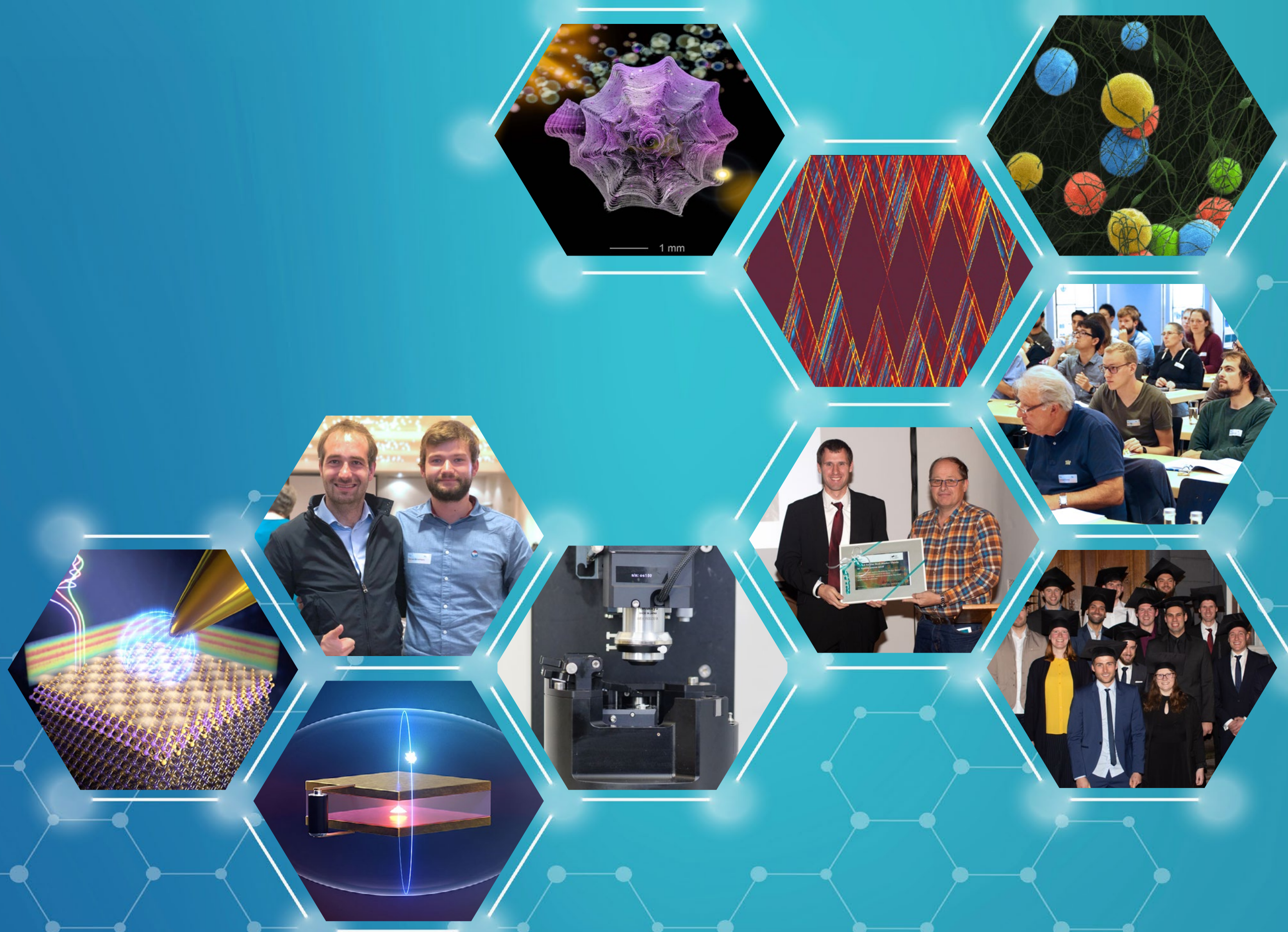
University of Basel
Swiss Nanoscience Institute

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

SNI INSight

Showcasing research and activities of the Swiss Nanoscience Institute

December 2019



Topological isolators

New, promising class of materials

Qnami

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Cause for celebration

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Dear colleagues,

Word will have got around that I had another bicycle accident and will therefore be out of action for some time. Fortunately, I am already on my way to recovery and am therefore able to wish you a happy and peaceful holiday season and then a good start to a successful and, above all, healthy New Year.

In the weeks before the accident, my mind was already clearly focused on the year that lies ahead. In 2020, the SNI will again be organizing the Swiss NanoConvention here in Basel, and so I've spent a couple of weekends inviting potential speakers and planning the basic program for the SNC. All the keynote lectures are now lined up, and planning work for the various sessions is largely complete.

The latest meeting of the Argovia referees, where we examined the Nano Argovia projects submitted for consideration, will also influence work over the coming year. The Committee proposed five new projects, which have now all been approved by the SNI Board.

Of course, the end of the year is a time not only for planning new activities but also for casting our minds back over the last 12 months – and we can once again do so with a certain sense of pride. We've been able to expand our network, and outstanding and resourceful scientists are members of the SNI. Time and time again, our researchers submit fascinating new projects and deliver exciting new findings – both at the doctoral school and as part of Nano Argovia projects. The SNI's participation in the ANAXAM technology transfer center will help cultivate another channel for cooperation with industry.

At a master's degree ceremony organized for graduates of the nanosciences degree in 2018/2019, it was wonderful to see how well the young people who began their studies with us 4–5 years ago have turned out.

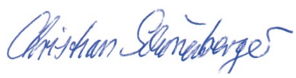
Fledgling companies that have emerged within the SNI network have also notched up some impressive achievements in recent months. Qnami has just announced that it has secured funding of more than CHF 2.6 million for the successful market launch and further development of its quantum sensor. In addition, ARTIDIS has just joined the world's largest "medical city" at the Texas Medical Center Innovation Institute and announced the successful closure of a CHF 8.8 million seed financing.

Other research has some way to go before reaching the market. For example, a number of research groups in the SNI network are working on understanding topological materials and on putting the special properties of this new class of substances to practical use. In the cover story of this SNI INSight, we therefore hope to offer an introduction to the particular features of these new materials.

As a perfect gift at the end of the year we had some great news in the last days: an ERC Consolidator Grant for Patrick Maletinsky and the approval of two NCCRs with the Department of Physics and the Biozentrum as leading houses. Congratulations!

Now I would like to thank all of you who have sent me your best wishes and flowers in the last weeks. Many thanks to all those who supported me and the SNI throughout the year and contributed to our success. I wish you a few relaxing days and look forward to a hopefully healthy year 2020.

Kind regards,



Prof. Dr. Christian Schönenberger, SNI Director

Insulator on the inside, conductor on the outside
Topological insulators are a key topic at the SNI

In recent months, we've mentioned the subject of topological insulators time and time again. But what are these materials that, despite being insulators, also conduct electricity on their edges and surfaces? What hopes are pinned on the new materials, where does their peculiar name come from, and what questions are SNI scientists currently addressing?

Promising new materials

Topological insulators represent an entirely new class of materials whose discovery gave rise to a new field of research – some of which is undertaken by scientists from the SNI.

A common property of all topological insulators is that they behave like insulators on the inside, whereas the edges have metallic properties and conduct electricity. A three-dimensional crystal of a topological insulator therefore conducts electricity only on its surface, while no current can flow inside. Two-dimensional, atom-thin topological materials are only conductive at their edges, and in a one-dimensional material the charge carriers can only move at the two ends.

