KAVLI NEWSLETTER
Kavli Institute of Nanoscience Delft

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Interview with Kavli AiR 2022 Andrija Pavlović and his LP Duo partner Sonja Lončar

By Eliška Greplova

Q: First of all, I would like to welcome you to the Kavli Institute - we are thrilled to have LP Duo here and to see you perform. Let me start by asking a bit about LP Duo background: You are both accomplished solo musicians, what made you start the LP Duo and what do you most enjoy about performing together?

S.L. Andrija and I met, well now it's almost 20 years ago. Although we were both already active as solo pianists or in other ensembles, we were always looking for someone with whom we could share music, thoughts about music and research on this subject, but also on many others. Our first step as a duo was studying in Germany, where we spent almost 5 years and completed Master and Konzertexamen studies on the subject of piano duo. Our repertoire was initially classical at the beginning and during our studies we went through most of the major classical works written for this ensemble. We participated in many competitions all around the world and got over 30 international prizes as solo or duo. Then, there was a concert at Carnegie Hall, New York, which is definitely the dream of every musician. After that, we felt we had to move on. It wasn't enough for us to be just performers, we wanted more. We wanted to compose, to perform our music, to make our instrument, to connect with other (art and science) disciplines, and to try to bend the boundaries of music that have been set.

Q: What is important not being alone on the stage is sharing, communication, and all the other beautiful things that are coming along playing with someone.
And what is even more important is to succeed in the perseverance of one ensemble. The different stages in artistic research that we went through together and separately, helped us to learn from each other and to develop in all directions.

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FROM THE DIRECTORS

As we emerged from the Covid-19 pandemic, we are faced with a new challenge. Since the end of February we live in a different Europe. Our heart goes out to everybody who has loved ones suffering as a consequence of the military conflict in the Ukraine. Many initiatives have sprung up to help people in need and also as Kavli Institute we try to pitch in. Our Kavli Institute is internationally oriented and we have colleagues from both Russia and the Ukraine. In dealing with this new challenge, it's heartwarming to see how science connects people.
In addition, our Kavli artist in residence, Andrija Pavlović and his LP duo partner, Sonja Lončar, also connect: people through music, but also music to science. Moritz Engelhardt reflects on how we as scientists can better connect to society.
Simon Gröblacher and Wolfgang Tittel show how to improve the connection between single rare-earth ions and photons.

Many members of our Kavli family have obtained personal grants for starting exciting new science. Moreover, Ronald Hanson has won the Physica prize 2022, Leila Iñigo de la Cruz the Convergence Health and Technology Open Research Award and Natalia Chepiga the Minerva prize 2022. On top of that Marileen Dogterom will take on, arguably, the most responsible position possible for a Dutch scientist as she becomes the president of the KNAW.

Kobus Kuipers

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Interview with Kavli AiR 2022 Andrija Pavlović and his LP Duo partner Sonja Lončar

Two musicians who met on the occasion of one project and others who share years and years of playing and researching together sound differently. The audience hears that, and that is where the beauty of making music in togetherness starts.

LP Duo has very unique sound and performance style. Can you talk a little about what is your main inspiration and influences?

A.P. Thank you for recognizing that. We are classical trained pianist, so the roots are there, in classical music. We performed most of the classical repertoire for piano duo (Bach, Mozart, Schubert, Debussy, Ravel, Stravinsky) but also contemporary XXI century master pieces (Satie, Messiaen, Stockhausen, Cage, Glass, Simeon Ten Holt). But, we also like jazz, rock, electronic music, and we played in popular bands and composed a lot of different music for theater or movies. One of our favorite records and reasons to play on two pianos, was ,,An Evening with Chick Corea and Herbie Hancock”. That is amazing blend of classical, jazz and popular music! So there was always a strong impulse to search for unknown and to look inside to find your own music. All about our work was always all about being above dualism, or how to merge let say opposites. That’s how we went from classical to quantum world in a literal but also essential way during the pioneering *Quantum Music* project (2015-2018). And our last album is called ,,Duality” (Universal Music), where we connect different musical genres but also the sound of acoustic and electronic music through our invention of the hybrid piano instrument.

- Your Artist in Residence project is not your first collaboration with scientists - in fact, it is not even your first collaboration with quantum physicists specifically. What inspired you to combine musics and (quantum) science in the first place?

Credits: Jos Wassink

S.L. Our collaboration with quantum physicists has actually been going on for several years now. It all started with a project called “Quantum Music”. Within the project we had a very intensive collaboration with quantum physicist Klaus Moelmer, Vlatko Vedral and Andrew Garner. Together with them, and our friend, engineer Dragan Novkovic professor of acoustics from Belgrade, we asked many questions and studied what is happening in the quantum world in terms of sound. I have to admit that it took us a long time to start understanding some things, because we come from a completely different field. But over time, we have slowly begun to understand at least very very small parts of the quantum world. The beginning of understanding the quantum world gave us incredible inspiration and made us explore further. There are many ways we can connect the quantum world with music. From a philosophical, but also a scientific point of view, merging these two seemingly distant disciplines is something that in the end is actually completely organic and gives us a huge space to try to make some completely new music. I think there is no greater inspiration for anyone than combining art and science, because that is what makes our world and what helps our world to be better.

What are you excited the most about during your stay at Kavli Institute? Is there a specific science or music area or collaboration that you are looking forward to explore?

A.P. I am really impressed! And so thankful to be in such inspiring environment among amazing scientist at TU Delft. I already established contacts with all departments, and we started to work on a several interesting topics. When it comes to Bionanoscience, I am impressed to listen about gene editing and proteins from Martin Depken, Chirlmin Joo, but also I like to investigate and compose neural (music) networks with Dimphna Meijer or to ,,play” the genetic code with Margreet Docter. Sure there will be more! And when it comes to the Quantum Nanoscience and Qu-Tech, I am so happy to work with Eliška Greplova and Christian Andersen recording some sounds of quantum computing, examining qu-bits with Lieven Vandersypen, slowing the music and frequencies with Kobus Kuipers or making atoms ,,play jazz” with Sander Otte. Do you know we already recorded the sound of one experiment?! Not to forget our external experts Klaus Moelmer form Aarhus University who visited TU Delft last week, and we worked on the possibilities to make new musical scales using the change of overtones.This is something we call ,,The Quantum Harmonic Circle”. It is so excited!

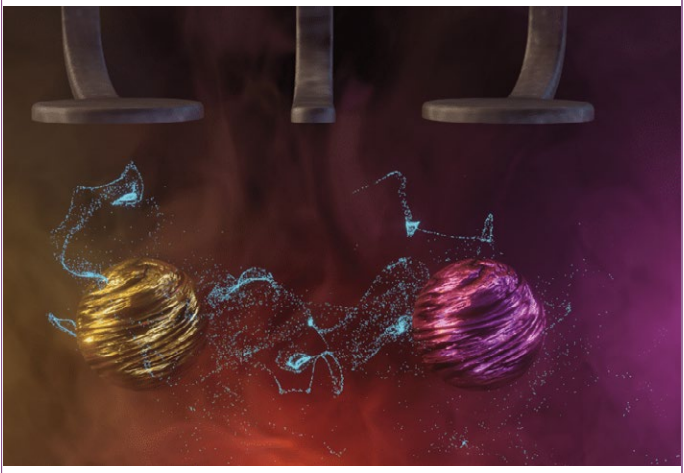
Gerrit Jan Mulder Prize for Raman van Wee

Raman van Wee (MSs Nanobiology at TU Delft and Erasmus MC) won the Gerrit Jan Mulder Prize on March 14th. This marks the first time the prize has been awarded to a student from Delft. Van Wee received the prize for his research into a new detection method for looking at individual proteins, the workhorses of the cell, one by one.

The method makes use of DNA nanotechnology to attach luminescent molecules to the protein. Van Wee: “We measure the distance between those molecules under the microscope. This is how we can determine the shape and size of the protein with sub-nanometer precision. These characteristics are unique to each protein and form a characteristic fingerprint. It would be fantastic if we could use this fingerprint method in the future to help detect diseases at an early stage.”

The yearly Gerrit Jan Mulder-award consists of a certificate and a personal prize of 2,500 Euros. The award is awarded annually to an Erasmus MC medical student for his/her end-of-study research and/or to a master student of one of the five Erasmus MC research masters, for excellent research relating to their first year master program research.

