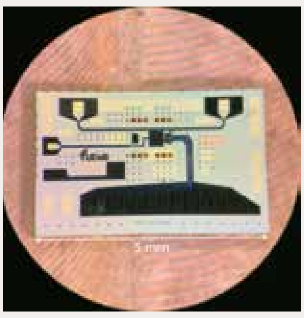
Index-symmetry breaking of polarization vortices in 2D random vector waves



We demonstrate that in random 2D light waves polarization singularities with the same topological charge actually attract rather than repel each other, leading to the formation of higher-order singularities: vortices. Moreover, it turns out that the charge balance of these vortices is broken: positive vortices occur more frequently than their negative counterparts.

L. De Angelis, T. Bauer, F. Alpeggiani and L. Kuipers
Optica 6, 1237-1243 (2019), Vol. 6, No. 9

Rapid gate-based spin read-out in silicon using an on-chip resonator



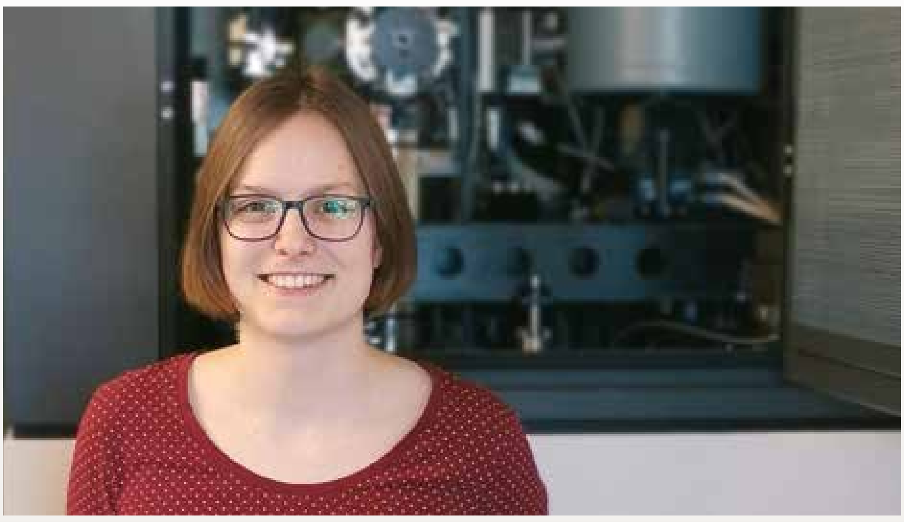
A novel method is demonstrated that achieves fast and precise measurement of a single electron spin, without requiring any averaging. The method is expected to facilitate scaling up quantum computers based on electron spins in quantum dots.

G. Zheng, N. Samkharadze, M.L. Noordam, N. Kalhor, D. Brousse, A. Sammak, G. Scappucci, and L.M.K. Vandersypen
Nature Nanotechnology 14, 742 (2019)

Unraveling quantum materials with an electron microscope

By Sabrya van Heijst – PhD candidate

In recent years the interest in quantum materials has spiked. Researchers foresee that the unique properties they possess give them great potential in various applications including MRI, magnetic field sensors, high-density storage devices, water filtration and quantum computing. Some applications have already been realized, while others are still in its infancy. Evident from the vast range in applications, this material group is quite broad. The question arises what exactly defines a quantum material. What makes them special? And how can one obtain the needed understanding of the unique properties, which these materials evidently possess?



The physical description of all materials is rooted in quantum mechanics. Yet, not every material can be classified as a quantum material. Quantum materials are those materials which at a macroscopic scale present with exotic quantum mechanical effects, such as quantum fluctuations, quantum entanglement, quantum coherence, and topological behavior. These quantum materials, including superconductors, 2D materials like graphene and topological insulators, have been gaining the interest of researchers in recent years. This due to their unusual and fascinating properties.

