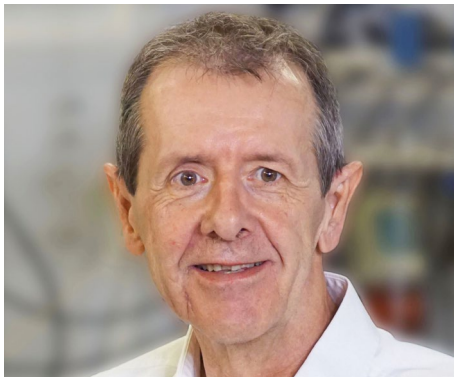
University of Basel
Swiss Nanoscience Institute

SNI
SWISS NANOSCIENCE INSTITUTE
EINE INITIATIVE DER UNIVERSITÄT BASEL UND DES KANTONS AARGAU

SNI update October 2018



Dear colleagues,

In September, SNI members from the Nano Argovia projects, the SNI PhD School, the Nano Imaging Lab, and the management team met at the Annual Event in Lenzerheide to discuss their research. It was already the fifth installment of the event, whose eclectic mix of basic and applied science reflects the diverse and fascinating developments within the nanosciences.

The Annual Event was followed immediately by the start of the fall semester, and we've already had the opportunity to welcome new students onto the nanosciences degree program at a meet-and-greet event. This year, Andreas Baumgartner and I are teaching Physics I as part of the nanosciences degree, and I will relish this opportunity to track the students' progress from the outset. In this issue of SNI update, you too will have the opportunity to find out more about two of our new students.

Now at a more advanced stage of his education, Tino Matter is the winner of the prize for the best master's thesis in 2017. I had the pleasure of presenting his award at the Annual Event ¬ and you can read about his prizewinning work in this issue of SNI update.

Just before the Annual Event, Tino Matter took part in a workshop we had organized for doctoral students at the SNI PhD School. The workshop aimed to teach students how to realize their own strengths and talk about them in a job interview – which can be a very helpful skill, especially at the start of your professional career.

In this SNI update, we also report on two Nano Argovia projects that were approved for 2018. The deadline for the next call for Nano Argovia proposals has now passed, and the assessors will spend the next few weeks evaluating the 24 applications we have received.

Those who would like to find out more about the Nano Argovia program are invited to attend the Nano-Tech Apéro at DSM in Kaiseraugst on November 14. This will be an opportunity to learn more about a range of applied Nano Argovia projects and to share experiences.

I look forward to seeing you at the Nano-Tech Apéro and hope you enjoy reading this issue of SNI update.

Kind regards,

Christian Schönenberger

Prof. Dr. Christian Schönenberger
SNI Director

Improving wound healing with a nanoglue

This year's prize for the best master's thesis in nanosciences at the University of Basel was awarded to Tino Matter. As part of his project at the Swiss Federal Laboratories for Materials Science and Technology (Empa), he studied bioactive nanoparticles that ensure rapid wound closure and aid healing.

Whereas wounds heal naturally in healthy patients, the process can stagnate in older people and those suffering from pre-existing conditions such as diabetes. Internal wounds can also cause problems in some circumstances because they are hard to close. Open wounds affect patients' quality of life, exacerbate the risk of infection, and result in huge costs for the healthcare system. There is therefore an urgent need for new treatment approaches that enable rapid wound closure and healing.

Bioactive nanoparticles are one solution

One possible approach to improve wound healing is to use bioactive nanoparticles. In his prizewinning master's project, Tino Matter investigated the viability of various nanoparticles as wound glues. With the help of a technique known as flame synthesis, he first prepared a range of nanoparticles and investigated their adhesive effect and ability to stop bleeding. He then combined the particles with other materials and tested additional properties, such as their antimicrobial activity, stimulant effect on blood vessel formation, and effectiveness as antioxidants.

"Nanoparticles in combination with bioactive glas (bioglass) turned out to be particularly promising candidates," he says. "Thanks to their large surface area, they adhere excellently to tissue and therefore act as a glue. They also have a significant stimulatory effect on clotting."