NWO-Veni grant for Maximilian Russ

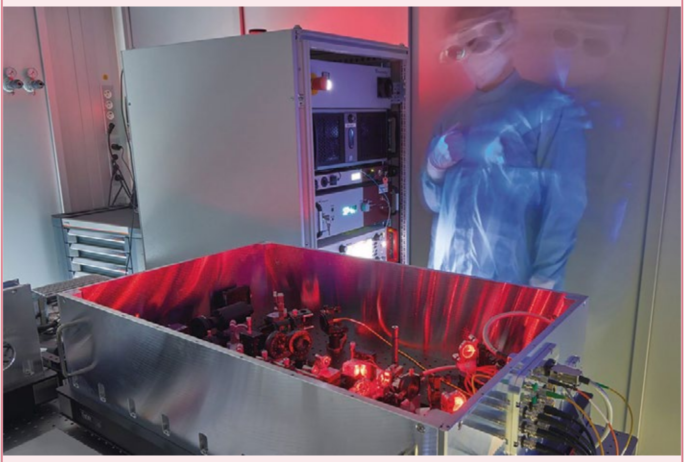


NWO has announced to provide a Veni grant to Maximilian Russ for his research on sensing local properties for novel spinqubit operations. The grant provides the opportunity to further elaborate own ideas during a period of three years.
https://qutech.nl/2021/12/16/veni-grant-for-maximilian-russ/

NWO-Veni grant for Eliška Greplová

NWO has awarded Veni grants to four researchers from the TNW faculty, including a grant to Eliška Greplová for funding insights from topology for a new way of engineering on-chip quantum networks. With these novel devices, quantum information can be distributed without detrimental effects from quantum noise, which is needed to scale up quantum technologies.

Fraunhofer and QuTech unite to champion quantum internet



Fraunhofer and QuTech unite in strengthening European innovation in quantum communication and quantum information networks. In a long-term, strategic partnership, the German Fraunhofer-Gesellschaft and QuTech will work together structurally on the development and knowledge transfer of the quantum internet. The partners aim to initiate and promote a wider scientific collaboration, to roll out new prototypes and testbeds, and to make better joint use of know-how in application-oriented research and transfer to industry.
https://qutech.nl/2021/12/14/fraunhofer-and-qutech-unite-to-champion-quantum-internet/

COLUMN

Towards a greener cleanroom

The Dutch climate policy aims to reduce greenhouse gas emissions by 49% by the end of 2030. TU Delft has rightfully dove into this enormous challenge by launching the campus-wide Climate Action Programme in April 2021. These initiatives made me introspect on how my day-to-day research activities are impacting the environment, both locally and globally. I am proud to say that I have had the privilege of being a daily user of the Kavli Nanolab facility for nearly 8 years. But of late, I have been troubled by the carbon footprint of my research activities, particularly with respect to the usage of resources such as single-use personal protective equipment (PPE) like gloves, shoe covers, face masks, ziplock bags to high-value materials such as silicon wafers, chemicals, gases and precious metals.

Let me highlight the case of the volume of most commonly used PPE in KN; for the year 2021, about 18,500 hair nets have been used which amounts to about 70 used every working day. This number serves as a good baseline for predicting the usage of other PPE; the volume of annual gloves usage is likely higher at around 55,500 units. The maximum capacity of users in the cleanroom at the KN end is capped at 100 personnel including the staff. However the average working day headcount is between 35-40 people, which tallies well with the PPE usage. About 7-10 kg of waste composed of PPE and its packaging is produced daily at the KN end. The carbon footprint measured in g CO_2e, for the production, transport and waste generated for manufacturing a single PPE item are as follows: Nitrile glove - 26 g CO_2e and non-woven polypropylene surgical mask - 13 g CO_2e (Rizan et al. 2021). The calculated carbon footprint for 1 g of non-woven polypropylene which is used for making disposable suits, hair nets and hoods is around 5 g CO_2e and low-density polyethylene shoe covers and ziplocks - 6 g CO_2e. Therefore a single user's carbon footprint purely from PPE usage, assuming two visits to the cleanroom per day amounts to roughly 400 g CO_2e, totalling around 4.2 tonnes CO_2e annually for all of KN. This is equal to the amount of CO_2 emitted from two round-trip flights between Amsterdam and New York.

The fate of these plastics after disposal is largely unknown. Except for LDPE, other PPE are notoriously difficult to recycle so most of it ends up in landfills and a fraction goes to waste-to-energy incinerators.The cleanroom community must become aware of the social and climate costs due to unchecked PPE usage and actively work towards reducing/reusing single-use plastic wearables. It is ideal to switch to biodegradable/recycled alternatives, however environmentally sustainable products continue to be twice as expensive than cheap polluting goods due to the current global economic model. TU Delft must increase the scope of its sustainability initiatives and support tailored intervention policies for offsetting the high initial costs of a low-carbon transition. Most importantly, the need to change behaviour must come from within. We, the scientific community must be cognizant of the impact our research activities have on the present. Our goodwill for the future of humanity must heed today's daunting threats of climate change, time is running out. - With inputs from Kavli Nanolab staff

Nandini Muthusubramanian
PhD, Quantum Computing Division
QuTech, Delft University of Technology

NEWS FROM THE IVORY TOWER – DO WE NEED A NEW WAY OF COMMUNICATING SCIENCE?

By Moritz Engelhardt, PhD candidate Grußmayer Lab

The last two years have seen an unprecedented educational campaign on virology, epidemiology, statistics and climate science for billions of people; with ambiguous success. Scientists have been discussing the dangers of climate change since at least 1957. Public health experts have risen to almost obscure prominence within weeks. Yet parts of society seem to have lost the confidence in scientific institutions. Did scientists underestimate the importance of effective communication outside of academia? Or was the surge of misinformation inevitable due to inherent bad-faith actors? As a PhD candidate taking my first steps in science, I can't help but reflect on my role as a communicator of my work to the public.

The modus operandi of science communication
The prevailing liberal view about communication seems to endorse a continuous dialogue of well-informed stake holders until a consensus has been reached. Science communication in large however relies on a one-way transmission of information about science from experts to the public. Science communicators thereby understandably follow the scientific method. They are rational, straight, and focus on the "facts" as far as scientific knowledge will permit. They present reports that reflect the state of scientific knowledge, including assumptions, probabilities, and models.

In doing so, they fail to communicate effectively. Communicators forget to consider whom their audience is, or its diversity. The people they need to reach are mostly not scientifically literate, and process information in highly irrational, often emotive and tribal ways. Such audiences are less likely to consider whether the sources of their information are scientifically authoritative; they want clear answers. Learning from communicators in other disciplines suggests a different approach, setting the focus away from logos and introducing emotional appeals (pathos), as well as trust building measures (ethos).

So, what is the consequence for my work at BN?
In the Grußmayer group we are working at the interface of biology and optics to develop cutting-edge (super-resolution) microscopy and analysis tools, establish new classes of fluorescence probes and apply them directly to address relevant questions in molecular and cell biology. My project encompasses the development and deployment of a whole battery of imaging modalities and analysis tools to understand the function of intracellular self-assembly and its dysregulation leading to neurodegenerative diseases such as Huntington's disease.

There is thus arguably a legitimate interest in the communication of findings to patients and their immediate family. It seems however rather unproductive to devote significant resources to educate the broader public about the sheer endless array of acronyms of super-resolution modalities. I admire the beauty of science to identify and focus on partially obscure, and highly specific problems. It is nonetheless only relatable that people outside of the respective field just have different interests, material concerns or simply better things to do, than to educate themselves about the latest progress in single molecule localisation. That's okay as long as the lack of knowledge does not affect society.

We need trust and participation
But what if the respective topic is just not as inconsequential as a new imaging modality, but climate change or infectious viruses. Does it suffice to inform people in the established one-way transmission as soon as a finding has significant impact on society? As these reactive and post-hoc measures in part led to the latest 'infodemic', we can call the approach close to short-sighted. It appears that we need to establish a general sense of what scientists have discovered, as much as how the scientific enterprise works. Introducing procedures and people within science, not the investigated subjects per se.

