swiss physical society

Nr. 78, März 2026

SPG Mitteilungen
Communications de la SSP

Photo: © Alain Herzog, EPFL

Annual Meeting of the
Swiss Physical Society
24 - 28 August 2026, EPF Lausanne

in collaboration with

CHIPP, NCCR SPIN, NCCR Genesis, NCCR SwissMAP, SGWG

Call for Abstracts: Submission Deadline 1 May 2026

More information on p. 4.

Inhalt - Contenu - Contents

Administratives Sekretariat - Secrétariat administrative

(Mitgliederverwaltung, Webseite, Druck, Versand, Redaktion) - (Service des membres, internet, impression, envoi, rédaction)
S. Albietz, SPG Sekretariat, c/o Departement Physik, Universität Basel
Klingelbergstrasse 82, CH-4056 Basel
Tel. 061 / 207 36 86, Fax 061 / 207 37 84, sps@unibas.ch

Wissenschaftliche Redakteure - Rédacteurs scientifique
Dr. Bernhard Braunecker, braunecker@bluewin.ch
Dr. Margherita Boselli, CERN, margherita.boselli@cern.ch

Impressum:

Die SPG Mitteilungen erscheinen ca. 2-4 mal jährlich und werden an alle Mitglieder abgegeben.

Abonnement für Nichtmitglieder:
CHF 20.- pro Jahrgang (Inland; Ausland auf Anfrage), incl. Lieferung der Hefte sofort nach Erscheinen frei Haus. Bestellungen bzw. Kündigungen jeweils zum Jahresende senden Sie bitte formlos an folgende Adresse:

Verlag und Redaktion:
Schweizerische Physikalische Gesellschaft, Klingelbergstr. 82, CH-4056 Basel, sps@unibas.ch, www.sps.ch

Redaktionelle Beiträge und Inserate sind willkommen, bitte wenden Sie sich an die obige Adresse.
Namentlich gekennzeichnete Beiträge geben grundsätzlich die Meinungen der betreffenden Autoren wieder. Die SPG übernimmt hierfür keine Verantwortung.

Druck:
Werner Druck & Medien AG, Leimgrubenweg 9, CH-4053 Basel

member of the scnat swiss academy of sciences

satw technology for society

Editorial

Michel Calame, SPS President

The year 2025, designated by UNESCO as the *International Year of Quantum Science and Technology* [1], offered a unique opportunity to witness the remarkable dynamism currently shaping quantum research worldwide. Through numerous events and initiatives, both scientists and the general public could experience the past impact and expanding reach of quantum science.

Switzerland has also recognized the growing strategic importance of this field. In May 2022, the Federal Council endorsed the creation of a national quantum initiative under the auspices of the Swiss Academy of Sciences [2]. Backed by a budget of 100 MCHF for the period 2023 – 2028, this initiative seeks to further consolidate Switzerland's leading position in quantum science and technology—from fundamental research to industrial and societal applications.

In this vibrant context, the *Communications de la SSP* remain committed to presenting contributions that reflect the diversity and vitality of quantum physics activities across Switzerland. Some forthcoming articles still require additional preparation, and rather than delaying publication, we have chosen to release this issue on schedule. We extend our sincere thanks to all contributors for their sustained engagement and to our readers for their understanding. The next issues will include these delayed contributions together with new material.

As the International Year of Quantum Science and Technology comes to a close, this is also a moment for reflection and forward-looking action. While Swiss quantum research enjoys global recognition for its excellence, a recent report shows the potential to better translate this scientific strength into technological and economic advantages for the country [3]. In this regard, initiatives such as the Swiss Chip FabLab are of particular significance [4]. Piloted jointly by academic and industrial partners and planned at the Swiss Innovation Park in Dübendorf, the FabLab aims to reinforce Switzerland's semiconductor capabilities and mitigate the risk of domestic industries relocating abroad. Given the central role of microchips in deep-tech innovation and Switzerland's tradition in precision engineering, sustained investment in advanced materials processing and integration facilities represent an essential step to nurture innovation in quantum technologies, communications, computing, and electronics at large. Preserving excellence in fundamental research while fostering its effective transfer to technological innovation should remain a key national priority.

More broadly, Switzerland's has consistently demonstrated its ability to transform scientific knowledge into industrial innovation and societal benefit, as recognized internationally — the country has led the Global Innovation Index for the past 15 years [5]. The Swiss dual education system, combining academic learning with practical training, is undoubtedly a key factor in this success. With this in mind, the *Communications de la SSP* propose to shine a spotlight on the instrumental work of physics laboratory technicians (Physiklaborant/in, Laborantin-e en physique), who are taught as apprentices within this vocational training system [6]. In this issue, the president of the professional association of physics laboratory technicians [7] introduces what this apprenticeship entails, and in future issues we will showcase projects conducted by apprentices.

Finally, this issue includes the announcement of our upcoming Annual Meeting, which will take place at EPFL from Monday, 24 August, to Friday, 28 August 2026. The program will feature strategic themes such as Quantum Science and Technology, Semiconductors, and Energy. We are pleased to welcome the participation of the Swiss Institute of Particle Physics (CHIPP), and three National Centers of Competence in Research—namely the established NCCRs SPIN and SwissMAP, and the newly funded NCCR Genesis.

We wish all our readers an enjoyable read and look forward to welcoming many of you at EPFL this coming August.

[1] International Year of Quantum Science and Technology, *https://www.unesco.org/en/years/quantum-science-technology*
[2] Swiss Quantum Initiative (SQI), *https://quantum.scnat.ch*
[3] Mapping the Global Quantum Ecosystem, OECD, December 2025, *https://www.oecd.org/en/publications/mapping-the-global-quantum-ecosystem_010c37da-en.html*
[4] SwissMem press release, *https:/www.swissmem.ch/de/engagement/innovation/gelungener-informationsanlass-zum-geplanten-swiss-chip-fablab.html*; ETH Zürich press release *https://ee.ethz.ch/news-and-events/d-itet-news-channel/2025/08/boosting-swiss-semiconductors-plans-for-chip-factory-gain-media-attention.html*
[5] SECO press release, *https://www.kmu.admin.ch/kmu/en/home/new/news/2025/switzerland-world-most-innovative-country.html*; Global Innovation Index 2025, *https://www.wipo.int/web-publications/global-innovation-index-2025/en/index.html*
[6] *https://www.physiklaborant.ch/*
[7] *https://www.aglpl.ch/*

SPS Annual Meeting, 24 - 28 August 2026

The next annual meeting will take place at the EPF Lausanne, in the building Centre Est.

The conference will open this year on Monday, 24 August with several events. Starting with the SPS General Assembly in the morning, the Award Ceremony will open the afternoon, followed by our now traditional historical symposium, this year with the focus on ***Progress in Quantum Science and Technology*** (see p. 7). After last year's success, an ***Energy Day*** (p. 7) will be organised again. It will consist of several invited talks and a panel discussion, followed by an apéro, which allows to intensify discussions, and also will give participants the opportunity to get in touch with companies active in the field, informing themselves on their strategies, products and also job opportunities.

Now an integral part of the conference, the 5th edition of the former *Women in Physics Career Symposium*, will be extended to a ***Diversity in Physics Career Symposium,*** taking place on Friday, 28 August with plenary speaker **Tomas Brage,** Lund University, and further talks.

From Tuesday to Friday, renowned speakers will address latest advancements in different research fields in the plenary sessions, while the parallel sessions will allow in-depth discussions in several topical fields.

A poster session on Tuesday and Wednesday will complement the scientific program.

Contributors to the program are this year the *Swiss Institute for Particle Physics* (CHIPP), the *NCCR SPIN*, the *NCCR SwissMAP*, the newly funded *NCCR Genesis*, and the also newly founded the *Swiss Gravitational Wave Coordination Group* (SGWG). Thanks to all these collaborations, our annual meeting will offer again an exciting program, covering latest advancements of physics in a wide range of fields at its best.

Scientific Program

Plenary Speakers

- **Christophe Ballif,** EPF Lausanne:
  Energy transition at scale: myths, realities and opportunities for physicists, from Switzerland to China
- **Livia Bove,** EPF Lausanne:
  A Laboratory View of Planetary Interiors: New Structures and Exotic States of Simple Molecular Systems under Extreme Conditions
- **Tomas Brage,** Lund University:
  Diversity Dimensions in Physics - always there, often forgotten
- **Matthias Gaberdiel,** ETH Zürich:
  Deriving AdS/CFT
- **Florian Kehl,** ETH Zürich:
  Enceladus in the Focus: Europe's Large-Class-Mission for the Search of Extraterrestrial Life on Saturn's Ice Moon
- **Juerg Leuthold,** ETH Zürich:
  Title to be announced
- **Jean-Philippe Martinez,** MPI for Gravitational Physics, Potsdam:
  Title to be announced
- **Andreas Müller,** Université de Genève:
  Physics Education Research today - an Applied Science
- **Pasquale Scarlino,** EPF Lausanne:
  High-Kinetic-Inductance Resonators for Hybrid Quantum Architectures and Photonic Metamaterials
- **Paris Sphicas,** University of Athens & CERN:
  Particle Physics: the path to the future
- **Anna Vangone,** Roche Pharma Research and Early Development Basel:
- *Designing Biology: How AI is Transforming Drug Discovery*
- **Vanessa Wood,** ETH Zürich:
  Vibrational modes in nanomaterials and practical implications for (opto)electonics and (electro)chemistry and beyond

Public Lecture

- **Didier Queloz,** ETH Zürich, ***Nobel Laureate 2019***:
  The exoplanet revolution and life in the Universe

It is planned to possibly supplement this lecture with a panel discussion (tbc), organised in collaboration with the NCCR Genesis.