In combination with tiny quantities of silver, the bioglass nanoparticles exhibit antimicrobial properties. If strontium is added as a dopant, new blood vessels develop more rapidly, aiding the wound-healing process. In all these approaches, testing the absolute safety of the various material combinations is critical for the research team working under Empa's Dr. Inge Herrmann, who supervised Tino during his master's thesis.

Tino Matter received the prize for the best master's thesis in nanosciences at the University of Basel.

He studied bioactive nanoparticles that ensure rapid wound healing. (Image: Tino Matter)

Fascinated by the topic

Tino had already studied the topic of wound glues in one of the projects he completed during his nanosciences degree. After a placement at the Institute of Microelectronics of Barcelona, the committed young nanoscientist was keen to get to know Switzerland's research landscape better and applied for a role in Inge Herrmann's team at Empa via the Sirop platform for

academic positions. He has been hooked on the topic of wound healing ever since. After successfully finishing his master's degree, he stayed on at Empa to complete his doctoral dissertation and continue working on the project. "As part of this research, we believe it's essential to work closely with surgeons. After all, we want to develop something that actually goes on to benefit patients," Tino explains.

An attractive combination of physics, mathematics and the natural sciences

When Tino Matter came to Basel to study nanosciences in 2012, he hadn't given any thought to projects, master's theses or doctoral dissertations. It was at an information day in Fribourg that he first heard about the nanosciences degree in Basel, which he felt was "a program that opened many doors by bringing together mathematics and all the natural sciences." In other words, it was just what he'd been looking for.

He has never regretted studying nanosciences and would choose this demanding interdisciplinary degree program again in a heartbeat. "The first couple of years especially were very time-consuming, but the subject matter was fascinating and it's incredible what I learned in that time," he recalls. Like so many of his colleagues, he particularly remembers the block courses. Here, students gain an insight into various fields and "learn about the mentality of the various disciplines", he says.

Interdisciplinarity and high quality

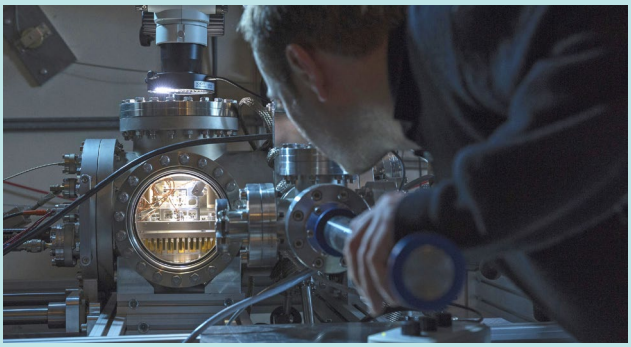
There's no doubt that Tino Matter adapts to these different mentalities and vernaculars with ease and enjoys taking on a wide range of commitments. During his studies, for example, he sat on the organizing committee for the International Nanoscience Student Conference (INASCON) as well as attending the latest Annual Event, where he received the prize for the best master's thesis, mingled with the SNI PhD students like a natural, took part in all the activities, and presented his fascinating research during the poster session.

The highly interdisciplinary nature of this research was one of the reasons why the project was chosen as the winner from a number of outstanding master's theses. Another key factor was that Professor Ernst Meyer, who supervised the thesis at the University of Basel, felt it was "one of the best he'd ever had the pleasure of grading".

We congratulate Tino Matter and wish him every success for the future!

Further articles about Tino's work can be found at:
https://mtmatter.github.io

Apply now for the new PhD School projects!



For the year 2019, eight new PhD projects have been approved. Highly motivated young scientists are invited to apply.

The successful candidates will join the attractive SNI program that currently supports more than 30 young scientists. Each doctoral student is supervised by two scientists from the interdisciplinary SNI network.

More information can be found at:
https://nanoscience.ch/en/2018/08/30/apply-now-for-the-new-phd-school-projects/

Introducing…

Tamara Utzinger and Tim Kubetzko – two of our new nanoscience students

First-semester students recently began the nanosciences degree at the University of Basel. We were curious to find out what relationship they have with the natural sciences, why they chose to study in Basel, and what expectations they have of the degree. We talked briefly with two of the new students to get a general idea.