As well as this "hybrid state" somewhere between an insulator and a conductor, the special thing about the materials is that – due to the laws of quantum mechanics – electricity is transmitted almost losslessly in the stated regions. The use of topological materials in electronic components therefore promises to bring unprecedented efficiency without the unwelcome generation of heat.

Moreover, one-dimensional topological insulators have also been mooted as an ideal way to store quantum information. For this, the necessary steps are taken to convert a nanowire into a one-dimensional topological insulator with two "metallic" edge states – conductive regions – at the left and right ends of the wire. From these two states, it is possible to define a qubit – the smallest unit of information in a quantum computer. This qubit is very difficult to destroy and would therefore be well protected against outside interference.

Complex origins

A topological insulator is more than just a combination of a conductive material and an insulating one. Indeed, the differences in electrical conductivity stem from various phenomena that are not readily understood. Getting to grips with these phenomena first requires an explanation of a few basic principles.

Topology

Topology is an area of mathematics that deals with the gradual deformation of structures. For example, since a ball of modeling clay can be turned into a disc simply by deformation, a ball and a disc are considered to be the same shape from a topological perspective. To make a ball into a ring, however, it is necessary to add a hole. A ring and a ball are therefore different shapes from a topological perspective.

The special properties of topological insulators are highly stable and protected – and are retained even in the event of defects or changes in the material.

From a topological perspective, ball and disc are considered to be the same shape. They differ from a ring or a tube which have - from a topological point of view - the same shape.

"I find it fascinating that we can now produce new materials that don't occur in nature – simply by stacking up two-dimensional crystals in an ingenious way. These crystals can exhibit completely new properties and can also become topological insulators. That's what makes this such an exciting area of research."

Prof. Dr. Christian Schönenberger and his team are also conducting research on topological isolators

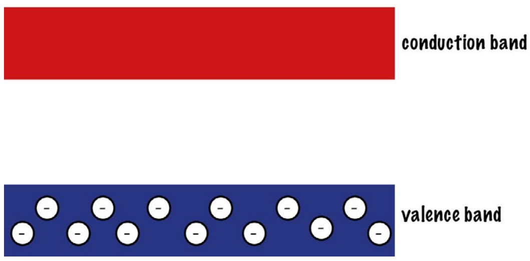
The electrons that whizz around atomic nuclei are responsible for chemical bonding and subsequently for holding materials together. In an insulator, all of the electrons in what is known as the "valence band" participate in bonding with the neighboring atoms. These saturated covalent bonds do not allow the transport of electrical charge – so the material is an insulator.

Physicists describe an insulator in slightly more abstract terms. The bonding electrons occupy all possible states within the valence band. An energy gap separates the fully occupied valence band from a conduction band that contains no electrons while under insulating conditions. This energy gap (or "band gap") represents the amount of energy that must be supplied in order to "excite" an electron from the valence band into the conduction band – for example, using thermal energy. The bigger the band gap, the more energy must be supplied and the better the insulator.

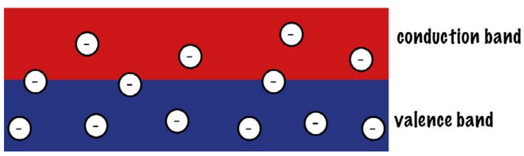
In a metal that conducts electricity, the chemical bonds are not covalently saturated. The conduction band and valence band overlap – in other words, no band gap exists in the first place. As a result, freely mobile electrons are always available, and current can flow without the need for thermal excitation. Metals therefore conduct electricity even at low temperatures.

On the inside, topological insulators have a band gap – like conventional insulators – and do not conduct electricity. But the edges or, in the case of three-dimensional materials, the surfaces of a topological insulator contain states with energies within this band gap. Electrons can adopt these energy states and are therefore able to conduct electricity.

Isolator



Metal



In an insulator, the valence and conduction bands are separated by an energy gap. The energy gap represents the amount of energy that must be supplied to "excite" an electron from the valence band into the conduction band. There is no energy gap in a metal that conducts electricity. As a results, freely mobile electrons are always available and current can flow without the need for thermal excitation.

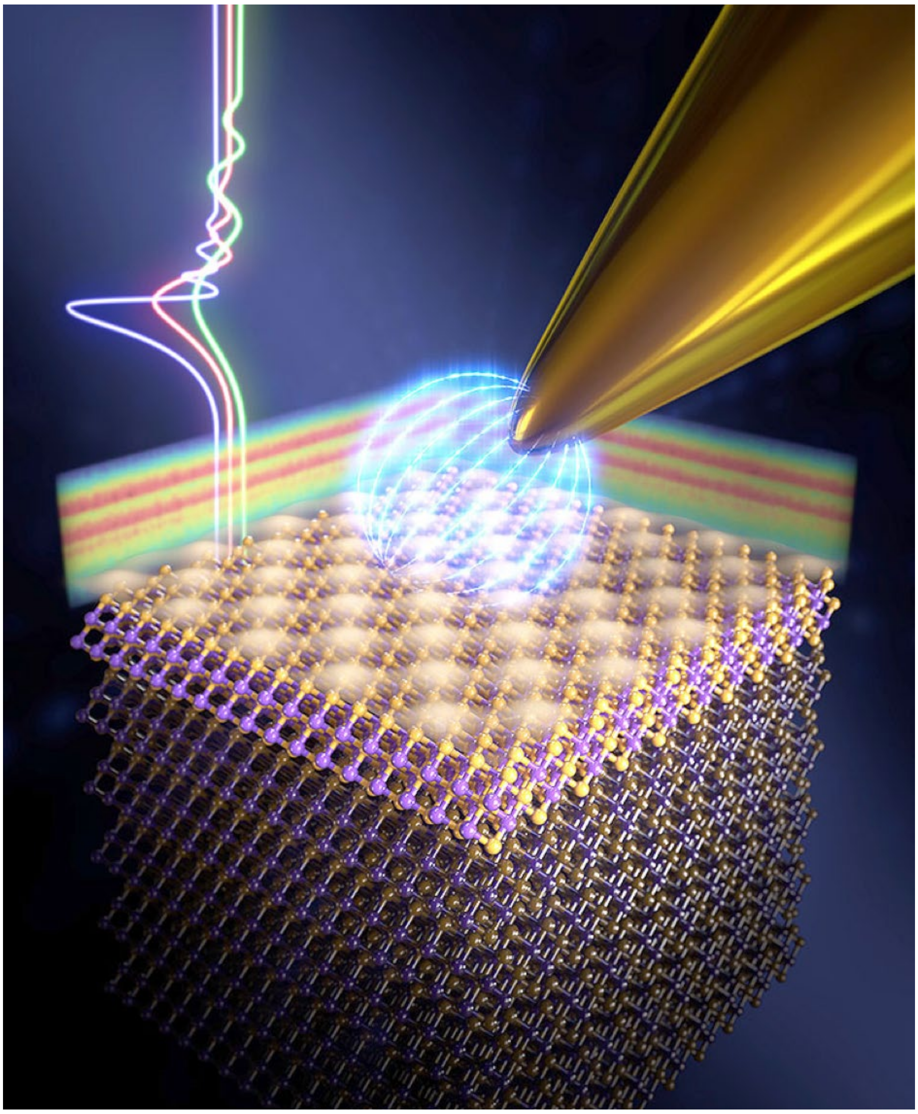
More information about topological insulators:

The birth of topological insulators
Joel E. Moore
Nature 464 (2010), 194–198
https://www.nature.com/articles/re08916?draft=collection

Topologically protected

Every topological insulator is characterized by a topological index. This numerical value is derived from the band structure of the molecule and is extremely difficult to change. If a topological insulator comes into contact with a conventional insulator with a different topological index, the laws of physics are such that the band gap disappears at the point of contact: the material acquires metallic properties at the contact point and becomes an electrical conductor.