Topical Sessions

The following parallel sessions are foreseen:

- Accelerator Science and Technology
- Applied Physics
- Atomic Physics and Quantum Optics
- Biophysics and Soft Matter
- Condensed Matter Physics
- Energy, Sustainability and Environment
- Gravitational Waves ****
- History and Philosophy of Physics
- Nuclear, Particle- & Astrophysics *
- Quantum Computing **
- Spintronics and Magnetism at the Nanoscale
- Semiconductors in Industry
- Theoretical and Mathematical Physics ***

* in collaboation with CHIPP; ** in collaboration with NCCR SPIN, *** in collaboration with NCCR SwissMAP, **** in collaboration with the Swiss Gravitational Wave Coordination Group (SGWG)

Depending on the number and contents of the contributed papers, each topical session may be split into special thematic subsessions.

Poster Session

The poster session will take place on 25 August in the frame of an apéro and will be continued on 26 August with a lunch buffet. **All** posters are presented on both session days.

The three most outstanding posters will be awarded with a "Best Poster Prize". It is required that at least the first author of the poster is personally present at the conference in order to be eligible for the award.

The maximum poster size is A0 (portrait).

Award Ceremony

Following our tradition, outstanding scientific work will be honored with the SPS awards in the fields of General Physics (sponsored by ABB Research Center), Condensed Matter Physics (sponsored by IBM Zürich Research Laboratory), Metrology (sponsored by METAS), Computational Physics (sponsored by COMSOL), Energy Technology (sponsored by Hitachi Energy), Sensing, Detection and Monitoring (sponsored by Sensirion) and Quantum Science and Technology (sponsored by ID Quantique). Each award is granted with CHF 5000.-.

Furthermore the winners of the Charpak-Ritz award, the CHIPP awards and the Prix Charles Haenny will also be honored.

The award ceremony will be held on 24 August at 13:00h.

General Assembly

The general assembly is scheduled for 24 August in the late morning. The agenda will be published in the next issue of the *SPG Mitteilungen*. We encourage all members to actively participate and contact the committee, at least three weeks before the meeting, if special points of interest should be discussed at the assembly.

Conference Dinner

A conference dinner is scheduled for the evening of 26 August in the "Musée Olympique" in Lausanne. The number of participants is limited. More Information will be available on the conference website soon.

Vendors Exhibition

A vendors exhibition will be organized in addition to the scientific program. An invitation letter has been sent to interested companies. If your company would like to join the exhibition, but did not receive the invitation letter, please contact: *sps@unibas.ch*

Lab Tours

Several lab tours, i.e. in the Swiss Plasma Center and further labs of the physics institute, are foreseen in the afternoon of the last conference day, after the parallel sessions end. You may apply for one of them directly in the registration form. Details will be provided at a later date on the web.

Abstract Submission

You can submit abstracts to all topical sessions. The choice between an oral or a poster presentation of your contribution is possible. Due to the limited number of time slots the session organizers might, however, have to change some oral presentations into posters. If possible, please mark both options in your submission, indicating that you are flexible regarding the presentation mode. Abstracts shall not be longer than ca. 100 words, and pictures are not allowed.

The submission of abstracts must be done online. The module will open in early March. Visit the conference webpage *https://www.sps.ch/de/events/sps_annual_meeting_2026* and follow the link to the submission form. Further explanations are available there.

The conference program will presumably be available in late June 2026. Please check the web regularly for further information and updates.

Submission Deadline: 1 May 2026

Conference Fees, Registration and Payment

The conference fees cover the participation to all sessions, including coffee breaks (all days), poster-apéro (Tuesday) and lunch buffet (Wednesday). The conference dinner on Wednesday evening will be charged separately.

Pay your conference fee in time and save money !

The conference fees, as shown in the table below, hold for payments reaching us until 10 July 2026 (early bird rate).

Category:	*CHF*
Individual members of SPS, CHIPP	180.-
Member students **before** Master degree (*)	100.-
Non-Member students **before** Master degree (*)	180.-
Other persons	260.-
Plenary speakers, invited speakers, awardees	0.-
Conference Dinner	95.-

(*) Students licence required

For payments done later, a surcharge of CHF 20.- will be added. This applies also for participants paying onsite.

For registration just follow the link above. Detailed payment information is available directly during the registration process. Please make sure that your name and the purpose of the payment are clearly indicated in the payment order.

Attention: Fees are only refundable according to the cancellation policy which will be stated on the registration website.

Registration Deadlines
Early Bird: 10 July 2026
Regular: 1 August 2026

Additional information for selected sessions

Condensed Matter (KOND)

The condensed matter program welcomes contributions from all topics within condensed matter physics. This includes but is not limited to contributions from magnetism, superconductivity, semiconductors, fundamental questions on novel quantum phases or applied research. We also welcome contributions focusing on method developments for research on condensed matter materials, and will aim to bundle your input into topical sessions that serve as a fertilizer for fruitful discussions.

Contact: Daniel Mazzone (daniel.mazzone@psi.ch), Ilaria Zardo (ilaria.zardo@unibas.ch)

Applied Physics: Bridging Theory and Innovation

Applied physics provides essential tools and methodologies for addressing scientific challenges across a wide range of scales, from nuclear and astrophysical processes to advanced technologies for fusion, sensing, and communication. Recent developments include high-precision isotopic and spectrometric techniques for astrophysics, fusion research, and environmental monitoring; advanced plasma diagnostics and modeling to improve the understanding of boundary plasmas and plasma–wall interactions in tokamak devices; and ultrafast laser-based methods for beam characterization and plasma spectroscopy. In parallel, progress in micro- and nanotechnologies—encompassing semiconductor detectors, magnetic nanostructures, spin-wave devices, and wavefront correction techniques—continues to drive innovation in imaging, high-frequency electronics, and communication systems.

This session of the SPS annual meeting will highlight applied physics research spanning plasma and fusion science, nuclear and radiation instrumentation, ultrafast photonics, micro- and nanoelectronics, and advanced diagnostic and modeling approaches. By bringing together expertise from these complementary domains, the session aims to foster interdisciplinary exchange and showcase developments that translate fundamental physics into impactful technologies.

Contact: Fabio Avino (fabio.avino@epfl.ch), Mike Seidel (mike.seidel@psi.ch)

Accelerator Science and Technology

A broad range of research applications can be accommodated by particle accelerators, which generate specific types of secondary radiation, such as X-rays, neutrons, muons or exotic particles, at very high energies. Another use case is in the field of medical applications for treating patients and diagnosing illnesses. Contributions are encouraged on all aspects of accelerator development for future high energy frontier electron, proton and muon colliders, high brightness synchrotron light sources, high intensity neutron sources as well as medical accelerators.

Contact: Mike Seidel (mike.seidel@psi.ch)

Energy, Environment and Sustainability

This session aims to foster broad participation from the research community, with particular encouragement for early-career researchers and students. Contributions may address fundamental or applied research, system-level analyses, or interdisciplinary perspectives at the interface of energy, environment, and sustainability. By welcoming a wide range of topics and approaches, the session seeks to stimulate exchange across disciplines.

Contact: Tomoko Muranaka (tomoko.muranaka@epfl.ch), Stephan Wirths (stephan.wirths@hitachienergy.com)

Gravitational Waves

For this special session, organised in collaboration with the Swiss Gravitational Wave Coordination Group (SGWG), contributions covering all aspects of gravitational wave physics are welcome. Particular emphasis is placed on contributions connected with the Einstein Telescope (ET), the LISA mission, and the ongoing LIGO-Virgo detectors, and gravitational wave activities linked to pulsar timing arrays and atomic interferometers.

Relevant topics include data analysis, theoretical aspects, and experimental challenges of any of the relevant experiments.

We particularly encourage PhD students and postdocs to submit abstracts and to join the meeting. Depending on the number of proposed contributions, the session will take place on one or two afternoons. Poster contributions are also welcome.

Contact: Steven Schramm (steven.schramm@unige.ch), Philippe Jetzer (jetzer@physik.uzh.ch)

Magnetism and Spintronics at the Nanoscale

This focus session concerns the latest advancements in the fabrication, measurement, and exploitation of novel functionalities in spintronic and nanomagnetic materials.

We aim to showcase recent work conducted by experimentalists and theorists from Switzerland and neighboring countries who are researching the magnetic properties of thin films, interfaces, and nanostructures. Dirk Grundler (EPFL), Yujeong Bae (EMPA) and Daniela Petti (Polytechnic University of Milan) will present invited talks during the sessions.

Contact: Ales Hrabec (ales.hrabec@psi.ch), Maria Ameziane (maria.ameziane@psi.ch), Ke Gu (ke.gu@psi.ch)

Quantum Computing (organized by the NCCR SPIN)

The quantum computing session aims to bring together the groups working on all aspects of quantum computing and simulation from hardware to software, experiment to theory, qubit materials, engineering, computer science and quantum information. This includes various qubit realizations such as atomic, ionic, photonic, superconducting, spin and other qubits, as well as cryo-CMOS control. On the software side, the session includes quantum algorithms, quantum error correction and mitigation, quantum information, as well as NISQ and fault tolerant computing and use cases.

The session is organized by the *NCCR SPIN: Spin qubits in Silicon* (https://nccr-spin.ch/), and will comprise a mixture of oral and poster contributions from both senior and junior researchers. Please submit your contribution before the abstract submission deadline.

Contact: Maria Longobardi (Maria.Longobardi@unibas.ch), Dominik Zumbühl (Dominik.Zumbuhl@unibas.ch)

Theoretical and Mathematical Physics (organised by the NCCR SwissMAP)

This sessions aims to offer a forum to the theoretical and mathematical physics community in Switzerland and beyond, ranging from statistical mechanics and probability, via PDEs and geometry all the way to holographic dualities and quantum gravity. The session is organised by the NCCR SwissMAP and will showcase contributions by researchers in Switzerland and neighbouring countries in areas relevant to the main research directions of the NCCR (https://www.nccr-swissmap.ch/).