Tamara Utzinger from Niederwil (Canton of Aargau, Switzerland)

Tamara Utzinger had her first insight into the nanosciences during a talk at her school in Wohlen and was immediately fascinated by the diversity and opportunities that the nanosciences have to offer. She learned more about the nanosciences and nanotechnology at a TechNight in Wohlen, which was organized by the Swiss Academy of Engineering Sciences (SATW) and also featured representatives of the SNI. Most importantly, it was here that she found out that the University of Basel offers an interdisciplinary study program in nanosciences. "It was absolutely fascinating, and I was drawn to the course immediately," Tamara recalls. She took a brochure about the nanosciences degree away with her to read and found exactly what she was looking for there.

Tamara Utzinger learned about the nano study program at a TechNight and was drawn to the course immediately.

The decision to study nanosciences after gaining her school-leaving certificate (Matura) in spring 2018 was therefore an easy one. She applied for and won a scholarship from the Canton of Aargau and is now eagerly making a start on her degree. She realized that the 90-minute commute from Niederwil to Basel was worth it to learn the basics of biology, chemistry and physics.

Tamara was interested in the natural sciences throughout her time at school but didn't develop a preference for one discipline in particular. Biology and chemistry were her major subjects at high school, and she is now particularly attracted to the interdisciplinarity of the nanosciences degree. "Now that all the introductions are over with, I'm looking forward to getting started for real," she says in our interview. In her first two weeks, she found a lecture on the development of the quantum computer particularly fascinating.

Tim Kubetzko from Lörrach (Germany)

Tim Kubetzko has been interested in physics since he was a boy. He also chose physics, along with music, as a major subject for his school-leaving certificate (Abitur). Throughout secondary school at the Hans-Thoma-Gymnasium in Lörrach, he enjoyed conducting research at the phaenovum student research center in his spare time and successfully took part in numerous science competitions.

It all began in the ninth grade with a project about a tower block in London, whose reflective facade had been setting fire to cars. The highlight of his activities at phaenovum saw him take part in the national "Jugend forscht" (Young Researchers) competition, ultimately qualifying for the world's biggest mathematics/natural sciences competition for high school students. At the competition, which was held in Pittsburgh (Pennsylvania, USA) in May this year, Tim took second place alongside Lennart Resch. Together, they had studied the falling properties of rope ladders with angled rungs and succeeded in proving that their falling behavior contradicts Galileo's law of falling bodies due to Earth's angular momentum (more information at: https://www.phaenovum.eu/de/neuigkeiten/aktuelles/news/phaenovum-jungforscher-beim-weltweit-groessten-mint-schuelerwettbewerb-in-den-usa-erfolgreich/?tx_news_pi1%5Bcontroller%5D=News&tx_news_pi1%5Baction%5D=detail&cHash=d3be8ea761d7672c043ae795f896f748)

Tim originally wanted to study bionics, because he was fascinated by its diverse and interdisciplinary subject matter. However, during his many hours at phaenovum, he got talking to PD Dr. Thilo Glatzel from the Department of Physics, who has been involved in phaenovum for many years and has supported numerous student projects there. Thilo told him more about the degree in nanosciences in Basel. “The wide-ranging nanosciences degree seemed like an ideal alternative,” says Tim. “I now have classes in biology, chemistry, physics and math, and am learning the basic principles in all of them. I suppose it’s a bit like a Swiss Army knife – it’s universally applicable.”

Tim Kubetzko has been involved in research projects since ninth grade and has won several prizes.

He is also delighted that he can continue to live in Lörrach during his studies and that there are relatively few students in his semester. “You know everyone after the first week,” he says. It also suits him that the first semesters have a fairly school-like structure and that the timetable is predetermined. Now, he is looking forward to his lectures in the various subjects – and, ultimately, to the opportunity to act as a link between the different disciplines by applying this broad-based education.