This happens when the topological insulator is inside a vacuum, for example. No current flows in the vacuum – in other words, the vacuum is an insulator. However, the band gap disappears at the boundary between the topological material and the vacuum, allowing a current to flow – on the outer surfaces of a three-dimensional body, on the edges of a two-dimensional layer, and on the ends of a one-dimensional nanowire. These properties of the topological insulator are not affected by changes or defects in the material. In technical terms, they are said to be topologically protected.



The gold tip is moved across the surface of the topological insulator and experiences energy loss only at discrete, quantized energies (indicated by the curves). This is related to the image potential states (IPS) that are formed over the conducting surface of the topological insulator and are schematically depicted in the background. (Image: University of Basel, Departement of Physics)

Almost no friction in topological insulators

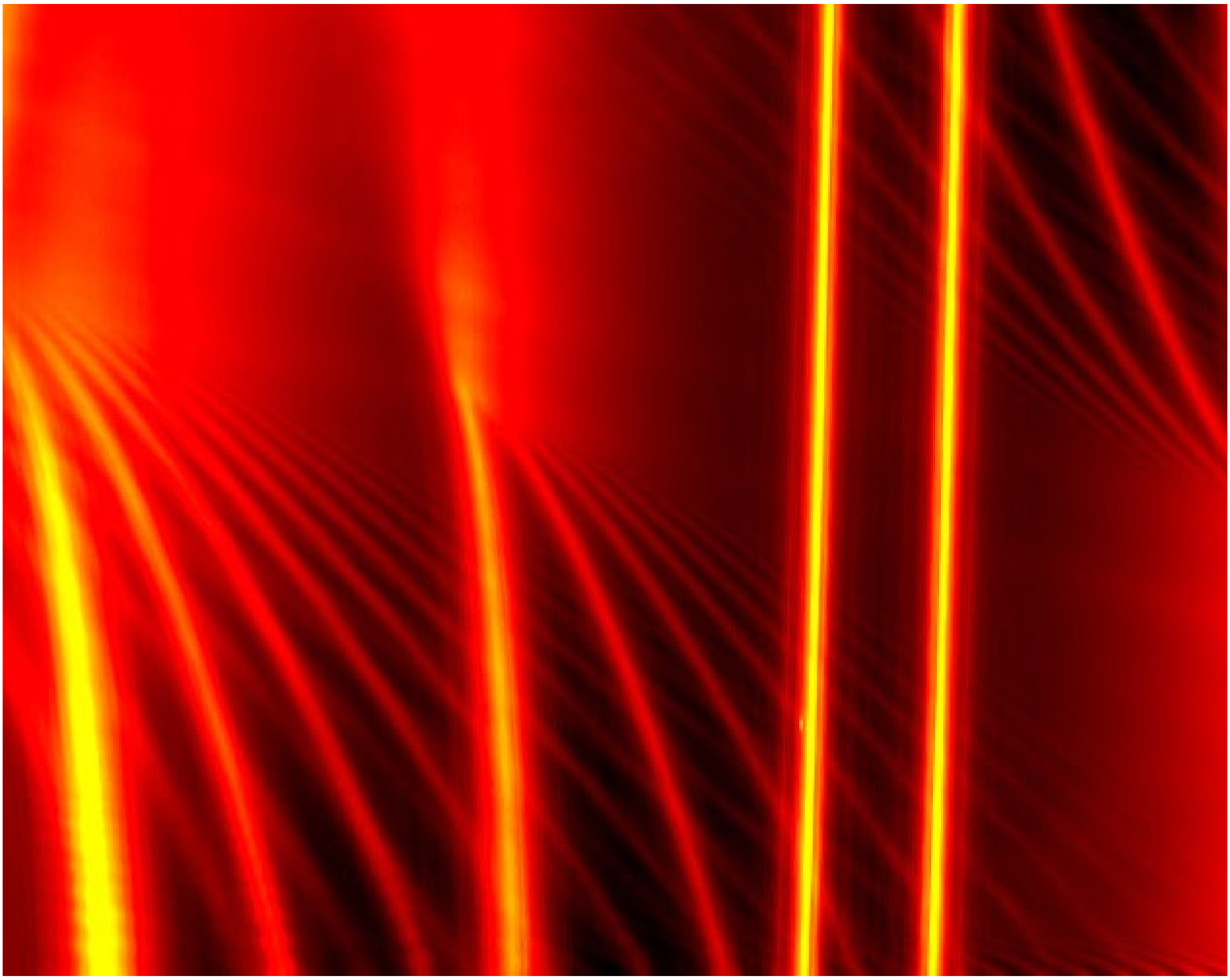
A number of research groups in Basel are studying these highly unusual materials. For example, the group led by Professor Ernst Meyer recently published measurements in Nature Materials demonstrating that significantly less heat is generated by friction in topological insulators than in conventional materials. Moreover, as part of her doctoral dissertation at the SNI PhD School, Dr. Dilek Yildiz used an atomic force microscope in pendulum mode to study the effect of friction on the surface of a topological insulator made of bismuth telluride. “As well as a very slight loss of energy to heat, we described a new quantum mechanical mechanism that allows us to control the friction precisely. This is absolutely crucial when it comes to potential applications,” says Professor Ernst Meyer.

High-resolution fingerprinting

The team led by Professor Dominik Zumbühl developed a method that could pave the way for individual examination of conductive regions in a topological insulator. Using momentum resolved tunneling spectroscopy, the scientists recently managed to create an exact fingerprint of the conductive regions of a quantum Hall system in nanometer resolution. These systems also show the formation of conductive regions at the edges (edge channels), and the researchers believe that the method will also be suitable for the detailed analysis of topological insulators.

Searching for new materials

One of the tasks of Professor Christian Schönenberger’s research group



Measured tunneling current and its dependence on the two applied magnetic fields: The fans of red/yellow curves each correspond to a fingerprint of the conducting edge states. Each individual curve separately shows one of the edge states. (Image: University of Basel, Department of Physics)

is to search for completely new materials with the properties of a topological insulator.

Within the framework of an ERC Advanced Grant, the group is investigating what are known as van der Waals heterostructures. These are stacks of two-dimensional crystals consisting of individual atomic layers of different materials held together by van der Waals forces.

"I find it fascinating that we can now produce new materials that don't occur in nature – simply by stacking up two-dimensional crystals in an ingenious way. These crystals can exhibit completely new properties and can also become topological insulators. That's what makes this such an exciting area of research," says Christian Schönenberger.

We are bound to hear a great deal more about topological insulators over the coming years – and it remains to be seen whether they will ultimately be used in electronic components or play a role in the development of powerful quantum computers.

Funding secured and product presented

A positive end to the year for Qnami

Qnami, a fledgling start-up from the SNI network, has received some excellent news in recent weeks: the young company not only presented ProteusQ, its quantum microscope for the analysis of magnetic materials, but has also secured an investment of over CHF 2.6 million to launch the platform and continue its development. These are the ideal circumstances for the team, which now numbers ten, to begin supplying the device to beta testers and processing orders at the start of next year.

A market-ready product

Qnami was founded in November 2017 by Professor Dr. Patrick Maletinsky, Dr. Mathieu Munsch, Dr. Felipe Favaro, and Dr. Alexander Stark.

The company aims to develop quantum solutions for high precision measurements. After 2 years of development, Qnami presented ProteusQ, a first quantum platform for material analysis in nanometer resolution. This device, which the team debuted at the Material Research Society Fall Exhibition in Boston in the first week of December, will allow a broad range of scientists and engineers to study the magnetic properties of their materials in a quantitative and non-perturbative way.