Contact: Julian Sonner (Julian.Sonner@unige.ch)

Semiconductors in Industry

Semiconductors are the backbone of modern industry. They power everything from smartphones and electric vehicles to advanced medical devices and AI systems. In today's era of digital transformation, their role is critical for enabling faster computing, energy efficiency, and connectivity across sectors. Global supply chain challenges have highlighted their strategic importance, making innovation in semiconductor physics essential for resilience and competitiveness. The goal of this year's Physics in Industry session is to provide a unique opportunity to explore how fundamental principles drive breakthroughs in semiconductor technology—fueling progress in electronics, automation, and sustainable solutions.

Contact: Valeria Bragaglia (vbr@zurich.ibm.com), Gian Salis (gsa@zurich.ibm.com)

Energy Day 2026

How should the research community contribute to the energy transition?

The Energy Day is an event dedicated to energy research and technology. We foster the research community to engage in evidence-based discussions on the future of Switzerland's energy system and to reflect on how research can most effectively contribute to the energy transition.

Through a series of high-level lectures and panel discussions by leading experts, the Energy Day aims to identify today's critical challenges and to clarify the concrete research and system-level tasks that must be addressed to advance the energy transition: What is the current state of scientific knowledge, technological development, and societal needs? Which challenges do we face, and what responsibilities do we assume as researchers?

Contributions from industry, students, and local actors are welcome, with the goal of strengthening dialogue and accelerating progress from research to implementation.

The event also aims to strengthen interaction between research and industry by increasing the participation of industrial partners and startups. A compact exhibition format is planned to encourage informal exchange, discussion of collaboration opportunities, and career-related dialogue during conference breaks.

Contact: Tomoko Muranaka (tomoko.muranaka@epfl.ch)

Historical Symposium 2026: *Progress in Quantum Science and Technology*

Tradition

Since 2010 the SPS organizes every year one or sometimes two half-day symposia in addition to its annual meetings. When the SPS section *History of Physics* was founded in 2011, the motivation step arose that historical highlights in Physics and their influence until to our days should be presented to the interested public. We later decided to integrate the symposia in our annual meetings to reduce the organizational effort. Today they are presented as vernissage at the beginning in order to send out a strong message to the public and to reach especially young people. In most cases, three or four lectures are offered, with the first lecture also focusing on the person or the event from a theoretical, historical, and philosophical perspective. Subsequently, the impact on the present day is considered, from the point of view of fundamental research, applied physics and, if possible, from technology. This concept of such a scientific journey through time is well received by the audience, including younger and elder colleagues, from universities and industries, but also from outside.

Entanglement

The Year of Quantum Science and Technology proclaimed by Unesco for 2025 informed the world that the quantum realm is not just a static collection of atoms and molecules arranged in a structured way, as observed under a microscope, but a pulsating nano-cosmos of its own strong interactions between individual, but also between entire collectives of atoms. One of the most bizarre phenomena that is completely beyond human understanding is that of so-called *quantum entanglement*, i.e. the coupling of quantum states of individual particles, be they emitted light quanta, called photons, but also individual atoms, molecules and even entire groups of molecules. This opens up new application possibilities, the best known of which are those of the quantum computer, but also methods of quantum encryption (cryptography) and many other approaches in modern computer and communication sciences. And it continues, revealing more and more possible applications in the fields of measurement technology and production engineering.

Symposium

Based on these considerations we will present this year's event under the title ***Progress in Quantum Science and Applications***, where we want to report on the latest developments in the field of modern quantum research, with a focus on entanglement, which is opening up new application areas, and where more and more industrial opportunities are emerging.

The program contains presentations from

- **Julian Sonner,** Université de Genève:
  Inseparable Quanta: Entanglement in Modern Physics
- **Géraldine Haack,** Université de Genève:
  How to exploit heat exchanges to generate and manipulate entanglement ? From quantum thermodynamics to quantum technologies
- **Cornelius Hempel,** PSI Villigen / ETH Zürich:
  Quantum entanglement between trapped ions: creation, detection and use for sensing and computation
- **Thibaud Ruelle,** CSEM:
  Next-Generation Miniature Atomic Clocks: From Lab Concepts to Compact Reality

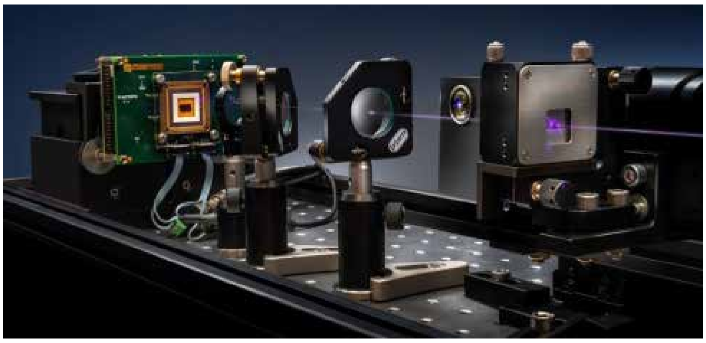
The abstracts of the presentations, together with organisational details will be published in the next issue of the *SPG Mitteilungen*.

This symposium will take place on **24 August 2026** in the afternoon, and is free of charge.

Other Examples [1]

One of the examples of the German consortium QUILT is Quantum Imaging. The idea is to create two entangled photons and manipulate them so that one photon is in a spectral region favorable for material analysis, while the other photon is in a spectral region where optimal detection technology exists. Quantum imaging is a continually developing field of quantum photonics in which exotic light-based physical phenomena are used to dismantle the limitations of classical optics to capture images in unprecedented resolution and challenging wavelengths. Photons that have been quantum entangled – intimately linked to one another regardless of the distance between them – are being used to open up new opportunities for imaging, microscopy, and spectroscopic methods.

1 Partners of the QUILT (Quantum Methods for Advanced Imaging Solutions) project are six Fraunhofer institutes, the Austrian Academy of Science and the Max-Planck-Institute for the Science of Light.



A setup used for quantum ghost imaging, where a special crystal is used to generate entangled photon pairs of different wavelengths from laser light (Image: Fraunhofer IOSB)

SATW Benefit

As quantum technology will be one of the most important technologies of the future, the emerging industrial potential of entanglement should be seen by the academies, the federal administration and the industries. We thank SATW, which is in charge identifying new technological visions for Swiss industry, for the support of this event.

Contact: Bernhard Braunecker (braunecker@bluewin.ch), Jean-Philippe Brantut (jean-philippe.brantut@epfl.ch) and Rachel Grange (grange@phys.ethz.ch)

Kurzmitteilungen - Short Communications

Symposium 100 Jahre Adolf Lohmann

Dieses Jahr am 20. April hätte Adolf Lohmann (1926 - 2013) seinen 100. Geburtstag feiern können. Professor Lohmann leitete das Institut für Angewandte Optik an der Universität Erlangen-Nürnberg von 1973 bis 1992. Er gehörte wie Herwig Schopper zur selben Generation von Doktoranden und Assistenten von Rudolf Fleischmann in Hamburg in den Jahren nach dem 2. Weltkrieg, die es irgendwann im Verlaufe ihres Lebens nach Erlangen verschlug [1]. Herr Lohmann ging aber nicht wie Fleischmann und Schopper in die Kern- oder Elementarteilchenphysik, sondern ins Gebiet der Optik, da er erkannte, dass die klassische Geräteoptik, wie man sie von Mikroskopen her kennt, mit ganz andere Leistungsdaten aufwarten kann, wenn man sie als Informationsverarbeitungssystem betrachtet, sie also mit bekannten Begriffen aus der elektrischen Signalverarbeitung klassifiziert wie Orts-Bandbreitprodukt und Kontrast-Übertragungsfunktion.

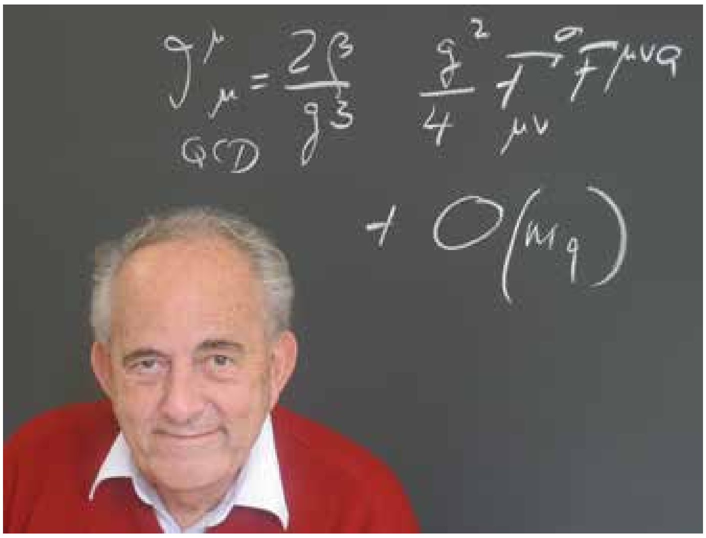
Anders als ein elektronischer Prozessor mit zeitsequentiellem Datenfluss ist ein optisches Hochleistungssystem ein echter, noch dazu gigantischer Parallelprozessor, allerdings mit den gravierenden Nachteilen, numerisch nur auf wenige Prozente genau zu rechnen und einem bislang unzureichend gelösten Problem, zwei- oder dreidimensionale Bilddaten schnell ein- und auszulesen. Lohmann war dennoch seiner Zeit weit voraus, denn heutige optische Systeme sind ebenfalls auf Halbleitern integriert und stehen in unmittelbarer Wechselwirkung mit digital-elektronischer Technologie, so dass dem optisch-hybriden Prozessorkonzept hohe Bedeutung zugemessen wird.