Nano Argovia projects

In the last issues of SNI update, we introduced running Nano Argovia projects. Today, you get to know more about the projects NQsense and NanoGhip.

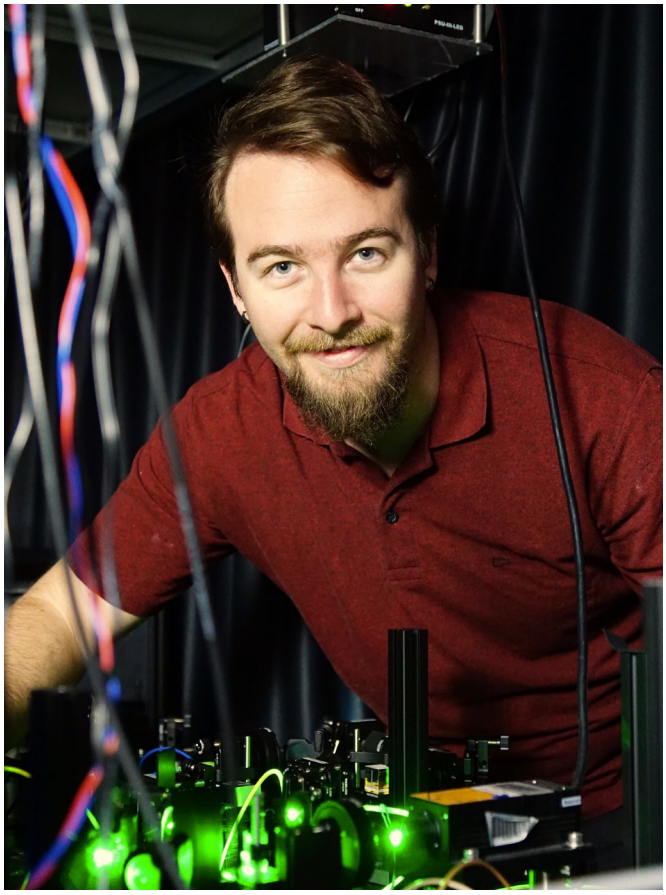
Working together to improve light yield – The Nano Argovia project NQsense seeks to optimize the sensitivity of quantum sensors for nanoscale applications

In the NQsense project, the team working under project leader Professor Patrick Maletinsky plans to fabricate a fully integrated quantum sensor with significantly improved sensitivity. This sensor could be used, for example, to support basic scientific research in the areas of materials science or to perform failure analyses in the semiconductor industry.

Diamonds as sensors

The team of scientists from the Department of Physics at the University of Basel, the Paul Scherrer Institute, and the industrial partner Qnami – a start-up from the Department of Physics at the University of Basel – is basing its work on tiny quantum sensors made of diamonds.

These are created by deliberately removing two carbon atoms from the diamonds’ crystal lattice. One is replaced with a nitrogen atom, and the second is left as a vacant site in the lattice. These nitrogen-vacancy centers (NV centers) host individual electrons that can be excited and manipulated. The intrinsic angular momentum (spin) of these electrons, and their electric dipole, are extremely sensitive to tiny magnetic and electric fields. Exposing the diamond sensor to fields of this kind causes a change in the intensity of the NV center’s luminescence. This can be detected using an optical device and used to draw specific conclusions about the influencing field.



Dr. Felipe Favaro De Oliveira, CTO at Qnami, seeks to optimize the sensitivity of quantum sensors.

Ambitious goals

In recent years, the team has already achieved significant improvements in the tiny sensors' complex and demanding production process. Now, the scientists are exploring ways to boost the sensitivity of their sensors. That is easier said than done, because diamonds have a high refractive index. As a result, most of the light emitted by the NV centers is reflected inwards by the outer surfaces, leaving it unavailable for measurements.

"At the moment, we can use about one to two percent of the emitted photons for our measurements. As part of the Nano Argovia project NQsense, we now want to design and produce structures that allow us to boost the yield to up to 50 percent," comments Professor Patrick Maletinsky on the impending challenge.