The goal should be the improvement of society's belief in, and the generation of moral, demographic, and epistemic trust into science. For this to be effective, we must expand our toolbox to consider social sciences as important windows to human behaviour, and engage with, not ignore, politics. The new generation of researchers & communicators should emphasize, that just stating the facts is hardly enough when much is at stake; we need to know our audience, communicate outside of our established channels, and encourage participation.

Marie-Eve Aubin Tam receives ERC Starting Grant 2021

Marie-Eve Aubin-Tam (BN) has received the ERC Starting Grant 2021, with her proposal entitled "Light-responsive microalgal living materials". These fellowships are awarded to researchers with 2-7 years of experience since the completion of their PhD, a scientific track record of great promise and an outstanding research proposal.
https://www.tudelft.nl/en/2021/tu-delft/erc-starting-grant-for-four-tu-delft-researchers

Kavli seed project: Towards nanocavity-enhanced coupling between a single rare-earth ion and a photon

By Simon Gröblacher TNW and Wolfgang Tittel QuTech

The quantum internet promises provable-secure communication using quantum key distribution (QKD), networked and blind quantum computing, and distributed quantum sensing. Common to all is the need for light-matter interfaces that employ atoms or optically addressable centers, ideally in the solid-state environment and interacting with telecommunication-wavelength photons. For instance, single emitters supplemented by fusion gates allow the creation of pairs of entangled photons; and large ensembles can be used for multiplexed multi-photon quantum memory, which is key to quantum repeaters and hence long-distance transmission.

Due to their unique combination of convenient optical and spin-level structure, long population lifetimes, remarkable spin and optical coherence times, as well as large inhomogeneous broadening, ensembles of rare-earth ions doped into inorganic crystals have emerged during the past decade as excellent candidates for optical quantum memories. However, the long population lifetimes also represent a caveat as they hamper the observation of single photons emitted from individual ions, thereby impacting the creation of quantum light sources. In 2018 two research groups in the US showed, that this problem can be solved by exploiting the Purcell effect, which allows increasing the ion's emission rate by coupling it to a mode of a nanophotonic cavity with large quality factor and small mode volume.

Combining the complementary knowledge of rare-earth-ensemble-based quantum memory and quantum communication in the Tittel group, and of nanofabricated photonic crystal structures in the Gröblacher group, we have simulated, created and optically tested silicon nano-photonic cavities coupled to an erbium-doped crystal in view of such an interface. This crystal is particularly promising for quantum network applications due to the well-known 1550 nm absorption line in erbium, which is also at the heart of widely used fiber amplifiers.

The first step in this project involved finite element simulations of electric and magnetic field distributions of the designed silicon cavity (see Fig. 1a for a schematic). After having found a suitable design, we created many desired devices out of a silicon-on-insulator (Si on SiO_2) waver using standard e-beam lithography, reactive ion etching, as well as wet etching to remove the silica layer. This resulted in suspended silicon photonic structures (Fig. 1b), which were subsequently transferred onto an crystal.

The nano-cavity was then coupled to a lensed or a tapered optical fiber. Measurements of the cavity quality factor resulted in values up to 50 000, which, together with a simulated mode volume of around 0.5 mm3, allows us to project a Purcell enhancement of the spontaneous emission rate in excess of a factor of 1 000 – enough to enable detecting single photons emitted from a single erbium ion. Characterization of the cavity-enhanced interaction at 4K is in progress.

The KIND synergy grant has helped kick-start this collaboration and made it possible to quickly obtain these first results. Without the grant, we would have not been able to find the appropriate resources and take the risk of trying something new. The KIND synergy grant further strongly benefited a successful application for funding through the NWO KLEIN-1 program.

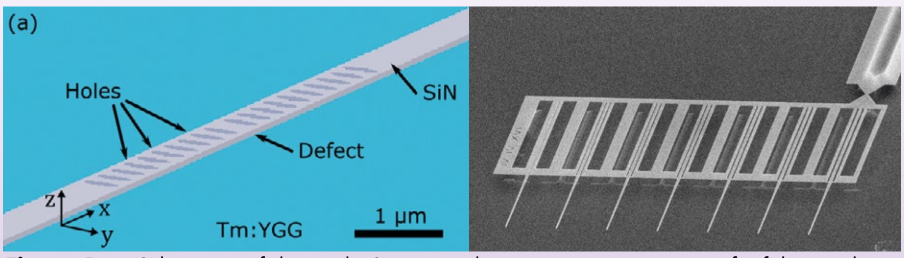


Figure 1. a. Schematics of device. b. Scanning election microscope image of a fabricated nanocavity array.

NEW EMPLOYEES

Name	Date of employment	Title	Lab
Chenyu Wen	01-10-2021	Postdoc	Cees Dekker Lab
Marcos Arribas Perez	01-11-2021	Postdoc	Koenderink Lab
Hande Eyisoylu	01-01-2022	PhD	Koenderink Lab
Ran Huo	15-01-2022	PhD	Grussmayer Lab
Adja Zoumaro-Djayoon	01-02-2022	Technician	Bokinsky Lab
Marianne Bauer	01-03-2022	PI	Bauer lab
Marijn van den Brink	01-03-2022	PhD	Danelon Lab
Jeong-Joo Oh	01-05-2022	Postdoc	Aubin-tam Lab
Swareena Jain	15-01-2022	PhD	Zwanikken Lab
Helena La	15-01-2022	PhD	Conesa Boj Lab
Annick Teepe	01-02-2022	PhD	Van der Sar Lab
Julius Fisher	01-12-2021	PhD	Hanson Lab
Alireza Ghafari	01-02-2022	PhD	Sebastiano Lab
Benjamin van Ommen	01-11-2021	PhD	Taminiau Lab
Sean van der Meer	01-11-2021	PhD	Di Carlo lab
Niels fakkel	15-11-2021	PhD	Sebastiano Lab
Liza Morozova	15-01-2022	PhD	Vandersypen Lab
Martijn Veen	01-02-2022	Software/fabrication engineer	Di Carlo lab
Eline Raymenants	15-03-2022	Postdoc	Vandersypen Lab
Laurens Feije	15-03-2022	PhD	Taminiau Lab
Sebastian Miles	01-01-2022	PhD	Wimmer Group
Taryn Stefanski	01-10-2021	Guest PhD	Andersen Group

Kavli seed project: "Magneto-acoustics: A platform for non-reciprocal propagation of sound and microwaves"

By Gary Steele and Toeno van der Sar

What was the goal?
Creating hybrid quantum systems is a key potential of the complementary expertise present in the groups of our Kavli institute. Our long-term goal is to create hybrid systems of superconducting circuits and single spins that are coupled with wave-like collective excitations such as phonons and magnons. Such hybrid systems can combine favorable properties of their building blocks for applications in quantum technology, but also allow exciting studies of coupling between different types of physics, such as ferromagnetism and (quantum) mechanics.

Surface acoustic waves form a powerful interface between different quantum systems. Recent work demonstrated the coupling of quantized acoustic waves to quantum circuits. Through the magnetoelastic effect, it is predicted that it is possible to achieve strong coupling between acoustic waves and spin waves in magnets. In this seed project, we aimed at combining low-damping surface acoustic waves with the intrinsic non-reciprocity of spin waves in magnets to realize unidirectional transmission of information on a chip. The idea is to use the ferromagnet to break time-reversal symmetry in the flow of quantum information. The long-term goal is to create on-chip microwave isolators and circulators that can be used in quantum circuits and realize exotic new physics such as chiral and topological states of quantized sound.

What have we achieved?
We have realized devices that enable SAW excitation and transmission, a technology that was new to both our groups. The devices use interdigitated capacitors to excite and detect SAWs in a LiNbO3 thin film (Fig. 1). This material is well known for its strong piezoelectricity that enables efficient excitation of SAWs. Their fabrication turned out to be a bit challenging, due to the closely spaced metal strips that require precise dose testing and a challenging lift-off of the metal. After a few months, we succeeded in creating interdigitated capacitors that allowed us to excite and detect surface acoustic waves with wavelengths of a micrometer traveling at 3440 m/s across our chip (Fig. 1).