Herrn Lohmann zu Ehren wird an der DGaO Tagung am Freitag 29.05.2026 vormittags ein Sondersymposium veranstaltet, wo von früheren Institutsangehörigen über besondere Ereignisse, Ergebnisse und Erfahrungen aus ihrer späteren Berufszeit berichtet werden soll, die irgendwie Bezug zur Lohmannschen Schule oder Lehre haben. Auf der Homepage der DGaO (www.dgao.de) wird das Programm schätzungsweise ab Ende Februar einzusehen sein.

1 In der letzten Ausgabe berichteten wir auf Seite 26 über die Erlanger Jahre des späteren CERN Generaldirektors Herwig Schopper.

Prof. Dr. em. Peter Minkowski (Zurich 1941 - Bern 2025)

Peter Minkowski was born in 1941 in Zurich, where he also grew up. His family originated from Poland. He studied at ETH Zurich and completed his doctorate under Markus Fierz in 1967. Subsequently, he worked as a postdoc, first at the University of Louvain in Belgium, then at the PSI (formerly the Swiss Institute for Nuclear Research), and as a Fellow at CERN.



However, many of his most renowned works date from his time at Caltech from 1973–1976. These years were a pivotal and revolutionary era for particle physics as a whole, and Caltech played an essential role in this (thanks in part to Feynman and Gell-Mann). In 1973, Harald Fritzsch, Murray Gell-Mann, and Heiri Leutwyler (all at Caltech at the time) authored a paper in which they argued that the strong interaction could be an SU(3) gauge theory of quarks and gluons. In that same year, Gross, Wilczek, and Politzer independently demonstrated that these types of theories are asymptotically free.

It thus became evident that Quantum Chromodynamics (QCD) was the correct theory of the strong interaction and that the same type of theory describes both the electroweak and the strong interaction. Following this success, it was natural to consider whether there could be a unified theory for all three interactions. To this day, the most promising Grand Unified Theory is the SO(10) gauge theory, which Peter proposed together with Harald Fritzsch [1].

In this theory, at very high energies, there is only one type of matter, which transforms under SO(10). In contrast to earlier attempts based on SU(5), Peter's theory also unifies neutrinos with the rest of matter into a single field. In addition to the elementary particles known at the time, this theory includes right-handed neutrinos.

After arriving in Bern in 1976, initially as a visiting professor, he elaborated an elegant mechanism in a paper wherein the existence of heavy right-handed neutrinos explains why the left-handed neutrinos we observe at low energies are so extremely light [2]. His discovery is known today as the Seesaw Mechanism.

Peter's paper was, however, scarcely cited for the first 27 years following its publication, until a conference was held in Paris in 2004 to mark the 25th anniversary of the discovery of the Seesaw. Following an incident where Peter shouted at the conference organizers during a dinner in an elegant Parisian restaurant—pointing out that he had discovered the mechanism not 25, but 27 years prior—his work is now cited over 300 times per year and has since garnered over 5600 citations.

In the year of the Seesaw paper, Peter became an Associate Professor in Bern, and then a Full Professor in 1989. He attained emeritus status in 2006. His research covered many areas. Beyond unified theories and neutrino physics, he also conducted research in QCD, specifically regarding glueballs and scalar resonances. Together with Peter Grieder, he was also involved in the development of the DUMAND Experiment (Deep Underwater Muon And Neutrino Detector Project). From 1985–1987, he served as President of the Swiss Physical Society.

A standard curriculum vitae does not do justice to a colorful and unique character like Peter. We spent the drive to and from his funeral in Zurich trading anecdotes about our encounters with him. We believe that this would have pleased Peter, who often and happily told us anecdotes about his own encounters with famous physicists, such as Feynman and Gell-Mann.

When we informed a former postdoc about Peter's death, he aptly remarked: "Things were certainly never boring with Peter!" We will hold him fondly in our memories.

Gilberto Colangelo, Thomas Becher, Universität Bern

[1] Annals of Physics. 93 (1–2): 193–266, (1975)
[2] Physics Letters B. 67 (4): 421–428 (1977)

Progress in Physics (111)

The power of small telescopes: science and sustainability

Aurora Sicilia-Aguilar and Paula S. Teixeira, University of Dundee, UK

In the quest for larger telescopes, we may still want to properly acknowledge the humbler yet powerful ground-based, small counterparts. Such telescopes still have much to offer, in particular, we profit from their wide fields of view, their time availability, and also their lower monetary and environmental impact costs.

Understanding star and planet formation

Star and planet formation are two sides of the same problem: in the fight between gravitation and thermal pressure that shapes the gas clouds in our galaxy and beyond, a star will form when gravity wins and a denser lump in the cloud collapses. Evolution from a pre-stellar core to a protostar, and eventually, a star, involves a contraction by 6 orders of magnitude in size in a timescale well below one million years. Conservation of angular momentum thus leads to the formation of a young star surrounded by a protoplanetary disk (Fig. 1). This disk eventually disperses, leaving behind a newly-formed planetary system.

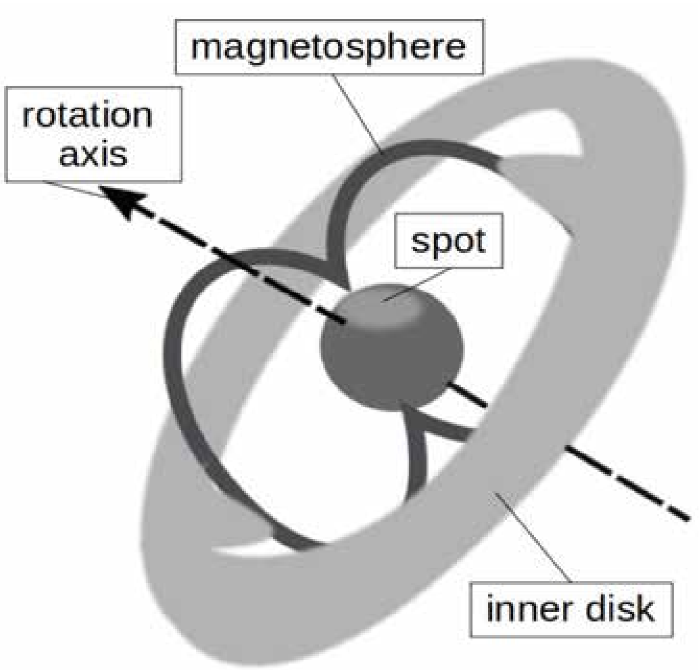


Fig. 1. A cartoon of the innermost regions of a young star (not to scale; a disk would extend over the size of a Solar System, while the magnetosphere is typically a few stellar radii). The magnetic field of the star disrupts the disk and channels accretion, which creates a hot spot on the stellar surface. Stellar spots produce variability as the star rotates, and material lifted from the disk can obscure the star, producing "dips".

For those of us living in the habitable zone around the Sun, looking for other nascent systems in nearby star-forming regions is the way to try to reconstruct the history of our own system, as well as to estimate the chances of forming similar planets. But observing these systems is exceedingly challenging. While a protostar in a nearby star-forming region may have an angular size comparable to a few percent of the diameter of the full Moon, and a disk would be comparable to a 1.5 km crater, a star would be the size of a volley ball lying in one of the craters, and the habitable zone of the disk would be barely the size of a volleyball court... Moreover, most nearby star-forming regions are probably not analogues to where the Sun formed. Exploring more distant regions is thus equivalent to looking at a small marble sitting in the middle of a hula ring, all based on the Moon.

Interferometers can nowadays resolve the innermost regions of some star-planet systems. Optical interferometry can map accretion columns, albeit mostly for bright stars that are often not solar analogues, and with lengthy (and costly) observations. Submillimeter data can also resolve protoplanetary disks, but most objects are not resolved beyond what would be equivalent to the orbit of Jupiter, since the inner disk is small, faint, and relatively warm. The inner disk is too faint in the submillimeter even for interferometers such as ALMA, and spectropolarimetry or IR interferometry can only target few close, bright stars, very different from the Sun, so that statistical studies of the inner regions of nascent planetary systems are thus lacking.

In the task of putting the Solar System into context, we also note that not all systems evolve in the same way. This means statistics are needed, covering as many stars as possible, with different ages, initial conditions, and environments. Because not all nearby star forming regions are analogues to the one in which our Sun formed, nor cover the entire age range to visualize the process, we need to probe distances further out. Away from bright objects and beyond the limits of interferometry.

Tracking small scales: *Using time to map space*

The power of alternative observational methods, going beyond the spatial resolution of imaging, has been long noticed. It is not by chance that many recent missions are built around making the most of repeated observations, from the Gaia Mission to map the Milky Way [1], to the Vera Rubin Observatory [2]: the focus has shifted onto *using time to map space*.

Time is able to turn around the problem posed by spatial (or angular) resolution. Small scales that are hard to resolve in images are also the ones that display changes with the shortest temporal cadences. Often, short enough to be comparable to human timescales (Fig. 2). Time resolution is not only a powerful tool to investigate tiny structures: In fact, when dealing with the very small spatial scales around young stars, *using time to map space* is the only feasible method to study statistically significant numbers of sources, especially for the normally faint solar analogues.