"The Nano Argovia program offers the ideal framework for our product's further development, as we can exploit synergies with our partners at the University of Basel and the Paul Scherrer Institute, as well as benefiting from our partners' excellent technical equipment," says Mathieu Munsch, CEO of the industrial partner, Qnami.

Nano-Tech Apéro

On Wednesday, November 14, 2018, you will have the opportunity to find out more about projects in the Nano Argovia program at the NanoTech Apéro. The event will be held at DSM in Kaiseraugst from 4 pm to 6:30 pm and will be followed by an aperitif.

Further information is available at:
https://nanoscience.ch/wp-content/uploads/sites/8/2018/09/nano-tech-apero_dsm-1.pdf

Registration is strictly required.
(michèle.wegmann@unibas.ch).

Detecting tiny changes using biosensors – The Nano Argovia project NanoGhip is developing a prototype of a biochip for drug discovery

In the Nano Argovia project NanoGhip, an interdisciplinary team led by Dr. Martin Ostermaier from InterAx Biotech AG (Villigen, AG) is investigating a new screening method for active substances that could lead to the discovery of new medicines. The scientists aim to develop a new type of biochip that analyzes how the chemical and biological molecules in question react with protein complexes in real time. Even at this early stage, it could also provide information about the safety profile of the tested compounds.

Relaying signals

Membrane proteins play an important role in our cells. As well as being fundamental for our survival, they are involved in the development and treatment of diseases. In this context, G protein–coupled (GCP) receptors are particularly significant. Among other functions, they relay signals to the cell's interior and thereby regulate a whole cascade of vital reactions. In doing so, many of these G protein–coupled receptors interact with a wide range of proteins to form protein complexes.

Searching for new active substances that influence these receptors is difficult because, instead of analyzing one individual protein, it is important to consider entire protein complexes in order to replicate the natural conditions in the cell as closely as possible. Given that these protein complexes are anchored within membranes in their natural environment, they must also be integrated into membranes for the screening process.

On a chip measuring approximately 10 x 10 mm (gold square), tiny artificial vesicles with integrated protein complexes are placed in four small channels (volume: 0.06 µl). Then, biosensors are used to observe how various test substances affect the protein complexes. The data provides information about the biological properties of the test substances, ultimately allowing researchers to draw conclusions regarding the efficacy and safety of the potential active pharmaceutical ingredients they are studying ((Image: InterAx Biotech/Biozentrum).

Tiny changes

In order to create a biochip, the researchers in the NanoGhip project incorporate natural protein complexes into synthetic membranes. These have very similar properties to the natural membranes but surpass their natural counterparts in terms of robustness. The researchers then use biosensors to monitor structural changes in the protein complexes when test substances come into contact with the system. These tiny conformational changes of the G protein–coupled receptors have a magnitude of just 0.1 to 1.4 nanometers. Using the protein-based biosensors, the scientists derive information about whether a test substance prevents the GPC receptors from relaying signals to the cell's interior.

The Nano Argovia project NanoGhip is a close collaboration by scientists from InterAx (a start-up of the Paul Scherrer Institute and ETH Zurich), the Paul Scherrer Institute, and the Department of Chemistry and Biozentrum at the University of Basel, with each of them contributing their own very different areas of expertise. "In this project, we've brought together a unique combination of experts that allows us to exploit synergies and explore a new approach to the biological screening of substances on a chip," summarizes project leader Martin Ostermaier.

Network partners' events:

Biozentrum Lectures: A phage that counts
Bonnie L. Bassler, Squibb Professor and Chair in Molecular Biology at Princeton University and Howard Hughes Medical Institute Investigator, USA.
Friday, October 26, 2018, 12:15 pm, Biozentrum Basel
https://nanoscience.ch/wp-content/uploads/sites/8/2018/09/bonnie_bassler_flyer.pdf

Energiezukunft zwischen Mythos und Realität (The future of energy – between myth and reality)
Thursday, November 8, 2018, 8:30 am to 4:30 pm, Hightech Zentrum Aargau, Brugg
https://www.hightechzentrum.ch/veranstaltungen/energietechnologie/203-energietechnologien.html