"With ProteusQ, we want to help scientists and R&D engineers to develop advanced materials for future applications in electronics or healthcare," says Mathieu Munsch, CEO of Qnami, in our interview.

"It was important to us that our customer would benefit from quantum performance while using an environment that is familiar to them. Our collaboration with Horiba – a well-known manufacturer and global distributor of atomic force microscopes – plays an important role in

ProteusQ will allow a broad range of scientists and engineers to study the magnetic properties of their materials in a quantitative and non-perturbative way. (Image: Qnami)

The founders of Qnami, Alexander Stark, Felipe Favaro, Mathieu Munsch, Patrick Maletinsky, in spring 2019.

this regard." This allows Qnami to build on existing expertise and customers to work with proven systems while also benefiting from a significantly more powerful device.

"The magnetic properties of materials play an important role in modern electronics, but they're often poorly understood, in particular at sub-micron scale," says Mathieu Munsch. "Our technology allows customers to open a new eye on these questions."

Financing secured

In November 2019, Qnami also managed to secure a round of funding that will safeguard the device's launch and further development. The round was led by Quantonation, a venture capital fund specializing in quantum technology and further supported by the Swiss venture capital company investiere, the German investment firm High-Tech Gründerfonds, the start-up financing program of Zürcher Kantonalbank, and private business angels – who crucially also contribute their industry experience. Overall, Qnami has over CHF 2.6 million at its disposal.

Based on diamonds

At the heart of the ProteusQ platform are tiny quantum sensors made of diamonds with deliberate vacancies in their crystal lattices. These "nitrogen-vacancy centers" (NV centers) host individual electrons that can be controlled. Magnetic fields acting on these "trapped" electrons cause a change in their intrinsic angular momentum (spin) which can be detected optically.

The micrometer sized diamonds are attached to a tiny cantilever probe and integrated into an atomic force microscope. "As the material's surface is scanned, an image gradually emerges of the magnetic fields in nanoscale resolution," explains Alexander Stark, who is responsible for the instrument development. "It's possible to study a wide range of materials – even the most delicate, atomically thin structures. In principle, they're even suitable for biological materials, as they don't interact with the material being analyzed."

Numerous achievements in recent months

The principles underlying the technology originate from Patrick Maletinsky's lab at the Department of Physics of the University of Basel. In recent months, Qnami has covered considerable ground, moving from a research platform to the market-ready product that is now available.

Further information:

Qnami::
https://qnami.ch

Horiba Scientific:
https://www.horiba.com/en_en/products/by-segment/scientific/

Staff with suitable qualifications first had to be identified and recruited, and the team has now grown to ten members, including quantum engineers and experienced business people – each of whom is an expert in their field and yet an all-rounder and team player prepared to take on a range of different tasks.

There were then a number of technical hurdles to overcome. As part of the Nano Argovia project NQsense, for example, Felipe Favaro worked with colleagues from the University of Basel and the Paul Scherrer Institute (PSI) to optimize production of the diamond sensors and boost the light yield of the diamonds. "With the Nano Argovia project, we not only succeeded in improving production to the necessary standard but also gained a new team member in Gediminas Seniutinas," says Mathieu Munsch.

Dr. Gediminas Seniutinas was involved in NQsense as a postdoc at the PSI and is now responsible for clean-room production of the diamond sensors at Qnami.

Thanks to numerous further optimizations, both large and small, ProteusQ is now not only ready for use but also suitable for sale in its current form. In 2020, Qnami therefore will open its application lab so that customers from all over the world can use the quantum microscope and measure the benefits for their own applications.

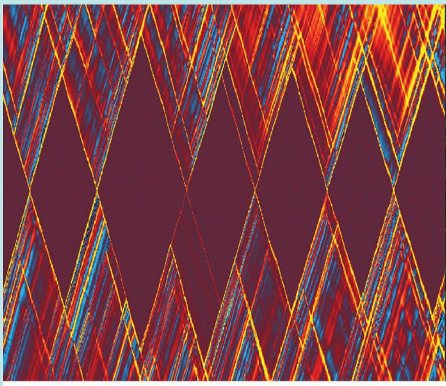
Swiss NanoConvention 2020

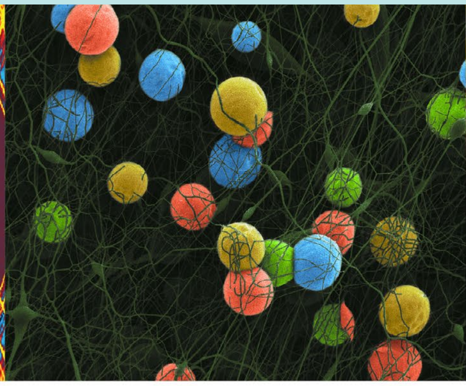
The next Swiss NanoConvention will take place from 2–3 July 2020 in Basel.

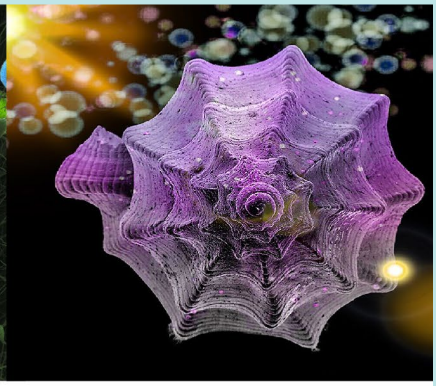
All keynote speakers and topics for the sessions are confirmed. More information at:

http://swissnanoconvention.ch/2020/

Congratulations to the winners of the Nano Image Award







Quantum sunrise
Electronic measurement of an 20nm quantum dot in a nanowire.

Christian Jünger, Department of Physics, University of Basel

Nanoparty
Drug-loaded microparticles from polycaprolactone produced by electrospraying in the Nano Argovia project PERIONANO

Fabiola Costanzo, Oliver Germershaus, Jasmin Föhr School of Life Sciences, FHNW

Lepicythara
Not really Nano but still very small and extremely attractive: a tiny snail from the genus Neogastropoda.

Daniel Mathys, Nano Imaging Lab, Swiss Nanoscience Institute, University of Basel

Many thanks to all participants!

SNSF Scientific Image Competition

There is another chance to win a prize with great pictures. Please submit your photos and short video clips to the Swiss National Science Foundation.

Further information:
http://www.snf.ch/de/foerderung/wissenschaftskommunikation/bilder-wettbewerb/Seiten/default.aspx#Gewinner%202019

Youtube:
https://youtu.be/aqqmAES3KYI

Information and networking

In September each year, SNI members come together for the Annual Event at Hotel Schweizerhof in Lenzerheide. This year's occasion once again provided an excellent platform for learning about interdisciplinary research supported by the SNI, as well as for strengthening existing contacts and forging new ones.

Insights into research

After a short welcome address by SNI Director Christian Schönenberger, this year's program began with a talk by Professor Ernst Meyer, who gave a vivid explanation of how he and his team investigate the degree of energy loss when individual molecules are moved on surfaces. Following on from this keynote lecture, doctoral students from the SNI PhD School and project leaders from the Nano Argovia program reported on their research.

The busy afternoon of talks was rounded off with a poster session, which once again represented a highlight for all those in attendance. Doctoral students and project leaders presented their latest research findings across a total of 24 posters, which were the subject of some enthusiastic discussions. Guests also had ample opportunity to discuss the various research topics over the subsequent dinner, but that was just the beginning of a science-packed evening.