Timescales in the surroundings of forming stars range from the few days of typical stellar rotation, to the few years comprising the Keplerian orbit of a protoplanetary disk fragment at a couple of astronomical units' distance (Fig. 2). The

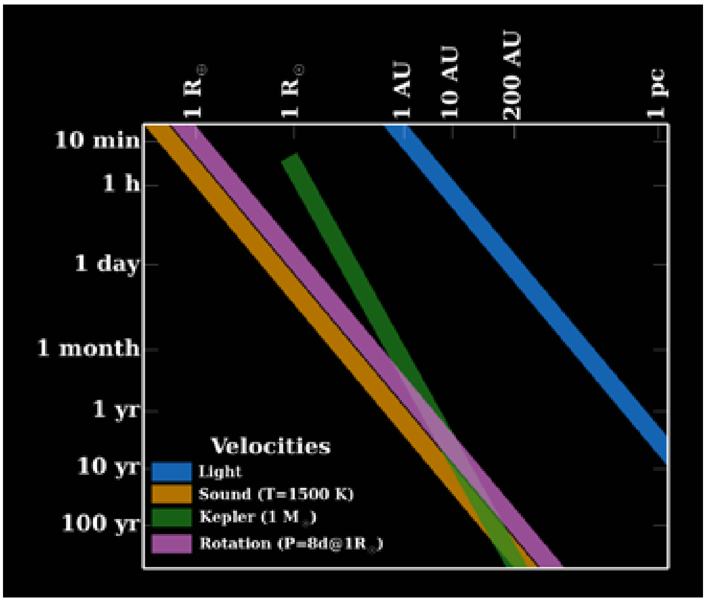


Fig. 2. Using time to map space. How fast different signals can cover distances ranging from Earth's radius to interstellar distances.

spots, hot or cold, on the stellar surface, and the irregularities of the inner disk that may be related to planets, cross our line-of-sight creating different patterns on the measured luminosity of a star and thus revealing what cannot be resolved in an image. Travel time also depends on what is moving: Whether it is light casting a shadow, or a stellar or planetary rotation, or a sound wave propagating in the circumstellar medium. The relation between the size of a region and how rapidly it changes, means that to detect stellar rotation, we may just observe for a few weeks and that by gathering observations over a few years, we can picture changes in the parts of the disk that will give rise to planets in the habitable zone.

An example: The North-PHASE Legacy Survey

North-PHASE stands for "*Periodicity, Hot spots, Accretion Stability and Early evolution in young stellar clusters in the northern hemisphere*" and it is a 5-year (2023 - 2028) Legacy Survey at the Javalambre Observatory (Spain), led by the University of Dundee [3]. Using time-resolved, multi-cadence, multiwavelength, large field data, it is unveiling structures and processes in young stars at the relevant scales for inner planet formation, while also studying the connection between stars, their formation history, and their clusters, independently of astrometry. North-PHASE is unique at *using time to map space* thanks to the combination of filters that allow to investigate the temperature of stars and spots and the material properties of the inner disks, while covering thousands of young stars in each shot for a statistical study of their variability and the physical processes to which it is linked. And it is also unique because of its wide-field camera [4,5].

North-PHASE produces stunning wide-field images, each covering about 10 times the size of the full Moon and providing multi-color data on hundreds of thousands of stars (Fig. 3). Hidden within the beauty of the large-field images are the technical details, such as an extremely robust coordinate solution over the entire large field and an amazing CCD stability that is allowing us to detect variability down to below 1% - and all this with a ground-based, 83 cm telescope. The irregular observing cadence of North-PHASE can measure rotational periods of thousands of stars, including many young solar twins of different ages, and the current two years of data are already revealing variations in the spots that betray stellar rotation, as well as in the disks that surround them.

By observing each star more than a hundred times per year, we can track luminosity variations below 1 part in 100 and explore the mechanisms behind the changes. In some stars, sinusoidal curves reveal rotation of a star with a spot, and the multiple photometric bands allow us to track the size and temperature of the spot(s). In others, we discover that the protoplanetary disk is not as flat as one would expect, causing eclipses that repeat themselves in a semi-regular pattern. These eclipses can be pinpointed to a location in the disk where some perturbations (accreting material, winds, or maybe nascent planets) lift the dusty disk surface to obscure the star (Fig. 4). And such examples are only the beginning: the complexity and diversity of the available data is now at a stage where citizen science can make a key contribution to the analysis.

Fig. 3. A view of the Tr37 cluster and the surrounding IC1396 nebula taken by North-PHASE. The region is located at 920 pc (3000 light years). Colors represent different filters, with g (470 nm) being blue, J0660 (covering the Hydrogen alpha line at 656 nm) in green, and z (890 nm) in red. Only about 1/5 of the very large image is displayed here.

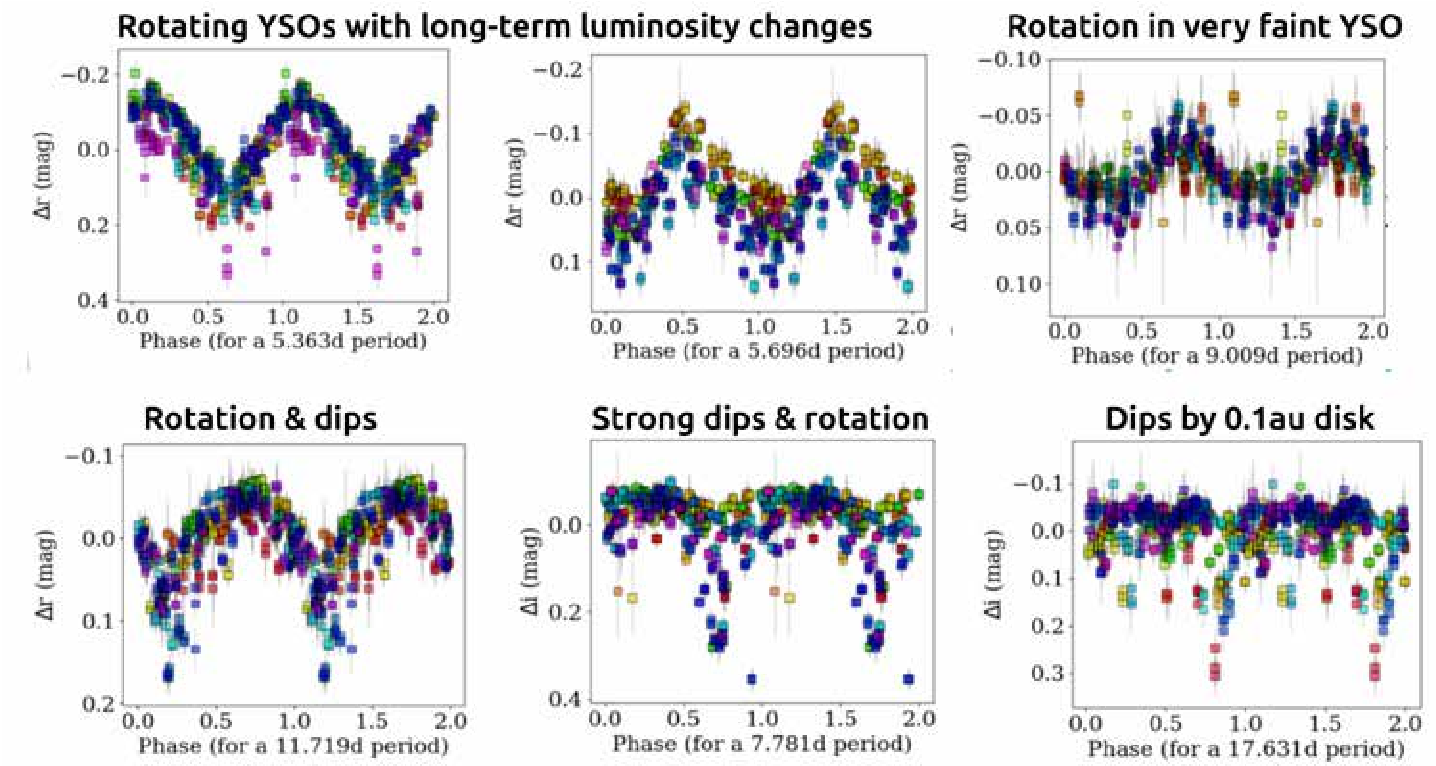


Fig. 4. Several of the variable stars identified by North-PHASE during its first 2 years. The data is presented as changes in brightness folded to account for the periodicity (phase space for the given period, plotted twice). The color scheme marks the time evolution, from red to violet. Brighter magnitudes are smaller, hence negative changes correspond to the star getting brighter. Only one of the 6 filters available is shown per star. Examples show sinusoidal curves due to rotation of stars with a spot and dips caused by disk material near the star or further out.

Small telescopes and the quest for sustainable astronomy

The North-PHASE Legacy Survey represents a step toward more sustainable astronomical research, demonstrating how high-impact science can be achieved with reduced environmental cost. Operating from the Javalambre Observatory (OAJ) with a modest 83 cm ground-based telescope, the survey fully leverages the scientific potential of low-carbon infrastructure. Smaller telescopes require substantially fewer construction materials, reduced land disturbance, and lighter ongoing operational loads, allowing them to deliver competitive scientific output while generating a fraction of lifetime emissions. This structural advantage is reflected directly in the OAJ's comparatively low annual electricity consumption (600 MWh in 2021; [6]), which remains far below that of major facilities.

OAJ further advances sustainability by integrating renewable energy systems directly into its operations. Its 200 kW solar array provides 50% energy self-sufficiency, reducing dependence on carbon-intensive grid electricity, while geothermal systems supply 73% of heating and cooling needs [6], sharply curbing emissions associated with climate control, historically one of the most energy-demanding aspects of observatory operations. These systems not only reduce carbon output but also enhance operational resilience and demonstrate a scalable template for sustainable facility design.

At a broader level, sustainable astronomy requires a structural shift away from constant investment in new, massive research infrastructures that lock in emissions for decades through construction, global supply chains, and high-intensity operations [7]. Facilities like the OAJ embody an alternative paradigm: modern design principles that prioritize efficiency, modularity, and minimal resource use. The automated control systems developed for smaller observatories [8,9] explicitly aim to maximize operational efficiency while reducing routine maintenance, material throughput, and human intervention. By reducing commuting and professional flights, which are activities recognized as among the most carbon-intensive within the astronomical profession [10], the OAJ's operational model mitigates one of the field's most challenging emissions sources.