Innovative, Functional Coatings: New technologies and materials, surface protection, and design possibilities with 3D printing
Wednesday, November 14, 2018, 1:00 pm to 7:00 pm, Empa, Feuerwerkerstrasse 39, Thun
https://events.empa.ch/event.php?vnr=146-10A&_ga=GA1.2.118773465.1515497128

Events

Another varied and interesting program at the fifth SNI Annual Event

It's almost like a family gathering when members of the SNI meet at Hotel Schweizerhof for their Annual Event in September, just before the fall semester gets underway. Project leaders of Nano Argovia projects and young scientists from the SNI PhD School present their projects in different areas of applied and basic science through a series of talks and posters, and the breaks provide an opportunity to discuss new findings and projects.

Participants of the Annual Event are listening to the latest research findings of diverse SNI projects.

This year, representatives of two start-ups were also on hand to report on their projects. Dr. Danuta Cichocka, CEO of the start-up Resistell, presented a method that allows the quick and accurate testing of bacterial strains' susceptibility to antibiotics. The Basel-based company has won the Swiss MNT Network Start-up Prize for the method, which involves monitoring the tiny movements of bacteria positioned on cantilevers.

Dr. Felipe Favaro de Oliveira, CTO at Qnami, gave a talk about the Nano Argovia project NQsense. Qnami is involved in the project as an industrial partner and is working alongside teams at the University of Basel and the Paul Scherrer Institute to boost the photon yield of quantum sensors (see article on NQsense).

Another highlight of the meeting was the late-night lecture by Professor Daniel Müller from the Department of Biosystems Science and Engineering at the Federal Institute of Technology (ETH) Zurich in Basel (D-BSSE). Daniel Müller gave a vivid and entertaining presentation of his research and stayed with colleagues until late at night to discuss the nanoscale balance his team has developed in collaboration with Professor Christoph Gerber. This is designed to determine the mass of individual cells and is now being marketed by the company Nanosurf.

During the late-night lecture, scientists discussed the nanoscale balance until late at night.

The Annual Event offers an ideal platform for discussions about scientific projects.

The Annual Meeting also provided an opportunity to thank and honor some SNI members for their special achievements.

For example, Professor Jens Gobrecht of the Paul Scherrer Institute was made an honorary member of the SNI in recognition of his long-standing support of the SNI and his commitment to the Nano Argovia program. Tino Matter received an award for the best master's thesis in nanosciences at the University of Basel in 2017, while Dr. Tomaž Einfalt received the Outreach Award for the second time in recognition of his tremendous commitment to various SNI outreach activities. Claudio Schmidli received the Best Poster Award, and Noah Ritzmann won the prize for the best talk by a PhD student.

Jens Gobrecht was made an honorary members of the SNI.

Claudio Schmidli received the Best Poster Award and Noah Ritzman won the prize for the best talk by a PhD student.

The dates have already been decided for the next Annual Meeting, which will be held on September 12 to 13, 2019. The venue will once again be Hotel Schweizerhof in Lenzerheide.

Identifying and focusing on strengths

From a young age, we are told what we are bad at and where we can improve. In the run-up to the Annual Event, the SNI's PhD students experienced a completely different – and more positive – approach in a workshop about personal strengths. Yvonne Ulrich from MeTi Coaching taught 21 of the young scientists how to address their strengths, which they had all identified beforehand using the CliftonStrengths® Finder (Gallup).

In the test, the PhD students were presented with 177 pairs of statements and had to decide which statement was more applicable in each case. As a result, they received an overview of their five dominant talents.

It is important to be aware of these strengths, because Gallup research indicates that "when considering where to invest one's time, energy and attention … the best place to start is in an area of strength". Of course, that is not to say that weaknesses can simply be ignored.

"The StrengthsFinder workshop helped me to understand myself a little better and apply this understanding when planning my career. I think my career development strategy has changed for the better," commented Wojciech Szmyt.

In the workshop, the PhD students learned to realize their own strengths and to put them into words. According to Yvonne Ulrich, who has worked in the pharmaceutical industry for over 25 years and talks to many candidates in job interviews, it is commonplace to ask people about their own talents. It therefore makes sense to have appropriate wording prepared for this question.