Our goal was to study the coupling between the SAW and spin waves in a magnet. Spin waves are made of collectively precessing spins in a magnet and can couple to acoustic waves via the magneto-elastic effect. We deposited a nickel film between our SAW excitation and detection lines and searched for signs of coupling by varying the magnetic field (Fig. 1). We observed that SAW transmission vanished with increasing field, a promising sign of some form of coupling and the final results of the project. These results are a good starting point for further investigation of the coupling in devices. As a next step, we plan to look for signs of coupling by characterizing the devices using magnetometry based on spins in diamond.

What did it SEED?
Although we saw promising signs of coupling between the SAW and the magnet, the data were not sufficiently conclusive to establish the nature of the coupling. Nonetheless, the device fabrication was successful and these promising signs merit further investigation. A challenging aspect of a 6-month project is that it provides little space for unexpected challenges and that the merit for the person performing the measurements is not obvious. Nonetheless, it provided the postdoc leading the project with the opportunity to look for a next position, which he successfully obtained so that is actually an excellent outcome. As to the question 'did it seed something'?: we very much strengthened the ties between our groups and are planning to continue collaborating on this project by integrating it into a PhD project of a student of which we are both promotors. The student will image the magnetic noise from the ferromagnet as a function of SAW excitation using NV-magnetometry.

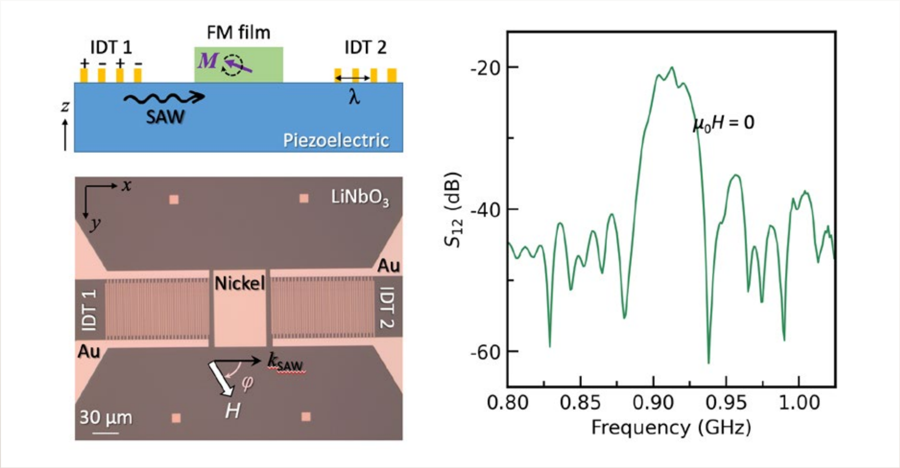


Fig. 1 - Left: Surface acoustic waves (SAWs) are excited and detected by interdigitated capacitors (IDTs) on piezoelectric LiNbO3. The coupling to the ferromagnet (FM) should yield non-reciprocal SAW transmission. Right: Resonance demonstrating SAW-mediated microwave transmission between the IDTs.

New platform opens quantum networking to everyone

Since last November, everyone can freely access Quantum Network Explorer (QNE) to experiment with quantum networks. QNE is developed by QuTech and specifically aimed at researchers, students, software developers and future users of quantum network applications. QuTech believes in the power of community and wants to contribute by enabling users from different backgrounds to explore and experience the possibilities of quantum networks. Try it yourself at www.quantum-network.com/
https://qutech.nl/2021/11/19/new-platform-opens-quantum-networking-to-everyone/

Marileen Dogterom elected as president of the Royal Netherlands Academy of Arts and Sciences (KNAW)

Marileen Dogterom will succeed Ineke Sluiter as president of the Royal Netherlands Academy of Arts and Sciences (KNAW), the forum, conscience, and voice of the arts and sciences in the Netherlands, effective June 1, 2022. She will combine this board position with her research work at TU Delft.
https://www.knaw.nl/nl/actueel/nieuws/marileen-dogterom-gekozen-als-nieuwe-president-knaw

Natalia Chepiga wins the Minerva Prize 2021

Natalia Chepiga and Wiebke Albrecht (AMOLF) have won the Minerva Prize 2021. The prize is intended for young, promising female or non-binary physicists in the Netherlands, who excel in a field of physics, experimental and/or theoretical. This year, Wiebke Albrecht and Natalia Chepiga will share the prize and the prize money of €5,000.
https://www.nnv.nl/minervaprijs/

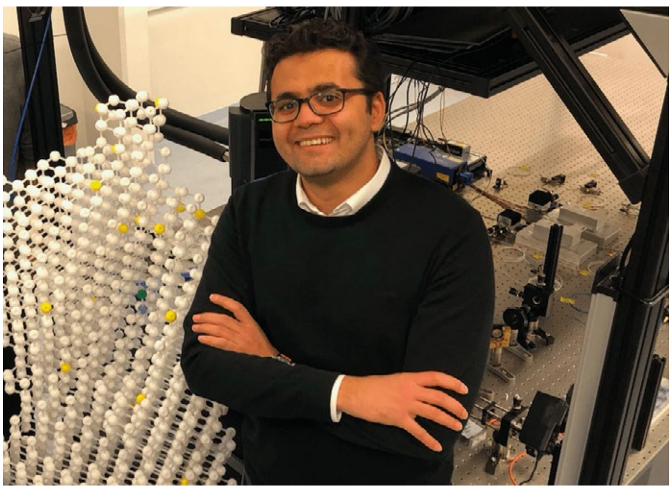
Ronald Hanson wins Physica Prize 2022

The Physica Prize 2022 has been awarded to Ronald Hanson, distinguished professor in quantum computing and quantum internet at TU Delft and group leader at QuTech. Ronald Hanson earned world-wide recognition as one of the leading quantum scientists of his generation. Besides being an excellent researcher, Ronald Hanson played a key role in uniting the Dutch quantum physics community into a joint vision and plan (National Agenda Quantum Technologies), and in securing funding for executing this agenda from the National Growth Fund. Hanson will receive the prize at the conference FYSICA 2022 on Friday April 22nd, when he will give the Physica Lecture.
https://qutech.nl/2021/12/13/ronald-hanson-wins-physica-prize-2022/

Leila Iñigo de la Cruz wins Convergence Health and Technology Open Research Award

Leila Iñigo de la Cruz (PhD candidate at BN) has won a Convergence Health and Technology Open Research Award as one of the four winners of the TU Delft. This award is presented to Master students and Early Career Researchers (PhD, Postdoc or research assistants/associates) from TU Delft, Erasmus MC and Erasmus University who are committed to open science in their research.
https://www.riotsciencenl.com/award-winners

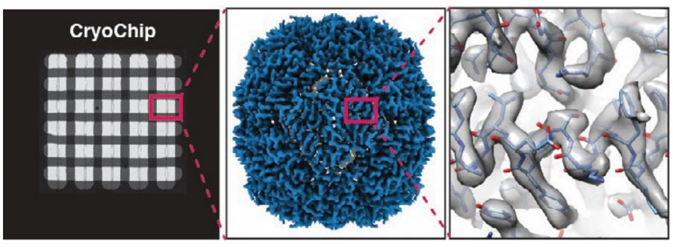
Mohamed Abobeih receives Rubicon grant for quantum computing research at Harvard



The NWO Rubicon programme gives young, highly promising researchers the opportunity to gain international research experience. 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.
https://qutech.nl/2021/10/05/mohamed-abobeih-receives-rubicon-grant-for-quantum-computing-research-at-harvard/

ERC Proof of Concept Grant for Arjen Jakobi

Arjen Jakobi receives the ERC Proof of Concept Grant for his groundbreaking research on cryogenic electron microscopy (cryo-EM). Cryogenic electron microscopy, in which samples are cooled to extremely low temperatures, is an essential technique for determining the structure of biological macromolecules. Jakobi is developing new tools for electron microscopy, which makes it possible to reveal details of protein molecules in a complex environment.