Moreover, multi-year photometric legacy surveys such as North-PHASE generate extensive datasets that form high-value, long-lived scientific archives. These archives allow repeated exploitation of existing observations, multiplying the scientific return per unit of energy and material invested [11]. By enabling large-scale time-domain studies without requiring additional observational cost, archival science maximized the scientific yield per unit of energy and material invested. This highly efficient use of resources directly addressed the subsequent imperative of data recycling and reducing the technical debt, focusing on developing tools that allow the community to explore and analyze existing data.

Data recycling and reducing the technical debt

If we want to go forward in the quest of making astronomy more sustainable, we need to consider that telescope databases are full of data, some of which were not used to the extent originally intended due to various reasons - finding the unexpected and lacking enough time to go in depth within the extremely hectic research and teaching world is one of them. Data wasting, similar to food wasting, generates a large CO_2 footprint without proving much benefit. Thus, creating tools that allow us to explore and analyze existing data down to its deepest possibilities is also an important part of making astronomy sustainable.

One example is the substantial amount of spectroscopic data that was acquired with the intention of finding radial velocity planets around young stars. While initially expected that the processes around the star, such as accretion, would be eminently stochastic and thus different from the stable signatures of planets, this was found to not be the case, and the task of finding the planets became technically unfeasible. But if the signatures of forming stars were so robust and regular, why not use them instead to disentangle the way stars connect to their disks? With the creation of the STAR-MELT public Python package [12,13], we enabled the existing spectral data, from about any high-resolution spectroscope from the major observatories, to be easy to analyze and combine, extracting emission lines that reveal the location and time variability of the footprints of accretion columns on the stellar surface.

Therefore, additional community work towards the creation of tools that facilitate the analysis and recycling of existing data is also a valuable tool to reduce the technical debt as well as the carbon footprint of astronomy. Comprehensive exploitation of older archival data, combined with recent observations, will further increase the scientific yield and allow us to track stellar variability over longer timescales.

Citizen science, or the human power for analyzing large datasets

Involving citizen scientists in the analysis of data has multiple benefits, both for the professional scientists as well as for the community, especially, in the light of dwindling numbers of children choosing STEM subjects in the UK and, in particular, in Scotland. Often, we do not know what we can do until we are facing a situation where we can actually do it. For many, the chance never comes. This was not the story of Williamina Fleming and Joanna Mackie, but it could well be the story of youths in underserved communities. Dundee was home to sisters Williamina and Joanna, who, in the late 19^{th} century, emigrated to the US to work as maids. They landed at the house of the Harvard Observatory director, who realized they were too intelligent to be just maids, so he employed them among their women 'computers' to become pioneers in stellar classification.

Interpreting complex variability data when applied to processes that we do not yet understand and for which there are no significant number of examples available yet is still similarly hard as it was a hundred years ago, and because of this, it is still a field where the power of citizen scientists can make a difference. We are starting the Williamina & Joanna School of Variable Stars to bring an opportunity to experience science to young people from Dundee, raising their aspirations and awareness of their own capabilities to do physics and science at a time it can still affect their school decisions, to counteract the STEM subjects' decline observed in Scotland. Imagined as a long-term project similar to "*Light your life*" by Prof. Cornelia Denz [14], we plan to involve local youths in the analysis of North-PHASE data, collaborating with the Mills Observatory in Dundee, which turns 90 years old this year and is the first observatory built with the purpose of public engagement in the UK. The project will launch in January 2026, with the help of staff, PhD and undergraduate students from the University of Dundee. The coming months and year will tell us where the effort of citizen scientists brings us in our quest of *using time to map space*.

References

[1] https://www.esa.int/Science_Exploration/Space_Science/Gaia
[2] https://rubinobservatory.org/
[3] Sicilia-Aguilar, A., Kahar, R., Pelayo-Baldárrago, M., et al. 2024, MNRAS **532**, 2108 "North-PHASE: Studying periodicity, hot spots, accretion stability and early evolution in young stars in the Northern Hemisphere".
[4] https://oajweb.cefca.es/telescopes/jast80
[5] https://oajweb.cefca.es/telescopes/t80cam
[6] Corradi, R. L.M., Highlights of Spanish Astrophysics XII, Proceedings of the XVI Scientific Meeting of the Spanish Astronomical Society held on July 15 - 19, 2024, in Granada, Spain. M. Manteiga, F. González Galindo, A. Labiano Ortega, M. Martínez González, N. Rea, M. Romero Gómez, A. Ulla Miguel, G. Yepes, C. Rodríguez López, A. Gómez García and C. Dafonte (eds.), 2025, "Sustainability in the Spanish observatories"
[7] Knödlseder, J., ADASS XXXII (2022) proceedings, "The carbon footprint of astronomical observatories"; https://arxiv.org/abs/2409.04054
[8] Yanes-Díaz et al. 2018, Proceedings Volume 10704, Observatory Operations: Strategies, Processes, and Systems VII; 1070421 (2018), https://doi.org/10.1117/12.2313208
[9] Yanes-Díaz et al. 2022, Proceedings Volume 12186, Observatory Operations: Strategies, Processes, and Systems IX; 121860Y (2022), https://doi.org/10.1117/12.2626105
[10] Stevens et al. 2019, Nature Astronomy, Volume **4**, p. 843-851, "The imperative to reduce carbon emissions in astronomy", https://arxiv.org/abs/1912.05834
[11] Knödlseder et al. 2024, Nature Astronomy, Volume **8**, p. 1478-1486, "Scenarios of future annual carbon footprints of astronomical research infrastructures", https://arxiv.org/abs/2409.04054
[12] Campbell-White, J, Sicilia-Aguilar, A., et al. 2021, MNRAS **507**, 3331 "The STAR-MELT Python package for emission-line analysis of YSO"
[13] https://github.com/justyncw/STAR_MELT
[14] https://www.uni-muenster.de/Cells-in-Motion/newsviews/interviews/denz.html

Dr **Aurora Sicilia-Aguilar** is a Reader in Physics/Astrophysics at the University of Dundee and the Theme Leader for Astronomy and Space Physics for the Scottish Universities Physics Alliance. Her career developed in the USA, Germany, Spain and the UK. She is an expert on observational star formation, with a particular emphasis on time-resolved data. She is also the PI of the North-PHASE Legacy Survey, an international collaboration currently running at the Javalambre Observatory, Spain.

Dr **Paula Stella De Viveiros Teixeira** is a Lecturer in Physics at the University of Dundee who has cultivated a career working across Portugal, the USA, Germany, Austria, and the UK. While her primary background is in astrophysics and observational star formation, she has transitioned her focus towards environmental science and renewable energy. Currently a member of Astronomers for Planet Earth, her research supports sustainable energy systems by assessing climate impacts and hydro-climatic risks.

Physicists in Industry (17)

The Role of the Industrial Physicists

Bernhard Braunecker

Culture Shock

Most physics graduates (around 90%) take a job outside the university after completing their studies, preferably in industry. There, a different culture of behavior awaits them than the one they were used to at university. Complex problems, which they previously had to solve on their own, are now dealt within a team under strict deadlines, with everyone being assigned a specific task segment. Instead of publishing as much as possible, as was previously the case, they now have to maintain silence towards the outside world. Instead of long-term visions, seemingly banal but immediately implementable small steps to optimize a technology or minimize the costs of a development project are the daily tasks. For many industry newcomers, this culture shock understandably leads to uncertainty and, looking back, they would have been glad to have been prepared for the new situation during their studies. In the past, the SPS took this concern into account by organizing the symposium series "*Careers for Physicists*" so that relevant information from industry could reach students in higher semesters. Nowadays, it is the session presentations at the SPS annual meeting, organized by the SPS section *Physics in Industry*, where speakers from start-ups report first-hand on their products, primarily to get young people interested in their company, but also to report on their corporate culture.

Physicists as Technology Developers

In the following, we will not look at the role of physicists in a start-up, but in a large company that has been established on the market for many decades and plays a leading role on the global market with its cutting-edge products. Large companies of this kind must therefore be open to innovation, which makes them attractive to graduates. Physicists are then employed either in a central R&D department to further develop a new technology, the feasibility of which has usually previously been demonstrated by an institute, to product maturity, or in the business units to integrate newer technologies into products or processes. In the first case, typical tasks are, for example, for a new type of lidar technology: What are the application limits? When does the system noise outweigh the measurement signals and can reliable information still be extracted from the noise even with very weak input signals? Do additional measures such as permanent internal calibration make sense in order to minimize systemic errors? In addition, it must be clarified whether the new technology can only be used situationally or in the instruments of *all* business areas, for example in civil surveying and medicine, where the highest resolution is required, as well as for defense instruments, where robustness is the top priority in the application? This last point is important for a large company to know whether the other business areas can compensate if one business area experiences an economic downturn.

Physicists as Product Developers

Physicists can also contribute their strengths in various areas when transforming a technical innovation into marketable products. The starting point for every new product launch is always a careful consideration of the intersection of the three fields (a) development effort, (b) range of applications and (c) market access. In the case of (a), it must be possible to estimate what difficulties are to be expected, what specialist skills need to be provided and what time frame is required? For (b), it must be clarified which other possible applications are conceivable and which instrument variants would be required? Finally, under (c), the question must be asked whether market access has already been secured, i.e. whether market acceptance can already be seen and whether customers are ready for the innovation? Linked to this is the question of whether your own company is already in a position to handle the entire production logistics, including customer advice, in terms of sales?