Awards and lively discussions late into the night

Christian Schönenberger began by awarding Honorary Membership of the SNI to Joakim Rüegger for his extraordinary efforts during the start-up phase of the SNI in his role as Head of Higher Education at the Department of Education in the Canton of Basel-Stadt. In a short speech, Joakim Rüegger gave an entertaining account of how the Canton of Aargau decided to support the nanosciences at the University of Basel and throughout Northwestern Switzerland.

Then, Dr. Helmut Schift gave a late-night lecture on integrity in research – a topic he deals with intensively in his role as Consultant on Research Integrity at the Paul Scherrer Institute. Schift's talk covered not only the careful analysis and protection of data, but also topics such as authorship of publications or academic appointment criteria – a subject that triggered a number of lively and enthusiastic debates.

Positive feedback

The Annual Event provides an ideal platform for learning about interdisciplinary research supported by the SNI and discussions.

Although the first day of the Annual Event continued late into the evening, the lecture room was packed again the following morning as Professor Marek Basler took the audience on a journey into the world of bacteria in the second keynote lecture of the program. Basler described how some bacteria feature highly developed nano-harpoons that allow them to prevail over their competitors.

After a number of other fascinating talks, the meeting concluded with an award ceremony. Luc Driencourt received a prize for his talk on the production of hydrogen from water using a hematite photoanode. Thomas Mortelmans was presented with an award for his poster on the use of electron beam lithography to produce three-dimensional microfluidic systems.

This year, Dr. Alessandro Mazzetti from the Innovation Office of the University of Basel also attended the meeting as a guest after giving a workshop for the doctoral students: “I have been impressed by the capability of the SNI and its Annual Event to bring together top scientists, ranging from young brilliant PhDs to experienced scientists, with a real multidisciplinary approach.

It is fascinating to see many scientists with such different backgrounds in physics, chemistry, biology, and engineering being able to share their different perspectives and amazing science around the common “nano” field – opening such exciting perspectives for breakthrough innovation. I strongly believe that the ability of the Annual Event from SNI to bring together and catalyze both basic research and applied projects is unique in Switzerland and globally.

«I have been impressed by the capability of the SNI and its Annual Event to bring together top scientists with a real multidisciplinary approach. It is fascinating to see many scientists with such different backgrounds in physics, chemistry, biology, and engineering being able to share their different perspectives and amazing science around the common “nano” field – opening such exciting perspectives for breakthrough innovation. ”

Dr. Alessandro Mazzetti from the Innovation Office of the University of Basel attended this years’ meeting as a guest.

Christian Schönenberger awards Honorary Membership of the SNI to Joakim Rüegger.

Thomas Mortelmans receives a prize for the best poster, Luc Driencourt for the best talk.

Doctoral students – the company founders of tomorrow?

Before the SNI Annual Event began, Dr. Andreas Baumgartner, coordinator of the SNI PhD School, invited the SNI's PhD students to an innovation workshop. Here, Dr. Alessandro Mazzetti from the Innovation Office of the University of Basel introduced the young scientists to the world of innovation. He explained how academic work at the SNI can gradually progress from an invention into an innovative product.


Alessandro Mazzetti introduced the SNI PhD students to the world of innovation. (Image: Mehdi Ramezani)

The workshop provided an overview of a broad range of entrepreneurial activities – from intellectual property issues and financing to how to make a successful "pitch," in which a product is presented to a potential customer or investor. So successful was the workshop at infusing the doctoral students with the entrepreneurial spirit that some of them took part in the Innovation Office's monthly "Entrepreneurs Club" shortly afterwards.

"I really enjoyed the workshop. It showed us how academic research at the University of Basel and the SNI can lead to the founding of new enterprises – and already has done. Alessandro encouraged us to take part in the Entrepreneurs Club, which was not only a thoroughly inspiring event but also an excellent opportunity to make contact with brand-new and already-established companies," says Thomas Mortelmans, SNI PhD student.

Alessandro Mazzetti was also impressed by the SNI doctoral students' interest in understanding the meaning of innovation and entrepreneurship - as a possible path to actually improve people's life and solve the most pressing challenges for the future of human society: "Students were eager to get involved in the innovation ecosystem in Basel. They engaged in the workshop in a positive way, asking many questions & trying to understand what does it truly mean to be an "innovator" and an entrepreneur. I am really glad to be engaged, as part of the Innovation Office of the University of Basel, and to help these brilliant researchers to "cover the last mile" between their amazing discovery and the market/patient."

"The workshop showed us how academic research at the University of Basel and the SNI can lead to the founding of new enterprises – and already has done."

Thomas Mortelmans, SNI PhD student

New approaches to lithography

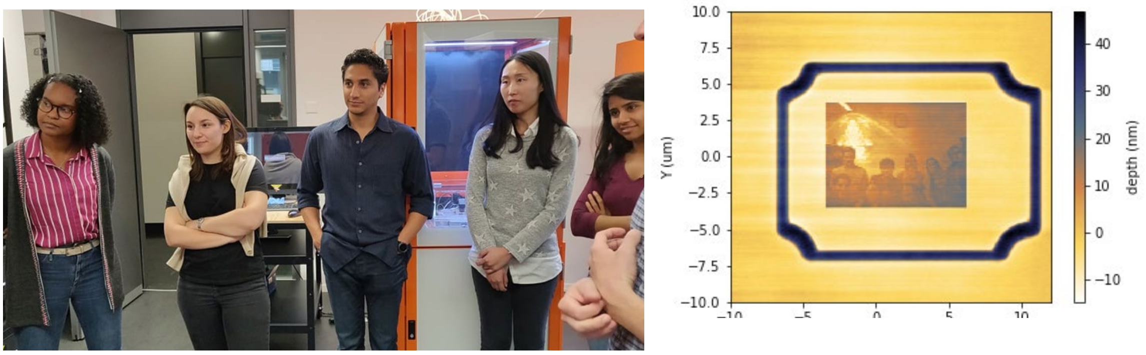
In early September, a number of doctoral students from the SNI visited the company SwissLitho at Technopark Zurich together with scientists from the Paul Scherrer Institute. SwissLitho began by giving the visitors a demonstration of its NanoFrazor technology, which uses a heatable probe to produce and simultaneously characterize high-precision nanostructures in a process known as thermal scanning probe lithography (t-SPL).

The doctoral students were then treated to a premiere when a SwissLitho employee presented the new Mix-and-Match technology for the first time. This combines the t-SPL of the NanoFrazor with a laser lithography system from Heidelberg Instruments (Germany) to create a hybrid technology that speeds up the production of components featuring both microstructures and nanostructures.

“We enjoyed a vivid demonstration in which a photo of our group was converted into a three-dimensional pattern in the space of a few minutes,” reports doctoral student Thomas Mortelmans, who organized the visit to SwissLitho.

More information:

SwissLitho
https://swisslitho.com



The group photo was converted into a three-dimensional microscale and nanoscale structure in a matter of minutes using the Mix-and-Match technology. (Images: Thomas Mortelmans)

An evening all about nanotechnology

On 29 October, the Swiss Nanoscience Institute (SNI) welcomed over 50 scientists to its Nano-Tech Apéro, which this year was hosted by the company Dectris in Baden-Dättwil. The Nano-Tech Apéro is organized by the SNI on an annual basis to provide information on applied research projects as part of the Nano Argovia program and as a discussion forum for representatives from industry and academia.

This short video clip shows an overview of this year’s Nano-Tech Apéro:

Nano-Tech Apéro:
https://www.youtube.com/watch?v=83tdx-h98wZE

A fascinating tour

Following a short welcome address, all of the attendees embarked on a tour of Dectris Ltd.’s premises to see for themselves how detector technology from the Canton of Aargau is conquering the world. After this fascinating tour, project leaders from various applied research projects spoke about their results. “I’m always amazed by the diversity of projects that are underpinned by nanotechnology and that we support as part of our Nano Argovia program,” says Christian Schönenberger.