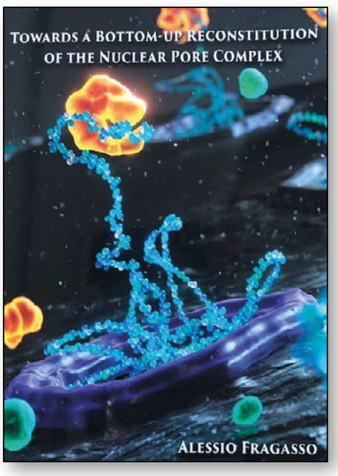
https://www.tudelft.nl/en/2022/tnw/erc-proof-of-concept-grant-for-arjen-jakobi

The Koenderink group has been awarded an EMW-M-2 grant

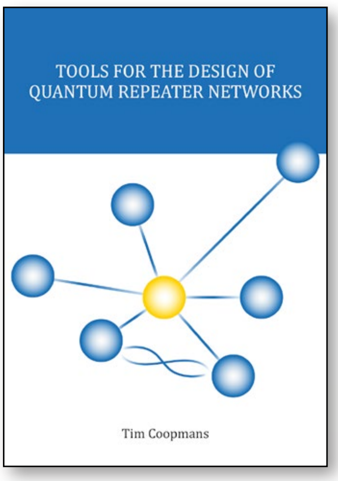
The Koenderink group has been awarded an EMW-M-2 grant, together with the Boukany group (ChemE).
In their ENW-M2 project, the two labs will join their expertise in cell biophysics (Koenderink) and electroporation (Boukany) to reveal the role of the actin cortex in membrane electroporation and cargo translocation (ROCKET), with the ultimate goal to make electroporation robust and predictable.
https://www.tudelft.nl/2022/tnw/tnw-cheme/the-boukany-and-the-koenderink-groups-have-been-awarded-an-emw-m-2-grant-700-keuro

PHD THESES

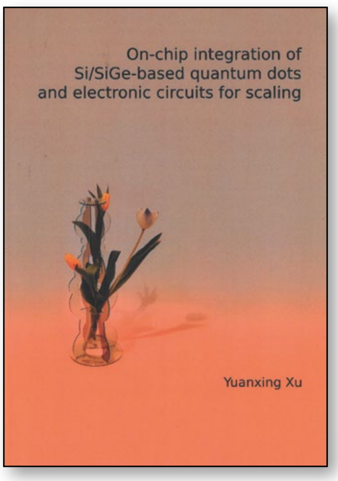
RECENT PHD THESES



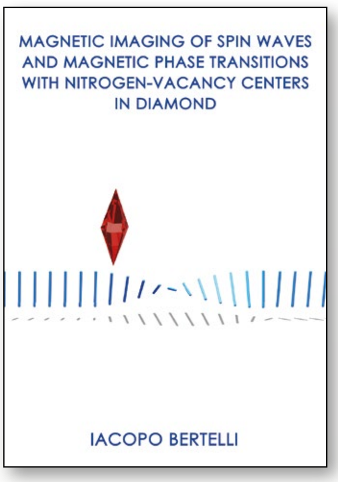
Alessio Fragasso
12 November 2021



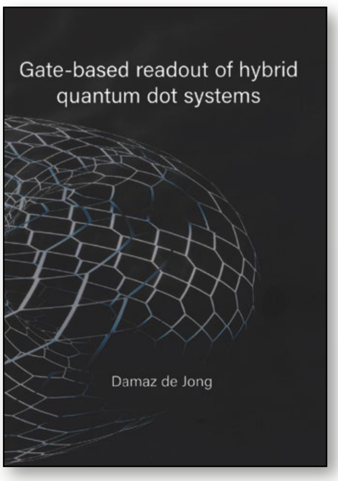
Tim Coopmans
19 November 2021



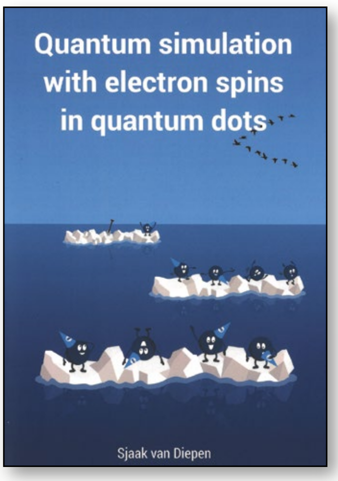
Yuanxing (Alice) Xu
23 November 2021



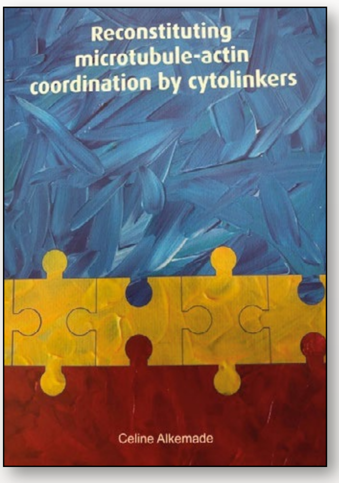
Iacopo Bertelli
24 November 2021



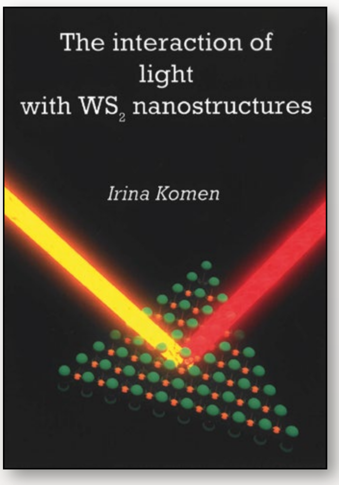
Damaz de Jong
25 November2021



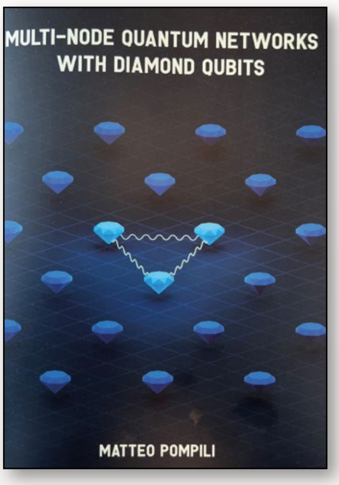
Sjaak van Diepen
01 December 2021



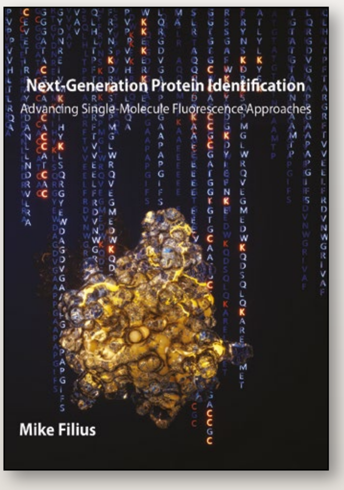
Celine Alkemade
13 December 2021



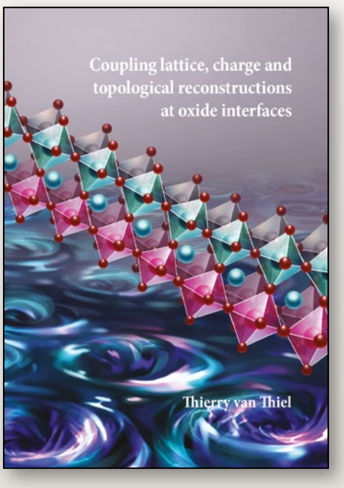
Irina Komen
20 December 2021



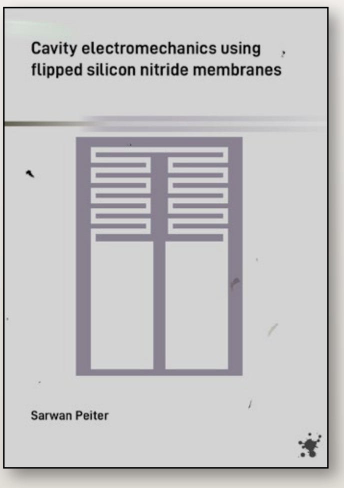
Matteo Pompili
15 December 2021



Mike Filius
27 January 2022

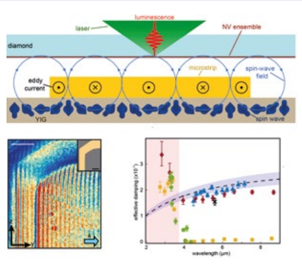


Thierry van Thiel
31 January 2022



Sarwan Peiter
11 February 2022

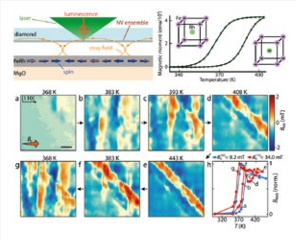
Imaging spin-wave damping underneath metals using electron spins in diamond



We show that electronic sensor spins in diamond enable imaging of spin waves that propagate underneath metals in magnetic insulators, revealing a 100-fold metal-induced increase in spin-wave damping. We argue that the damping enhancement is caused by spin-wave-induced electrical currents as well as, above a certain frequency, three-magnon scattering processes. These results open new avenues for studying metal – spin-wave interactions and provide access to interfacial processes such as spin-wave injection via the spin-Hall effect.