As an industrial physicist, you traditionally work more in the development area (a), whereby the manufacturing process must always be taken into account in every product development. For example, the design of a complicated optical system must not only deliver the specified imaging performance, but the minimization of manufacturing tolerances must also always be included in the ongoing optimization calculations. This requires a detailed knowledge of the manufacturing processes. Young physicists should therefore build up sufficient knowledge and self-confidence at an early stage in order to convince experienced production manager when it comes to investing in new and more precise machines, which will be a tough battle. In the second task (b), application analysis, physicists will have to be more involved in the future than they have been in the past in order to develop and specify the widest possible range of variants for the planned innovation and patent them as soon as possible. Physicists are ideally suited to this challenging task as they think in analogies, i.e. they can recognize fundamental similarities between different applications.

Humanoid robot from Hexagon Leica. State-of-the-art technology allows a wide range of practical applications. Image: courtesy of Hexagon

Point (c) is even more difficult, as psychology comes into play here alongside physics. Sales and distribution are generally very conservative, which is a consequence of their close relationships with regular customers, who are also usually conservative. When it comes to major leaps in innovation, there is mistrust, uncertainty and, unfortunately, often resistance to advice. In today's fast-moving world, ignoring quantum technologies, for example, can lead to existential problems for companies virtually overnight. They are therefore well advised to use the specialist knowledge of their physicists in customer support, because once customers see the advantages and lose their inhibitions, their own sales department can no longer resist them.

Physicists as Science Managers

In large companies, it is often customary to participate in external R&D programs in which a consortium of universities and other companies investigates new technological approaches that could be of interest for the company's own next-generation products. Programs of this kind include, for example, government-organized basic research programs in which the partners assess the industrial applicability of a research result. This is an appealing task for physicists, but it does not make them popular within their own companies, as it requires the best developers to be seconded, who are then missing elsewhere, involves a lot of unproductive effort, and ultimately it is unclear whether expectations will be met. If they are, patent disputes are often to be expected. However, such programs are enormously important, and in Asian countries they are mandated by the state. In this phase, companies must see themselves as colleagues and not yet as competitors. Another area where the expertise of physicists is in demand is in R&D programs for ESTEC, the technogy center of ESA and, increasingly, in military projects (see box).

Influence of the Corporate Culture

The extent to which physicists can and are allowed to use their skills in the intersection of the three areas mentioned depends heavily on the corporate culture. If a large company is run by lawyers or financial experts, more weight is always given to conservative sales, which brings in money, than to innovative R&D, which costs money. However, this only works for a while. In earlier times, technology giants such as Siemens, Volkswagen or BASF were traditionally always managed by a Dr.-Ing. or Dr.-rer.-nat. Their expertise allowed them to recognize the value of a technical or functional innovation from the outset and promote it accordingly. This requirement was then transferred to all subordinate management levels.

Nowadays, other paths are being taken and many companies offer different paths for personnel development: the so-called Y-models are well-known, in which physicists decide early on whether they prefer to work as an expert on technology projects in R&D and pursue a career as a group or laboratory manager, or whether they decide early on to pursue a career in company management. However, this requires MBA training, which can also be acquired during the professional career. The advantage of a career in corporate management is that you become universally deployable in the company, you can become more strategically involved with each level upwards, and you also earn more. The disadvantage is that you lose specific specialist knowledge and are quickly replaced, transferred or even dismissed if the targets set for the group, department or business unit you manage are not achieved. This significantly higher risk could be one reason why only a few female physicists choose this career path in corporate management, which has nothing to do with discrimination, but merely with a personal weighing up of benefits and risks.

Physicists as Top Managers

The question is whether we should not return to the previous situation, where technology companies were led or at least decisively shaped by physicists? In view of the rapid changes in the industrial world brought about by quantum technology, quantum biology and quantum informatics, strategic decisions must increasingly take into account the latest findings in the atomic field with regard to assessing potential opportunities and risks. Lawyers and financial experts lack the necessary internalized knowledge and their decisions are based on generally accessible information, which is not enough in view of the complexity. Physicists should therefore make a much greater effort to take on higher management functions in order to set the right course in good time as the half-life of new technologies becomes ever shorter. It should be discussed whether management skills should not be part of university physics training.

At ESA, as well as at big companies, system development nowadays largely runs in parallel between the various R&D departments. This means that even a preliminary design or a construction draft is assessed simultaneously at certain intervals by the test, production, assembly and application engineers. To this end, meetings are held in so-called Concurrent Design Facilities, where the design or the draft runs through all subject-specific programmes and where all engineers present can see how it meets the specifications set by them. Any proposed modification can be immediately implemented and verified if e.g. a mechanical modification at a larger optical payload may cause an unfortunate coupling between a specific acoustic resonance mode of the solid rocket boosters, and the payload's eigenfrequency of e.g. 45 Hz, which could cause serious vibrational problems at the launch.

More info can be found for example here: *https://www.esa.int/Enabling_Support/Space_Engineering_Technology/CDF*

Energie, Nachhaltigkeit und Umwelt (4)

Bericht aus der SATW-Energiegruppe

Bernhard Braunecker

Aufgabenstellung

Vor gut drei Jahren hatten sich etwa zehn Energieexpertinnen und -experten bei der SATW in einer losen Arbeitsgruppe zusammengefunden, um zu aktuellen Energiefragen Stellung zu nehmen. Auslöser war die seit Beginn des Ukrainekriegs in der Bevölkerung und in der Politik spürbare Verunsicherung über die langfristige Versorgungssicherheit von Energie und vor allem von elektrischer Energie in der Schweiz. Zwar gab es bereits 2022 einen Grundlagenbericht des Dachverbands der Akademien der Schweiz a+, der die gegenwärtige Situation bis ins Jahr 2050 extrapolierte, der allerdings nach Ansicht des SATW-Vorstands ergänzungsbedürftig war und weiterer Klarstellungen bedurfte [1].

Die sich *ad hoc* zusammengefundenen Gruppenmitglieder beschlossen deshalb an ihrer ersten Sitzung am 1. Dezember 2022, sich vorerst auf vier Themenbereiche zu konzentrieren, die hinsichtlich 2050 stärker betont werden müssten: (a) Energieversorgungssicherheit unter Einbezug aller Technologievarianten, (b) Neubewertung der Kerntechnologien, (c) wasserstoffbasierte Energiesysteme und (d) Reduktion des Energieverbrauchs von Rechenzentren. Während Punkt (a) zu einem ersten Positionspapier der SATW-Gruppe führte [2], basierte bei der Behandlung von Punkt (b) ein von der Gruppe verfasstes SATW-Faktenblatt weitgehend auf den im Juli 2021 im ***SPS Focus 1*** publizierten Erkenntnissen [3]. Das Thema „Wasserstoff“ (Punkt c) wurde danach gleich mehrfach behandelt, zuerst in einem von der SPG mitorganisierten SATW-Forum im April 2024, das die Beurteilung des Energieträgers Wasserstoff aus Sicht der Grossindustrie aufzeigte [4], anschliessend im ***SPS Focus 4***, worin primär der gegenwärtige Stand nuklearer SMRs [5] und ihr vorteilhafter Einsatz als kompakte Energiequelle in grosstechnischen Produktionsanlagen behandelt und dies dann am Beispiel der Wasserstoffproduktion illustriert wurde [6]. Einige Kollegen der SATW-Gruppe wirkten an diesem Report als Autoren mit. Als dritte Aktion der SATW-Gruppe kam Ende 2025 noch eine Studie über die Risiken von Wasserstoff in der täglichen Anwendung hinzu.

1 https://scnat.ch/en/uuid/i/5eca5222-206f-5922-8168-97a73b4a6e1e-Swiss_Energy_System_2050_Pathways_to_Net_Zero_CO2_and_Security_of_Supply

2 https://www.satw.ch/fileadmin/Documents/SATW/Factsheets_Versorgungssicherheit/SATW_Factsheet_Versorgungssicherheit_Energie.pdf

3 https://www.satw.ch/de/publikationen/kernenergietechnologien-ueberblick-ueber-den-aktuellen-stand-und-die-entwicklung und https://www.satw.ch/fileadmin/Documents/SATW/Focus_topics/Energie_Umwelt/SATW_Factsheet_Kernenergie.pdf

4 https://www.satw.ch/de/news/warum-wir-wasserstoff-und-synthetische-energietraeger-fuer-mobilitaet-dekarbonisierung-und-energiespeicherung-brauchen

5 Small and Medium (nuclear) Reactors

6 https://www.sps.ch/de/publications/sps_focus

Der verbleibende Punkt (d) der ursprünglichen Aktionsliste der Energiegruppe, wie der stark ansteigende Energieverbrauch in der Digitalisierung und hier speziell in Grossrechenzentren bei gleichzeitiger Steigerung der Rechenleistung reduziert werden kann, führte zu ***SPS Focus 3*** (Februar 2025). Allerdings bekam dabei das Thema der Effizienzsteigerung angesichts bemerkenswerter Fortschritte mehr Gewicht als geplant, was zu Lasten der Energiereduktionsfrage ging, so dass dieser Punkt noch der kritischen Betrachtung harrt. Dieser offene Punkt sollte von der SPG noch behandelt werden, denn bei diesem immer wichtiger werdenden Thema ist die Physik in mehrfacher Hinsicht gefordert, einerseits, da sie zu den Hauptbenutzern der Grossrechenzentren gehört und andererseits, weil energiesparsamere Lösungen nicht allein durch technische Verbesserungen erreicht werden können. Vielmehr sind neue Ansätze in der Rechnerarchitektur wie die spintronischer Art zu technischer Reife zu entwickeln, während im Programmierbereich zum Beispiel die Übernahme erprobter Optimierungsalgorithmen der theoretischen Physik zur Behandlung kollektiver Phänomene sich auch auf viele technische Fragestellungen anwenden liesse. Ergäbe sich dann eine schnellere Konvergenz der Lösungsansätze und somit eine Verkürzung der Rechenzeiten, würde dies den Energiebedarf deutlicher senken als es durch manche technische Massnahme geschähe.