Diverse approaches

One of the projects highlighted at the event centered around nanosensors that can be used in materials science or for failure analyses in the semiconductor industry. These diamond-based sensors are developed by the fledgling company Qnami. Another of the projects presented is carried out in collaboration with CIS Pharma AG with a view to developing nanostructured dental implants that support the regeneration of bone and soft tissue in the jaw and mouth area, and that can be manufactured for specific patients using 3D printing.

The further development of redox flow batteries was the focus of a third project showcased at the event. For this, researchers are working with Aigys AG to study the use of dispersed iron particles to optimize an environmentally friendly and cost-effective energy storage device for large-scale applications.

Making contacts

Additional projects, such as the development of an origami-based model of the heart or a detector of pesticides in water, were presented during the subsequent poster session. In a relaxed atmosphere, the poster session and the apéro were an ideal opportunity for attending scientists not only to discuss the various research approaches in more detail but also to broach new ideas and forge new contacts.

More information:

Nano Argovia program:
https://nanoargovia.swiss

Dectris
https://www.dectris.com

Qnami:
https://qnami.ch

CIS Pharma
https://www.cis-pharma.com

Aigys
http://www.aigys.com

«The diversity of projects that are underpinned by nanotechnology and that we support as part of our Nano Argovia program is always fascinating.»

Prof. Dr. Christian Schönenberger, SNI Director

A variety of information and an opportunity for discussions – this year's Swiss Nanoscience Institute Nano-Tech Apéro was held at Dectris Ltd. in Baden-Dättwil.

Cause for celebration

In November, the first master's degree ceremony was held for graduates of the nanosciences degree program at the University of Basel. Dr. Anja Car, who has been coordinating the nanosciences program since June 2017, worked with her colleague Jacqueline Isenburg to organize a nice celebration to mark the end of an intensive period here at the University of Basel.

The master's degree ceremony was a great celebration to mark the end of the intense time at the University of Basel. Sebastian Scherb received the 2018 prize for the best master's thesis in the nanosciences from his supervisor Prof. Dr. Ernst Meyer (Images: Ingrid Singh)

Held at the Wildt'sches Haus, the ceremony saw certificates presented not only to the 15 young master's graduates from the nanosciences program. Sebastian Scherb also received the 2018 prize for the best master's thesis in the nanosciences, in which he used atomic force microscopy to study compounds similar to graphene. The young scientist is now writing his doctoral dissertation at the Department of Physics.

The festivities at this first master's degree ceremony also included a performance by the chamber music ensemble of the FHNW Academy of Music/Musik Akademie Basel.

"It was a great party," said Professor Wolfgang Meier, director of the nanosciences study program. "Completing your master's degree is truly a cause for celebration, and we're delighted to witness the tremendous progress these young people have made during their time at the University of Basel. We're in no doubt that they now have an excellent foundation for their future careers – and we wish them the best of luck and success."

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Prof. Dr. Wolfgang Meier, director of the nanosciences study program

Research topics between carrot stalls

This year, the Swiss Nanoscience Institute (SNI) had a stand at the Rüeblimärt in Aarau for the first time. The SNI team provided visitors with information about SNI research activities in the field of nanosciences and an opportunity to try their luck on the wheel of fortune for a chance of winning gummy bears or a ballpoint pen. Children could also enjoy separating colors by chromatography and making their own Christmas decoration.

“It was amazing to see how interested people are in our research,” said Dr. Kerstin Beyer-Hans, who supervised the stand together with her colleagues. Indeed, the various SNI brochures, which provide an easy-to-understand and well-illustrated explanation of what nanoscience is all about and what the SNI’s priorities are, disappeared much faster than expected. Numerous visitors also expressed an interest in the nanoscience study program offered by the University of Basel.

It was a long day for the SNI’s outreach team, as the stand had to be set up by 5 am. “It was worth it,” says Kerstin Beyer-Hans. “We spoke to lots of people and were able to provide them with information about the SNI.”

The wheel of fortune attracted lots of people at the Rüeblimärt in Aarau and young visitors enjoyed the chromatographic separation of felt-tip pen colours.

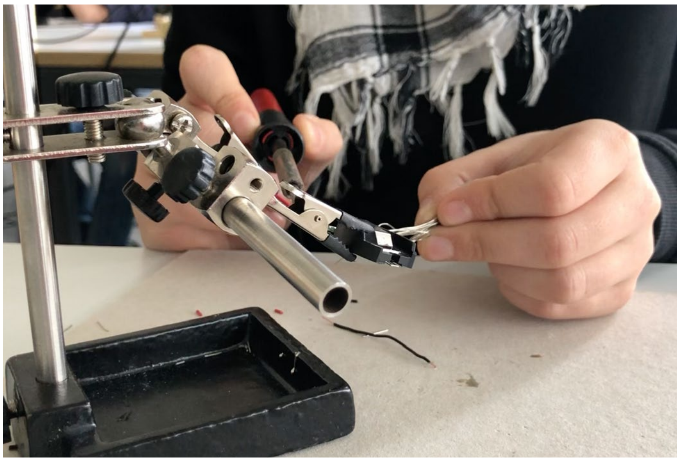
Activities for children with a keen interest

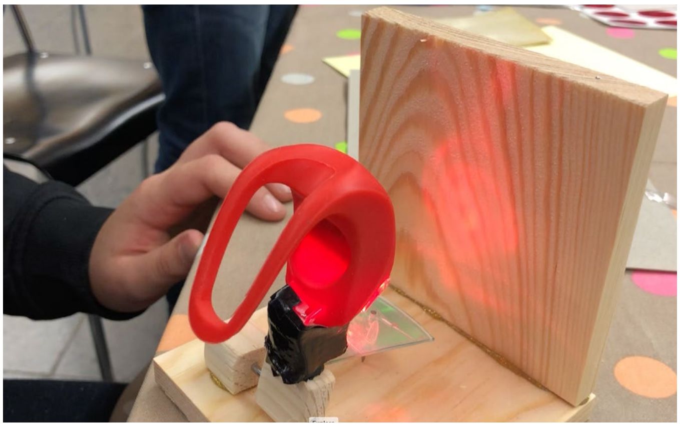
Every year, the fall season is packed with SNI activities specifically aimed at children and young people. For example, the SNI’s appearance at the Science Days at Europa-Park Rust has been a standard fixture for a number of years. The Future Day in November and various TecDays are also ideal opportunities for pupils to gain a better understanding of the natural sciences.

At this year's Science Days, the SNI stand was dedicated to the subject of DNA. Weeks beforehand, Dr. Kerstin Beyer-Hans and Sandra Hüni had planned, tested and purchased materials with a view to offering another new interactive program at this year's event.

As a result, visitors attending the Science Days were given a number of small colored beads in order to make their own DNA model. The model was then used to decorate a picture frame containing a selfie – taken either alone or with their friends or parents. In the process, the children learned that their hereditary make-up is stored on DNA, as well as discovering how this molecule is structured and that – at the DNA level – we're not that different from either Albert Einstein or chimpanzees.

In November, the SNI took part in the Future Day together with the Department of Physics. A total of 24 children signed up for this year's event, which was themed around Light and Microscopes. Following an introductory talk, the children had the opportunity to see how an atomic force microscope works and to build a wooden model of the device. They also used a self-built spectrometer to separate white light into its spectral colors – and had the chance to practice their soldering skills. Specifically, they built an unusual LED-illuminated Christmas decoration that required them to solder five connections – which can be quite a tricky task, as the kids soon learned.