The functionalities of these quantum materials are highly sensitive to structure and chemical variations at the single atom scale. Gaining insights for the understanding of the close relation between structural, chemical and local electronic properties would open the door to their applications as building blocks of next-generation nanodevices. A technique which would allow for the characterization of the structural, chemical, and local electronic properties would be beneficial. Today, transmission electron microscopy (TEM) is arguably the most efficient and versatile tool for the characterization of novel materials over spatial ranges from the atomic scale up to the micrometer level and beyond. This is mostly due to all the improvements within this technique in terms of both spatial and energy resolution.

Characterization on the atomic scale

In a transmission electron microscope an electron beam is shone through a specimen, and information is gathered from the transmitted electron beam. Various operation modes are possible, all providing different information on the specimen. One can for example obtain information on the structure and composition on the atomic scale using a mode called the scanning transmission electron microscopy (STEM) mode. In this mode the electron beam is focused to a small spot, which is subsequently scanned over the specimen. The images obtained from this operation mode show differences in intensity based on the atomic number of the atom at which it is focused; therefore, creating an image clearly showing differences between atoms within the atomic structure.

In addition, a transmission electron microscope can be equipped with a multitude of spectrometers. One very useful technique in the characterization of novel materials is EELS, or electron energy loss spectroscopy. When electrons pass through the specimen, electrons lose energy to a certain degree, due to scattering events. The amount of energy lost can provide information on both the chemical and local electronic properties. The latter is greatly valuable for the characterization of quantum materials. Yet, the spectra collected with this technique are difficult to understand within the desired energy lose region. This gives rise to the need of theoretical modelling in interpreting the obtained data.

Reducing dimensionality

In the ConesaBoj Lab we not only utilize TEM methods to investigate the wondrous properties of quantum materials, we are also interested in low-dimensional nanomaterials. In my project I work with layered materials such as molybdenum disulfide (MoS_2) and tungsten disulfide (WS_2). These 2D layered materials cannot be classified as quantum materials. Yet they are theoretically predicted to show novel properties when the dimensionality is reduced. Examples of such novel properties include metallic edge states, ferromagnetic behavior and enhanced mobility. Despite these theoretical predictions, experimental validation is lacking. This is because of the challenges in simultaneously accessing the structural and local electronic properties on the single atom scale.

In our lab we work with both experimentalists and theorists towards the full understanding of the unique properties of these novel quantum materials and nanostructures. We believe their true potential is yet to be unraveled, and they might be able to revolutionize the world of nanodevices.

Nynke Dekker elected as member of EMBO

The European Molecular Biology Organization (EMBO) has elected Nynke Dekker to its membership. Dekker joins a group of more than 1800 of the best life science researchers worldwide. Nynke Dekker's group focuses on understanding the key cellular process of DNA replication from a biophysical perspective in viral, bacterial, and eukaryotic systems. EMBO Members actively participate in the execution of the organization's initiatives by serving on Council, committees and editorial boards, by evaluating applications for EMBO funding, by mentoring young scientists and by providing suggestions and feedback on activities.

Japan-NL Quantum Conference

On 16 and 17 September a scientific Japan-Netherlands conference on Quantum Technologies took place in Delft. The idea was born during a QuTech faculty meeting where we took Ryoichi Ishihara's proposal to organize a joint QuTech - Tokyo Tech seminar broader: why not organize something for the entire Dutch and Japanese quantum communities? After all, we have been working together closely for decades, resulting in very successful scientific results including the first generation superconducting flux qubits. A program committee with scientists from Delft, Amsterdam and Eindhoven prepared a list of preferred speakers and -miraculously- almost all of them accepted our invitation. We had a dense program of high-quality scientific talks, including keynotes from Professors Yoshihisa Yamamoto, Yasunobu Nakamura, Ronald Hanson, Leo Kouwenhoven and Seigo Tarucha. Topics that that they covered: networks of optical parametric oscillators for Ising machines, superconducting quantum circuits including hybrid quantum systems, multi-node networks wired by quantum entaglement, using diamond based quantum nodes, Majorana qubit progress for protection of basic decoherence mechanisms and Si quantum dots and ways to raise gate fidelity and scale up the system.