I. Bertelli, B. G. Simon, T. Yu, J. Aarts, G. E. W. Bauer, Y. M. Blanter, T. van der Sar
Advanced Quantum Technologies 2021, 2100094

Magnetic imaging and statistical analysis of the metamagnetic phase transition of FeRh with electron spins in diamond

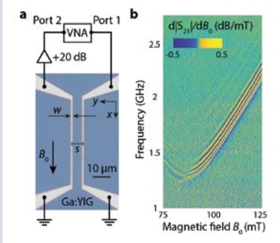


Magnetic imaging based on nitrogen-vacancy (NV) centers in diamond has emerged as a powerful tool for probing magnetic phenomena in fields ranging from biology to physics. A key strength of NV sensing is its local-probe nature, enabling high-resolution spatial images of magnetic stray fields emanating from a sample. However, this local character can also form a drawback for analyzing the global properties of a system, such as a phase transition temperature.

Here, we address this challenge by using statistical analyses of magnetic-field maps to characterize the first-order temperature-driven metamagnetic phase transition from the antiferromagnetic to the ferromagnetic state in FeRh. After imaging the phase transition and identifying the regimes of nucleation, growth, and coalescence of ferromagnetic domains, we statistically characterize the spatial magnetic-field maps to extract the transition temperature and thermal hysteresis width.

G. Nava Antonio*, I. Bertelli*, B. G. Simon, R. Medapalli, D. Afanasiev, T. van der Sar.
Journal of Applied Physics 129, 223904 (2021)

Electrical spectroscopy of the spin-wave dispersion and bistability in gallium-doped yttrium iron garnet

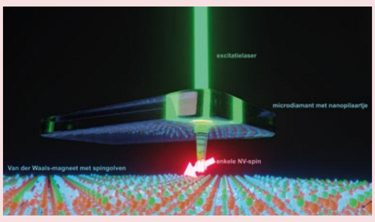


Spin waves are the elementary excitations in magnets that could be used as information carriers in next-generation electronics. In this work we generate and characterize spin waves in a novel magnetic material by measuring the microwave transmission between two microstrips. We observe fringes in the transmission when the microwaves excite gigahertz spin waves that propagate between the striplines.

The fringes result from the interference between the spin waves and the direct field of the excitation stripline. We use the fringes to extract the spin-wave dispersion and conclude that the spin waves have isotropic wavefronts, similar to light waves or water waves. These spin waves may therefore be harnessed in future wave-based computational devices.

J.J. Carmiggelt, O.C. Dreijer, C. Dubs, O. Surzhenko, T. van der Sar
Applied Physics Letters 119, 202403 (2021)

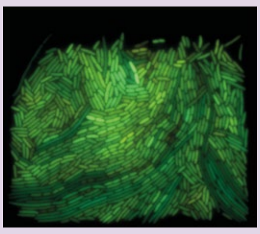
Spinsensoren in diamant onthullen golvende spinzee



We describe a newly-developed imaging technique for spin waves. Spin waves are the elementary excitations of magnets that could be used as information carriers in next-generation electronics. We use the spin of nitrogen-vacancy (NV) centers in diamond to image spin waves by detecting the microwave magnetic fields they generate. To obtain nanoscale resolution, we etch a diamond into a cantilever and integrate it into an atomic force microscope. As a next step, we intend to use this technique to image spin waves in single-layer van-der-Waals magnets.

J. J. Carmiggelt, B. G. Simon, I. Bertelli, T. van der Sar
Nederlands Tijdschrift voor Natuurkunde, June 2021

ppGpp is a bacterial cell size regulator



Cells of all species strive to maintain a characteristic size that depends upon environmental conditions. Working in Escherichia coli, Ferhat Büke discovered that the link between cell growth and cell size is maintained by the small molecule ppGpp, a signal that acts as an intracellular growth rate speedometer in bacteria. By tweaking ppGpp directly, Ferhat showed that ppGpp directly orchestrates cell division machinery together with metabolism, tuning the cell size to new conditions.

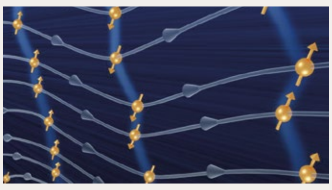
F. Büke, J. Grilli, M. Cosentino Lagomarsino, G. Bokinsky, S.J. Tans
Current Biology 31: 1-8 (2022)

Scanning a single protein, one amino acid at a time

We demonstrate a nanopore-based single-molecule peptide reader sensitive to single–amino acid substitutions within individual peptides. A DNA-peptide conjugate was pulled through the biological nanopore MspA by the DNA helicase Hel308. Reading the ion current signal through the nanopore enabled discrimination of single–amino acid substitutions in single reads. Molecular dynamics simulations showed these signals to result from size exclusion and pore binding. We also demonstrate the capability to "rewind" peptide reads, obtaining numerous independent reads of the same molecule, yielding an error rate of $<10^{-6}$ in single amino acid variant identification.

H. Brinkerhoff, A.S.W. Kang, J. Liu, A. Aksimentiev, C. Dekker
Science (nov 2021), Vol 374, Issue 6574, pp. 1509-1513

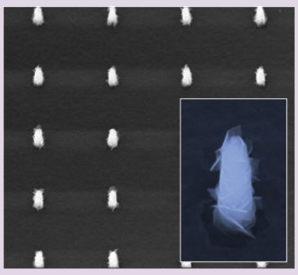
Many-body-localized discrete time crystal with a programmable spin-based quantum simulator



Researchers from QuTech created a time crystal, a novel exotic quantum phase of matter, using a quantum computer based on diamond. Together with a simultaneous experiment by Google, the results shed new light on the physics of out-of-equilibrium quantum systems. The team reports their findings in the November issue of Science.

J. Randall, C.E. Bradley, F.V. van der Gronden, A. Galicia, M.H. Abobeih, M. Markham, D.J. Twitchen, F. Machado, N.Y. Yao and T.H. Taminiau
Science (Nov 2021), Vol 374, Issue 6574

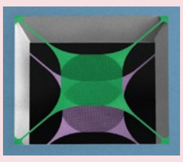
Position-Controlled Fabrication of Vertically Aligned Mo/MoS2 Core–Shell Nanopillar Arrays



This work presents a novel strategy to fabricate position-controlled Mo/MoS2 core–shell nanopillars by a combination of bottom-up and top-down methods. We demonstrate how individual Mo/MoS2 nanopillars exhibit significant nonlinear optical processes driven by the MoS2 shell, achieving the precise localization of the nonlinear signal required to implement 1D TMD-based nanostructures as building blocks of a new generation of nanophotonic devices.

L. Maduro, M. Noordam, M. Bolhuis, L. Kuipers, S. Conesa-Boj
Advanced Functional Materials, 2107880

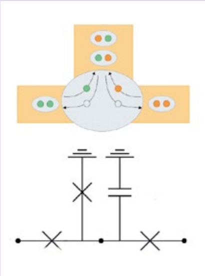
Coherent mechanical noise cancellation and cooperativity competition in optomechanical arrays



We demonstrate two new effects in an array of coupled mechanical membranes - noise cancellation and a competition between their respective cooperativities.

M.H.J. de Jong, J. Li, C. Gärtner, R.A. Norte, S. Gröblacher
Optica 9, 170-176 (2022)

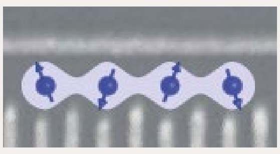
Multiplet supercurrent in Josephson tunneling circuits



Bringing two superconductors into contact allows supercurrent to tunnel from one to another without any energy cost. In specially designed devices with three or more superconductors, correlated charge transfer events between different superconductors allow the supercurrent to flow even at finite voltage. However, existing experimental implementations are plagued by dissipation and require engineering trajectories of single electrons. We predict that correlated supercurrent flow appears in macroscopic circuits that control the superconducting condensate instead of individual electron trajectories. In addition to relying on standard building blocks, these circuits have a much lower dissipation, therefore solving both experimental limitations at once.