Selfies, soldering Christmas decoration and making a wooden model of an atomic force microscope - all activities that help children to become interested in natural sciences.

This short video clip provides an insight into activities at the Future Day:

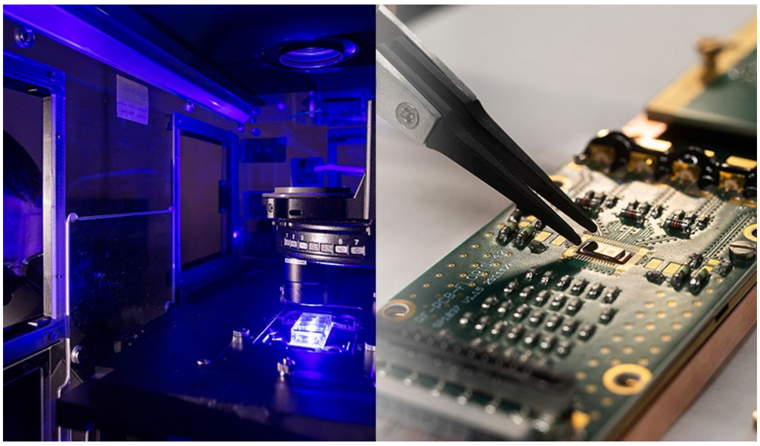
Future Day:
https://www.youtube.com/watch?v=orlvQAIYU6w

News from the network

The University of Basel gains two new National Centers of Competence in Research (NCCR)

The University of Basel has received a grant for two new National Centers of Competence in Research (NCCR), focusing on antibiotic research and quantum technology. The federal government is providing total funding of CHF 34 million for the two programs in the first funding phase to 2024, bringing the number of NCCRs with the University of Basel as their "leading house" up to three.

The Department of Physics heads the National Centre of Competence in Research (NCCR) for the development of a silicon-based quantum computer.



The Swiss Federal Government awards two centres for antibiotic resistance research and quantum computing to the University of Basel. (Image: University of Basel, Christian Flierl)

Media release University of Basel: https://nanoscience.ch/en/2019/12/16/the-university-of-basel-gains-two-new-national-centers-of-competence-in-research-nccr/ and https://nanoscience.ch/en/2019/12/16/the-department-of-physics-heads-national-centre-of-competence-in-research-nccr-for-the-development-of-a-silicon-based-quantum-computer/

Patrick Maletinsky receives ERC Consolidator Grant

Three researchers from the University of Basel receive one of the coveted ERC Consolidator Grants from the European Research Council (ERC). Patrick Maletinsky from the Department of Physics, Marek Basler from the Biozentrum, and Dennis Gillingham from the Department of Chemistry will receive a total of 6.7 million Euros over five years.

Media release University of Basel: https://nanoscience.ch/en/2019/12/10/patrick-maletinsky-receives-erc-consolidator-grant/

Prof. Dr. Patrick Maletinsky (Image: Department of Physics)

The team of ARTIDIS, a spin-off of the Biozentrum and the Swiss Nanoscience Institute, University of Basel. (Image: ARTIDIS)

ARTIDIS joins world's largest medical center and secures funding of CHF 8.8 Mio

ARTIDIS announced its successful integration in the highly competitive international Medical Device Cohort 2019 at the Texas Medical Center's Innovation Institute. Additionally, ARTIDIS successfully closed a CHF 8.8 million seed financing in two rounds securing early clinical validation and the next development phase towards market entry in 2021. The company, which is a spin off from the Biozentrum and the Swiss Nanoscience Institute at the University of Basel, is developing a medical device based on nanotechnology for clinical application in cancer diagnostics.

Media release ARTIDIS: https://artidis.com/artidis-joins-the-tmc-accelerator-device-cohort-to-ensure-that-its-cancer-diagnostic-and-therapeutic-optimization-innovation-gains-early-access-to-the-us-market/
and: https://artidis.com/artidis-gains-strong-momentum-in-2019-raising-chf-8-8-million-in-seed-financing/

Qnami announced the closing of a 2.6 Mio CHF seed round

Qnami announced the closing of a 2.6 Mio CHF seed round led by Venture Capital fund Quantonation and further supported by investiere, ZKB Start-up Finance and the High Tech Gründerfond. The funds will support the market entry of Qnami's first product, a quantum microscope for inspection of magnetic materials at the nanoscale, and further developments of quantum sensing applications.

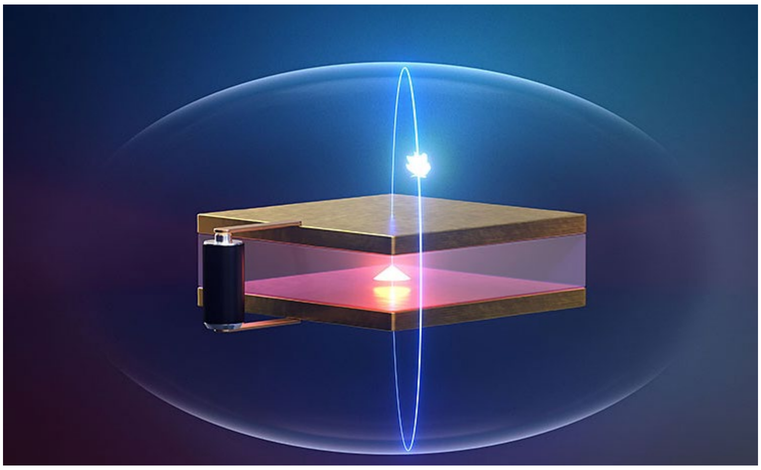
Media release Qnami: https://nanoscience.ch/en/2019/11/13/11079/

The Qnami founders: Dr. Felipe Favaro, Dr. Alexander Stark, Dr. Mathieu Munsch und Prof. Dr. Patrick Maletinsky. (Image: zvg)

A cavity leads to a strong interaction between light and matter

Researchers have succeeded in creating an efficient quantum-mechanical light-matter interface using a microscopic cavity. Within this cavity, a single photon is emitted and absorbed up to 10 times by an artificial atom. This opens up new prospects for quantum technology, report physicists at the University of Basel and Ruhr-University Bochum in the journal Nature.

Original source: https://www.nature.com/articles/s41586-019-1709-y



A microscopic cavity of two highly reflective mirrors is used to allow an enclosed artificial atom (known as a quantum dot) to interact with a single photon. A photon is emitted and reabsorbed up to 10 times by the quantum dot before it is lost. The quantum dot is electrically controlled within a semiconductor chip. (Image: University of Basel, Department of Physics)

FET-OPEN grant for topological states in germanium nanowires

Limited scalability and the high sensitivity of qubits as building blocks for the quantum computer are still in the way of the 'super computer's' big breakthrough. Researchers of the University of Twente, together with colleagues from Austria, Switzerland and the Netherlands may have found a promising solution to address these challenges. They have been awarded a 3.1 million euro financial contribution from the EU's Future and Emerging Technologies (FET) programme.