Social parts of the program included a dinner talk by Emeritus Professor Hans Mooij who took us back over 400 years when Holland was the only western country to have trade relations with Japan and a Ministry representative who spiced up his speech on governmental collaborations with some French literature.
In short, it was a very successful conference that no doubt will have a follow-up in the form of a return conference in Japan and possibly a joint collaborative R&D program funded on the national level. We thank all participants and sponsors, including KIND, for making it possible.

Lieven Vandersypen & Freeke Heijman

Tenure for Liedewij Laan

We would like to congratulate Liedewij Laan, who received tenure in April 2019.

COLUMN

The hardest lesson

The formula for granting a Ph.D. in Delft contains high praise: "your doctorate means that society can rely on your judgment". I have recently encountered a similar opinion during a panel discussion at the Kavli day. There, as a way of counteracting fake news, we were advised to "adopt a politician" and provide advice on any relevant topic. The motivation for such thinking is the high academic standard in finding hard questions, and then answering them in a way that survives scrutiny. While this idea is certainly appealing, I think it is incorrect.

Modern research is far from being a direct application of the scientific method and its characterization–hypothesis–deduction–testing cycle. Due to the growth of complexity, we must focus on learning our tools of the trade: critical thinking alone is useless if to test your hypothesis you need to work with a synchrotron. Another consequence of complexity is specialization: as a theorist, I am unable to understand the experiments in nearly as much detail as an experimentalist does, and I must trust that experimentalists do their job well.
At the same time, if very few people understand the details of my work, I appear as an oracle to everyone outside of a small group of expert colleagues. Finally, a physicists' work is especially easy compared to other disciplines because a lot of physics questions are already answered with unquestionable certainty. This certainty allows us to work with confidence, but being habitually confident discourages doubt.

Despite all these problems, we do acquire the skills needed to form an educated opinion.
We are trained to efficiently search for relevant information and compare different sources to reconstruct the context. We have a general understanding of how research works and can use it as a crude assessment of the reliability of a source. Finally, we are all exposed to working with data and statistics. A wonderful online course with a provocative name https://callingbullshit.org assembles a pedagogical summary of these necessary skills.

I fear though, that many academicians boldly state their opinion and expect that applying all these important skills would give the same answer. I am certainly prone to this fallacy: my misconceptions are plentiful and severe, both in topics outside of my expertise and within it.
We are eventually able to distill a balanced and educated opinion, but it does require careful, scrupulous, and tedious work that we must not postpone or skip. This is, I think, the hardest and the most important lesson for all of us: of all the people with misconceptions, you are the one whose wrong opinion you should correct first.

Anton Akhmerov

SCIENCE ART

Artist impression of the research efforts from Greg Bokinsky's Lab to engineer bacteria to produce powerful antibiotics to fight antimicrobial resistance. This artwork entitled "Antibiotic cornucopia" is inspired from the horn of plenty in classical antiquity which symbolizes prosperity and abundance. The artist uses this symbolic motif to represent a Erlenmeyer flask, container used to grow bacteria in the lab, from which emerge an abundant diversity of antibiotic treatments (depicted as pills) that could be harnessed to save lives.
Credit Jacob Kerssemakers

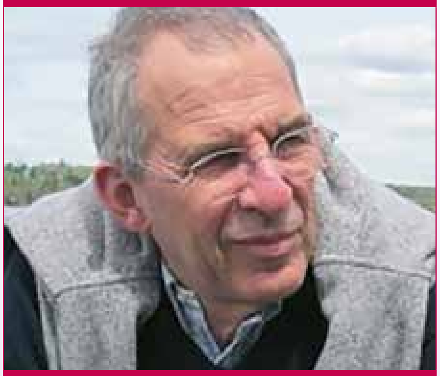
UPCOMING KAVLI COLLOQUIUM

Taekjip Ha

Date: T.B.A.

Johns Hopkins School of Medicine

UPCOMING KAVLI COLLOQUIUM



Kavli Chair Prof. Michel Devoret

Date: T.B.A.

Yale University

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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