A. Melo, V. Fatemi and A. Akhmerov
SciPost Phys. 12, 017 (2022)

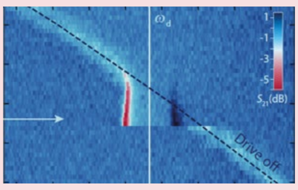
Quantum Simulation of Antiferromagnetic Heisenberg Chain with Gate-Defined Quantum Dots



To study magnetism we compose quantum matter out of electrons confined in semiconductor quantum dots such that only the spin degree of freedom remains. The electrons then form an antiferromagnetic spin chain with exchange interactions arising from wave function overlaps, which can be controlled with voltages on gate electrodes. We demonstrate techniques to study the energy spectrum, coherence and ground state configuration of the spin chain. This experiment paves the way for studies of complex forms of magnetism by leveraging the in situ control over interactions and the design flexibility of lithographically defined quantum dot lattices.

C.J. van Diepen, T.-K. Hsiao, U. Mukhopadhyay, C. Reichl, W. Wegscheider, L.M.K. Vandersypen
Physical Review X 11, 041025 (2021)

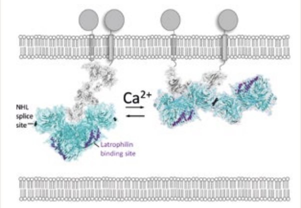
Four-wave-cooling to the single phonon level in Kerr optomechanics



While distortion from nonlinearity can lead to cool sounds from electric guitars, nonlinearity in detectors and amplifiers is usually the enemy of physicists trying to sense small signals. In work detecting mechanical resonators using high frequency SQUID cavities, Daniel Bothner and Ines Rodrigues from the Quantum nanoscience department found new ways of using nonlinearity, stabilising fluctuations of their cavity from external noise, and enabling enhanced cooling of their mechanical device to 1.6 phonons using nonlinear mixing techniques.

D. Bothner, I.C. Rodrigues and G.A. Steele
Quant-ph arXiv:2104.02511

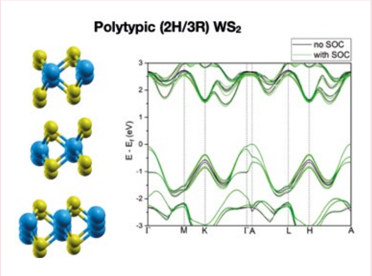
Structural insights into the Teneurin4 dimer reveal a compact conformation



Neuronal circuit wiring is an essential process for brain function that involves specialized macro-molecular complex formation at the neuronal synapse. Detailed structural insights into the composition and architecture of these macro-molecular complexes will help understanding the process of neuronal network formation, specifically neuronal target selection. Here, we determined the structure of a large, evolutionarily conserved synaptic transmembrane protein named Teneurin4. A combination of X-ray crystallography, cryo-electron microscopy and mammalian cell biology revealed that a novel compact conformation of the dimer, with three conserved calcium binding sites, is compatible with homomeric trans interactions at the neuronal synapse.

D. Meijer, C. Frias, W. Beugelink, Y. Deurloo, B. Janssen
The EMBO Journal (2022) e107505

First-Principles Calculation of Optoelectronic Properties in 2D Materials: The Polytypic WS2 Case



This work presents a first-principles density functional theory (DFT) calculation of the optoelectronic properties associated with the 2H/3R polytypism occurring in WS2 nanomaterials. We evaluate the band gap, optical response, and energy-loss function, confirming previous experimental measurements carried on the same material with electron energy-loss spectroscopy.

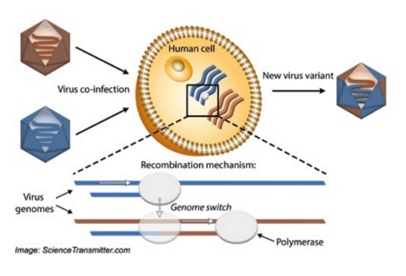
L. Maduro, S.E. van Heijst, S. Conesa-Boj
ACS Phys. Chem Au 2022

Quantum logic with spin qubits crossing the surface code threshold

The central requirement for correcting errors is expressed in terms of an error threshold. Reaching two-qubit gate fidelities above 99% has been a long-standing major goal for semiconductor spin qubits. Here we report a spin-based quantum processor in silicon with single-qubit and two-qubit gate fidelities, all of which are above 99.5%. These results show that semiconductor qubits have gained credibility as a leading platform, not only for scaling but also for high-fidelity control.

X. Xue, M. Russ, N. Samkharadze, B. Undseth, A. Sammak, G. Scappucci, L.M.K. Vandersypen
Nature 601, 343–347 (2022)

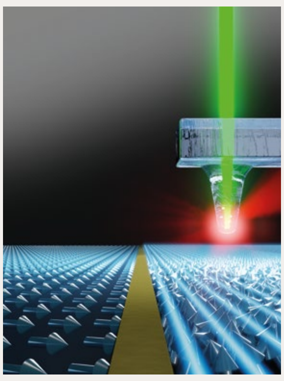
Induced intra- and intermolecular template switching as a therapeutic mechanism against RNA viruses



Genetic recombination is the major driver of viral evolution and allows crossing the species barrier. This study revealed the decades-long mystery of the trigger underlying recombination in RNA viruses using a combination of single-molecule methods, cell-based assays, mouse infection models, and next-gen RNA sequencing. While the study revealed that recombination occurs stochastic, it demonstrated that a novel class of antiviral drug can induce recombination to a level that no functional virus particles are produced, providing a novel mechanistic target for combating RNA virus infections.

R. Janissen, A. Woodman, D. Shengjuler, T. Vallet, K.-M. Lee, I. Moustafa, F. Fitzgerald, P.-N. Huang, L. Kuijpers, A.L. Perkins, D.A. Harki, J.J. Arnold, B. Solano, S.-R. Shih, M. Vignuzzi, C.E. Cameron, N.H. Dekker
Molecular Cell, 81(21):5567 (2021)

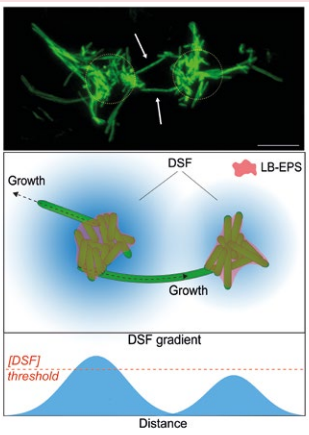
Directional excitation of a high-density magnon gas using coherently driven spin waves



Magnetometry based on nitrogen-vacancy (NV) spins in diamond has recently emerged as a powerful tool for probing spin waves – the elementary excitations of coupled spins in magnetically ordered materials. We use scanning NV magnetometry to reveal that coherently driven, low- wavenumber spin waves are efficient generators of a non-equilibrium magnon gas in target directions, opening new avenues for local control when driving spin transport or magnetization dynamics.

B.G. Simon, S. Kurdi, H. La, I. Bertelli, J.J. Carmiggelt, M. Ruf, N. de Jong, H. van den Berg, A. Katan, vT. van der Sar.
Nano Letters, Oct. 1, 2021. doi: 10.1021/acs.nanolett.1c02654

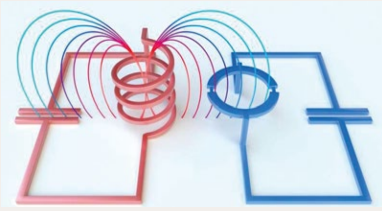
Controlled spatial organization of bacterial growth reveals key role of cell filamentation preceding Xylella fastidiosa biofilm formation



Morphological plasticity of bacteria forming filamentous cells are commonly interpreted as consequences from stresses such as starvation and DNA damage. In contrast, diverse human pathogenic bacteria have shown cell filamentation mechanism during biofilm growth. This systematic study not only demonstrates that cell filamentation is essential for biofilm formation, but also that the morphogenesis is governed by quorum sensing of diffusive signalling molecues, representing in turn an alternative target for antibacterial therapies.