TOPSQUAD

Original source: https://nanoscience.ch/en/2019/10/17/fet-open-grant-for-topological-states-in-germanium-nanowires-2/

ANAXAM builds on PSI's globally recognized expertise in neutron and X-ray analysis. (Image: PSI)

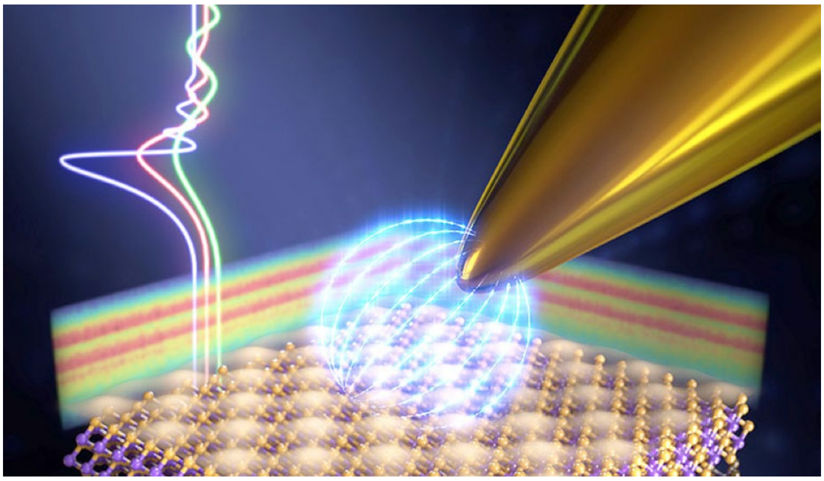
During a media conference, ANAXAM is presented to the public. (Image: Canton of Aargau)

Umbrella organization gives green light for ANAXAM national technology transfer center planned in Aargau

The Paul Scherrer Institute (PSI), the University of Applied Sciences and Arts Northwestern Switzerland (FHNW), the Swiss Nanoscience Institute (SNI), and the Canton of Aargau are planning a national Advanced Manufacturing Technology Transfer Center (AM-TTC) supported by the federal government together with industrial partners. The umbrella organization AM-TTC Alliance has approved the concept and the financial support required for the start-up phase of the nationally oriented project ANAXAM (Analytics with Neutrons and X-Rays for Advanced Manufacturing).

Media release Canton of Aargau: https://nanoscience.ch/de/2019/10/21/dachverband-gibt-gruenes-licht-fuer-das-im-aargau-geplante-nationale-technologietransferzentrum-anaxam/

On 1 December, ANAXAM started operations and was presented to the public on 5 December.
Media release Canton of Aargau: https://nanoscience.ch/de/2019/12/09/das-nationale-technologietransferzentrum-anaxam-hat-in-villigen-seinen-betrieb-aufgenommen/



The gold tip is moved across the surface of the topological insulator and experiences energy loss only at discrete, quantized energies (indicated by the curves). This is related to the image potential states (IPS) that are formed over the conducting surface of the topological insulator and are schematically depicted in the background. (Image: University of Basel, Departement of Physics)

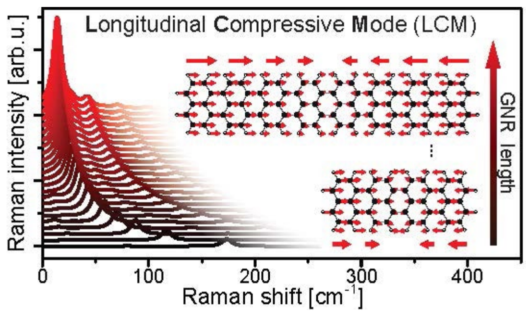
How to control friction in topological insulators

Topological insulators are innovative materials that conduct electricity on the surface, but act as insulators on the inside. Physicists at the University of Basel and the Istanbul Technical University have begun investigating how they react to friction. Their experiment shows that the heat generated through friction is significantly lower than in conventional materials. This is due to a new quantum mechanism, the researchers report in the scientific journal Nature Materials.

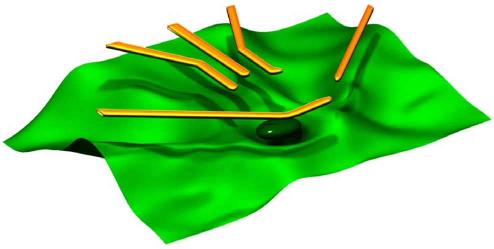
Original source: https://www.nature.com/articles/s41563-019-0492-3

Ideal method for determining the length of graphene nanoribbons

Writing in ACS Nano, researchers from the SNI network have described how Raman spectroscopy can be used as a sensitive method for the investigation of graphene nanoribbons. The technique can be used to analyze their structural integrity, length and substrate interaction. In contrast to low-temperature scanning tunneling microscopy, which is often used in this context, Raman spectroscopy allows straightforward characterization of instruments for practical applications.
Original source: https://doi.org/10.1021/acsnano.9b05817



Raman spectroscopy can be used as a sensitive method for the investigation of graphene nanoribbons (Image: Empa)

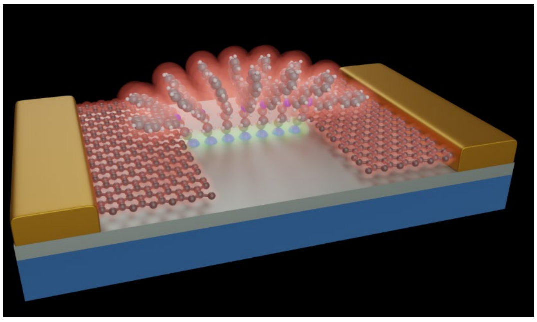


Artistic illustration of the potential landscape defined by voltages applied to nanostructures in order to trap single electrons in a quantum dot. (Image: Department of Physics, University of Basel)

Machine learning at the quantum lab

The electron spin of individual electrons in quantum dots could serve as the smallest information unit of a quantum computer. Scientists from the Universities of Oxford, Basel and Lancaster have developed an algorithm that can be used to measure quantum dots automatically. Writing in the Nature-family journal npj Quantum Information, they describe how they can speed up this hugely time-consuming process by a factor of four with the help of machine learning. Their approach to the automatic measurement and control of qubits therefore represents a key step toward their large-scale application.

Original source: https://www.nature.com/articles/s41534-019-0193-4#Ack1



Schematic representation of molecules anchored to a SiO_2/Si substrate. (Image: Empa)

Molecular electronics: A molecular bridge further

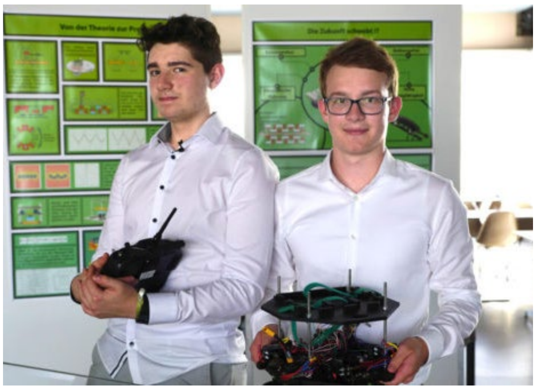
Electronics built from molecules could open up new possibilities in the miniaturization of circuits in the future. Empa researchers, together with partners from Switzerland, the Netherlands, Israel, and the UK, succeeded in solving a crucial detail in the realization of such circuit elements: A molecular bridge for electrons that remains mechanically and electronically stable at room temperature. The results have just been published in the journal "Nature Nanotechnology".

Media release Empa: https://nanoscience.ch/en/2019/09/18/molecular-electronics-a-molecular-bridge-further/

Alex and Felix have also won the European Contest for Young Scientists

The two high school graduates Alex Korocencev and Felix Sewing, who were supported by the SNI and the Department of Physics, have won the European Contest for Young Scientists with their magnetically levitated (maglev) train.

Further information: https://nanoscience.ch/de/2019/09/19/alex-und-felix-gewinnen-auch-den-european-young-scientist-award/



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Educating
Talents
since 1460.

Universität Basel
Petersplatz 1
Postfach 2148
4001 Basel
Schweiz

www.unibas.ch

Swiss Nanoscience Institute
Universitat Basel
Klingelbergstrasse 82
4056 Basel
Schweiz

www.nanoscience.ch