Taking account of team members' different talents is also vital when putting together an ideal team. This was another interesting concept for PhD students, who are likely to lead a series of different teams over the course of their careers and might therefore be in a position to put the Strengths Finder to use.

"An excellent workshop that took an interesting approach to familiarizing me with the relevant language and helping me communicate my strengths – especially during an interview," Eirini Rousounelou summarized.

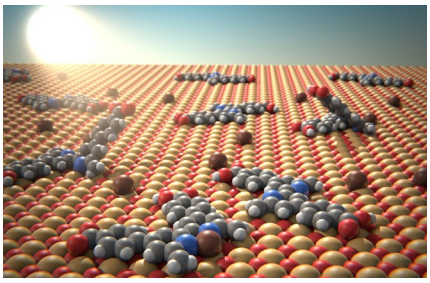
"The event made us focus on our strengths, which is something that we don't necessarily do in everyday life and that many of us don't find very easy," says Thomas Mortelmans.

Obviously, it can be fun to discuss strength.

Uni news and media releases from the SNI network

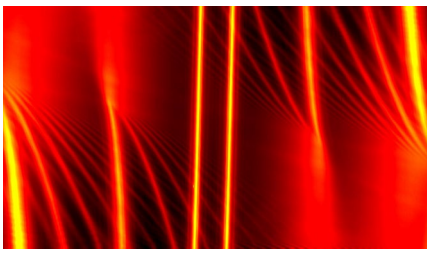
University of Basel, 9 October, 2018. Metal leads to the desired configuration

Scientists at the University of Basel have found a way to change the spatial arrangement of bipyridine molecules on a surface. These potential components of dye-sensitized solar cells form complexes with metals and thereby alter their chemical conformation. The results of this interdisciplinary collaboration between chemists and physicists from Basel were recently published in the scientific journal ACS Omega.

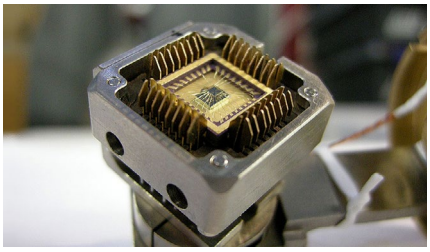


University of Basel, 12 September, 2018. Probing individual edge states with unprecedented precision

A new technique makes it possible to obtain an individual fingerprint of the current-carrying edge states occurring in novel materials such as topological insulators or 2D materials. Physicists of the University of Basel present the new method together with American scientists in Nature Communications.

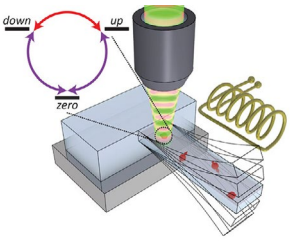


University of Basel. 27 August, 2018. New mechanism of electron spin relaxation observed



Physicists at the University of Basel are working on using the spin of an electron confined in a semiconductor nanostructure as a unit of information for future quantum computers. For the first time, they have now been able to experimentally demonstrate a mechanism of electron spin relaxation that was predicted 15 years ago. The scientists also succeeded in keeping the direction of the electron spin fixed for almost a minute – a new record. The results of the collaboration with researchers from Japan, Slovakia and the US have been published in Nature Communications.

University of Basel. 8 August, 2018. Novel approach to coherent control of a three-level quantum system



For the first time, researchers were able to study quantum interference in a three-level quantum system and thereby control the behavior of individual electron spins. To this end, they used a novel nanostructure, in which a quantum system is integrated into a nanoscale mechanical oscillator in form of a diamond cantilever. Nature Physics has published the study that was conducted at the University of Basel and the Swiss Nanoscience Institute.

All media releases can be found at:
https://nanoscience.ch/de/media-2/aktuelle-medienmitteilungen/

Your feedback is important!

Please send ideas, feedback and material for *SNI update* to Christel Möller (c.moeller@unibas.ch).
We are looking forward to your input.