S. Anbumani, A.M. da Silva, E.R Fisher, M de Souza e Silva, A.A.G. von Zuben, H.F. Carvalho, A.A. de Souza, R. Janissen, M.A Cotta
Nature npj Biofilms and Microbiomes 7(86) (2021)

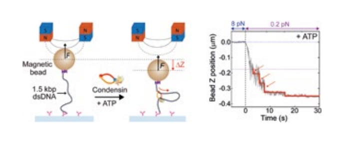
Cooling photon-pressure circuits into the quantum regime



Photon pressure couping is a new technique recently developed for coupling together quantum superconducting circuits in which the current through an inductor in one circuit changes the frequency of another circuit, directly analogous to optomechanics. In their recent result, Ines Rodruiges and Daniel Bothner from the Quantum Nanoscience department were able to bring photon pressure circuits into the quantum regime, cooling the thermal occupation of a radio-frequency circuit into its quantum ground state, opening up new potential applications in quantum sensing at radio frequencies.

I.C. Rodrigues, D. Bothner, G.A. Steele
Science Advances 7, eabg6653 (2021)

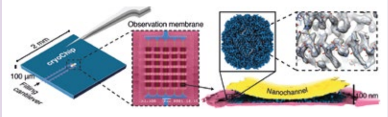
Condensin extrudes DNA loops in steps up to hundreds of base pairs that are generated by ATP binding events



Condensin SMC protein complexes are a ATP-driven motors that are involved in genome organization by extruding loops of chromosomal DNA. By using single-molecule Magnetic Tweezers combined with Molecular Dynamics simulations, this study investigated the molecular mechanism underlying the phenomena of extruding long DNA loop segments. The study revealed that the loop extrusion step size also depends on the DNA flexibility and that a single ATP-binding event allows condensin to extrude up to 800 bp at low DNA stretching forces.

J.-K. Ryu, S.-H. Rah, R. Janissen, J.W.J. Kerssemakers*, A. Bonato, D. Michieletto, C. Dekker
Nucleic Acids Research, gkab1268 (2021)

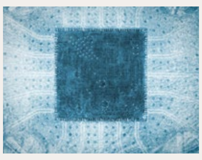
Nanofluidic chips for cryo-EM sample preparation from picoliter volumes



With cryogenic electron microscopy (cryo-EM) it is possible to study the 3D structure of the molecular machinery central to life at the nanoscale. Unreliable sample preparation is a severe bottleneck of the technique. We have introduced MEMS technology to cryo-EM sample preparation and designed nanofluidic chips that help solve these challenges. In proof-of-principle experiments we show that our approach resolves benchmark samples to up to 3 Ångstrom resolution, sufficient for atomic-level understanding of biological macromolecules."

S.T. Huber, E. Sarajilic, R. Huijink, W. Evers, A.J. Jakobi
eLife 11: e72629 (2022)

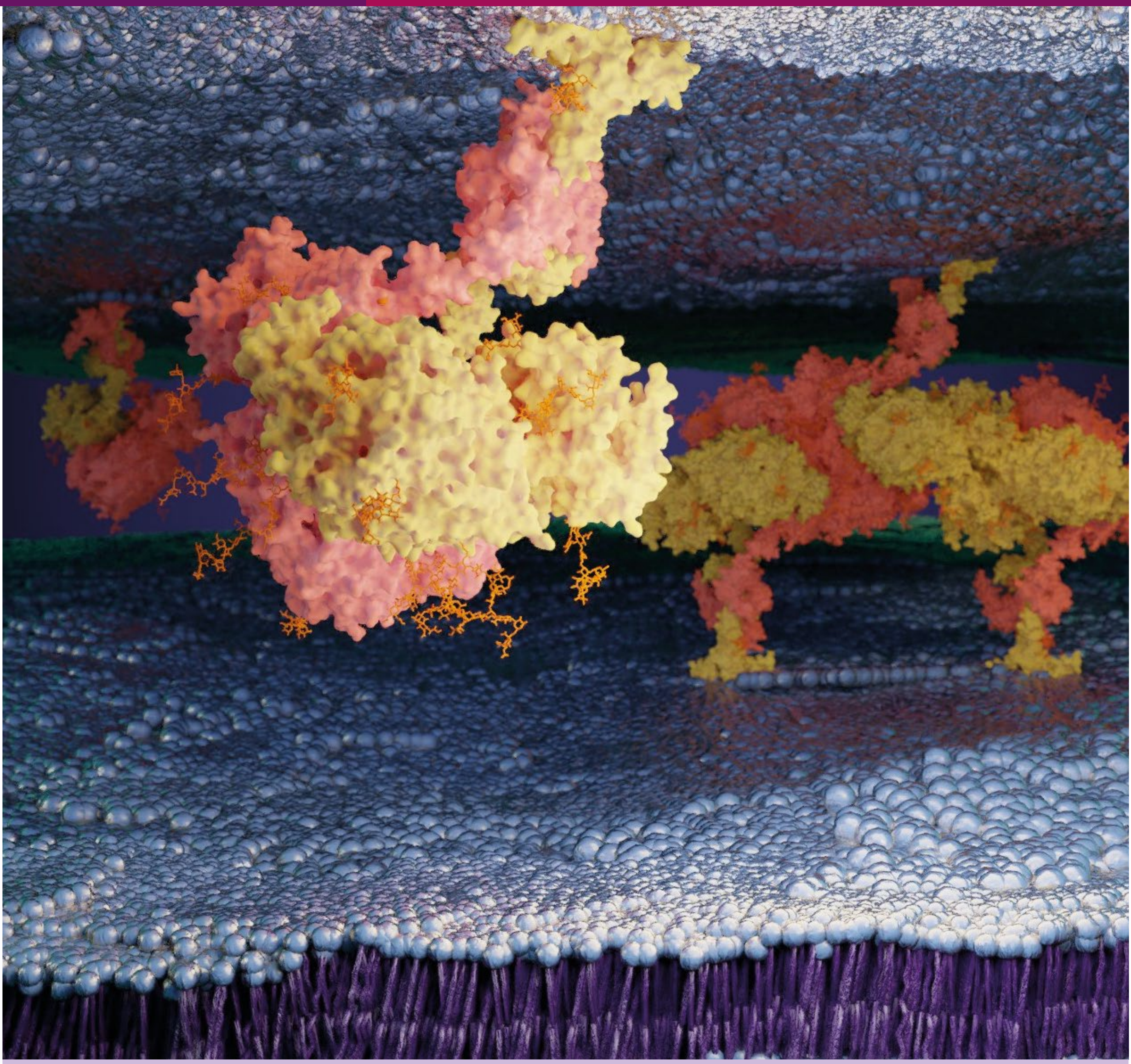
Logical-qubit operations in an error-detecting surface code



Researchers at QuTech have reached a milestone in quantum error correction. They have integrated high-fidelity operations on encoded quantum data with a scalable scheme for repeated data stabilization. The researchers report their findings in the December issue of Nature Physics.

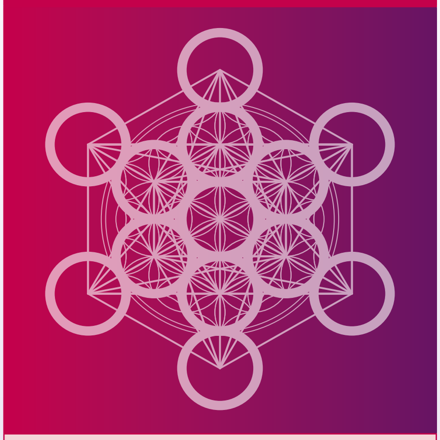
J.F. Marques, B.M. Varbanov, M.S. Moreira, H. Ali, N. Muthusubramanian, C. Zachariadis, F. Battistel, M. Beekman, N. Haider, W. Vlothuizen, A. Bruno, B.M. Terhal, L. DiCarlo
Nature Physics volume 18, pages80–86 (2022)

SCIENCE ART



Artist impression of the trans-cellular interactions of Teneurin4, a covalent dimer that is kept in compact conformation by three calcium binding sites to connect the pre- and postsynaptic membranes at the neuronal synapse. This research was published in The EMBO Journal, online 31 January 2022, doi: 10.15252/embj.2020107505
Credits: Enrique Sahagún, Scixel

KAVLI DAY 2022



August 25, 2022	
TBA	

COLOFON

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