Energiespeicherung

Als neues Thema in 2025 kam hinzu, wie die Energiespeicherung bis ins Jahr 2050 ausgelegt werden sollte, primär um die Volatilität der erneuerbaren Energien wie Windkraft und Photovoltaik durch kurzfristiges Laden und Entladen von Pufferspeichern so weit zu reduzieren, dass durch die schwankende Unter- oder Überlast der Netze nicht noch zusätzliche Destabilisierungsmomente das Gesamtsystem schwächen [7]. Das ist hauptsächlich in den Sommermonaten der Fall, um die tagsüber durch Solartechnik produzierte, aber nicht gebrauchte elektrische Energie nicht im gesamten Netz zirkulieren zu lassen, sondern sie temporär und an möglichst vielen und national gleichmässig verteilten Knotenstellen so lange zwischenzuspeichern, bis sie zum Beispiel in den Nachtstunden abgerufen wird. Die andere und fast noch wichtigere Aufgabe von Speichersystemen ist, sie als mittel- bis langfristig genutztes Energiereservoir für den zusätzlichen Bedarf in den Wintermonaten vorzusehen, falls es zu Versorgungsengpässen oder sogar zu Ausfällen bei der Stromproduktion kommen sollte. Nur wie im Folgenden gezeigt wird, bestünde 2050 bereits im Normalfall ein nicht unerhebliches Stromdefizit zwischen Angebot und Nachfrage in den Wintermonaten, das zu beheben ist.

7 SATW-FactSheet ‘Energiespeicherung 2050 - was braucht die Schweiz?‘, Autoren: Brigitte Buchmann (ehemals Empa), Konstantinos Boulouchos (ehemals ETHZ) und Christian Holzner (SATW), Februar 2026

Studien

Die Autoren der im Folgenden *Variante 1* genannten SATW-Studie unterscheiden somit auch zwischen kurzfristigen Speichertechnologien mit Zykluszeiten von Stunden bis Tagen, also von stationären Batterien, mobilen Batterien in PKW-Flotten und Pumpspeicherwerken, und mittel- bis langfristigen saisonalen Speichern wie die von Stauseen und von chemischen Energieträgern. Die rein technischen Betrachtungen werden in Variante 1 für verschiedene politische Szenarien vorgenommen. Zum einen in einem sogenannten Entwicklungspfad A, der marktorientiert ausgerichtet ist und grundsätzlich den freien und grenzüberschreitenden Handel von elektrischem Strom in der Grössenordnung von ca. 5 TWh vorsieht. Alternativ dazu wird ein Entwicklungspfad B besprochen, der auf der vollständigen Versorgungsautarkie der Schweiz bei Strom aufbaut, also ohne Abhängigkeiten von Importen aus dem Ausland wäre.

Beides sind Extremsituationen mit ihren Vorteilen, aber auch gravierenden Nachteilen. Pfad A beinhaltet in Zeiten zunehmender internationaler Krisen das Risiko, dass die erforderliche Versorgungssicherheit nicht mehr gewährleistet werden kann, wenn trotz abgeschlossener Verträge jedes Lieferland bei Engpässen primär an sich selbst denken wird wie die jüngste Geschichte es zeigte. Bei Pfad B würde auf der anderen Seite gerade in Nichtkrisenzeiten ein allgemeines Unverständnis in der Bevölkerung entstehen wegen der deutlich höheren Schweizer Erzeugerpreise. Die Frage wird deshalb sein, wie die Politik und die Stromkonzerne in den nächsten 25 Jahren jeweils die aktuell-optimale Lösung finden können zwischen beiden Extremen, und welche technischen, aber auch juristischen Möglichkeiten ihr dabei zur Verfügung stehen?

Es sei nun nicht verhehlt, dass die genannten Ausführungen der Variante 1 nicht von allen Gruppenmitgliedern geteilt wurden. So wurde unter anderem moniert, dass der Elektrizitätsbedarf massiv unterschätzt werde und somit auch der Speicherbedarf. Hinzu kommt, dass die Annahme, zur Minderung der sich im Winter ergebende Stromlücke von etwa 15 - 20 TWh könne stets auf vertraglich garantierte Importe zurückgegriffen werden, wie erwähnt nicht gerechtfertigt sei. Eine unabhängige, andere *Variante 2*, die von einem Kollegen der Gruppe ins Spiel gebracht wurde, gewichtet und bewertet sowohl Strombedarf wie Stromerzeugung anders, und sie unterscheidet sich daher im Detail markant in der Vorhersage bis 2050 von Variante 1. Nur, auch sie identifiziert eine Stromlücke etwa gleichen Ausmasses und auch sie hat kein Patentrezept, wie diese geschlossen werden kann. Wir vergleichen trotzdem beide Varianten, allein um zu zeigen, dass trotz aller ernsthafter Basisanalysen jede Vorhersage bis ins Jahr 2050 noch mit grossen Fragezeichen versehen ist. Die Schlussfolgerung wird sein, möglichst jetzt bereits viele Systemeinstellparameter technischer wie juristischer Art parat zu stellen, mit denen die Entscheidungsträger von Staat und Stromkonzernen operieren können. Beide Varianten fokussieren sich mehr auf die kritische Winterjahreszeit, wobei Variante 2 naheliegenderweise sich auf das Wintertrimester beschränkt, also auf die vier Monate November bis Februar, die angesichts der zu erwartenden milderen Wintertemperaturen in der Schweiz bis 2050 massgebend sein dürften.

Die Tabelle 1 zeigt, dass der alljährliche Strombedarf in 2050 bei Variante 1 zu 40 TWh im Sommersemester und 50 TWh im Wintersemester abgeschätzt wird. Variante 2 errechnet, ausgehend vom heutigen Bedarf von 23.2 TWh einen Bedarf in 2050 von 37 TWh für das Wintertrimester, was für das volle Wintersemester sogar 55 TWh bedeuten würde. Für das Sommersemester stimmen beide Varianten überein, dass der Bedarf von etwa 40 TWh gedeckt werden kann. Hinsichtlich des Wintersemesters weist Variante 1 ein Defizit von 16 TWh für Pfad A bzw. 21 TWh für Pfad B aus,

	Variante 1				Variante 2 [I]		
Schweiz (TWh_{el})		Sommersemester	Wintersemester			Pro Monat	Wintertrimester
					Bedarf 2025	5.8	23.2
					Zusätzlich	3.45	13.8
Strombedarf (2050)		40	**50**		**Strombedarf** (2050)	9.25	**37**
Stromerzeugung							
			Pfad A	***Pfad B***			
					Laufwasser		4
	Speicherwasser	20	20	20	*Speicherwasser* [II]		9
	Photovoltaik	20	8	8	*Photovoltaik* [III]		5
	KVA / ARA [IV]	1	1	1	*Wind* [V]		2
	Import	0	5	0	*Import*		0
	Total	**41**	**34**	**29**	**Total**		**20**
					Stromdefizit Wintertrimester		**17**
Stromdefizit Wintersemester		**0**	**16**	**21**	**Stromdefizit Wintersemester** (berechnet)		**25**

Tabelle 1: Strombedarf und Stromerzeugung in beiden Studienvarianten

I: Martin Schlumpf, Weltwoche Grün Nr. 42.25
II: Speicherseen (2025) Wintertrimester 7.45 TWh plus Zusatzausbau 1.5 TWh ⇒ 9 TWh
III: PV-Solar: Installiert 38 GW mit Auslastung 10% ⇒ 33.6 TWh/a, somit im Wintertrimester bei 4% Effizienz: 33.6 TWh/a · (4/12) · 0.04 = 5 TWh
IV: KVA (Kehricht-Verbrennungsanlagen); ARA (Abwasser-Reinigungsanlagen). Es wird keine Windenergie und Geothermie berücksichtigt.
V: 4.3 TWh/a (Wind) + 1.8 TWh/a (KVA) ⇒ Wintertrimester 2 TWh

während bei Variante 2 das Defizit von 17 TWh im Wintertrimester, wenn hochgerechnet auf das Wintersemester, dann sogar noch deutlich grösser wäre mit etwa 25 TWh.

Die Tabelle 1 zeigt auch, dass der alljährliche Strombedarf bei Variante 1 von 90 TWh auch von Variante 2 erhalten wird, wenn man den monatlichen Strombedarf im Sommersemester mit 5.8 TWh/m und im Wintersemester mit 9.25 TWh/m annimmt (siehe Box). Erstreckt man jedoch die Jahresberechnung über die 4 Monate des Wintertrimesters und betrachtet die restlichen 8 Monate als Sommermonate, kommt man lediglich auf 83.4 TWh/a. Das allein zeigt, wie unsicher all die Abschätzungen sind. Dennoch, und das ist die eigentlich alarmierende Botschaft, zeigen beide Varianten nahezu übereinstimmend, dass wegen der Wintermonate eine erhebliche Stromlücke von 16 - 25 TWh/a bestehen wird.

Chemische Speicherung

Besonderes Augenmerk gilt in Variante 1 den existierenden fossil-chemischen Energiespeichern wie den grossen Tanklagern von flüssigen oder gasförmigen Stoffen, da ihre Infrastruktur vorhanden, laufend gewartet und der Umgang mit ihr der Bevölkerung vertraut ist (Tabelle 2).

Speicherbedarf Schweiz (in 2050) (TWh_{el})	**Variante 1** Wintersemester	
	Pfad A	***Pfad B***
Stromdefizit gemäss Tabelle 1	16	21
Speicherbedarf		
Kompensation Stromdefizit [8]	27	35
Bedarf an Tanklagern für Industrie, Schwerverkehr	10	10
Bedarf an Tanklagern für Luftfahrt	5	5
Bedarf Chemische Speicherung: Total (Winter)	**42**	**50**

Tabelle 2: Elektrizitätsspeicherbedarf in Form chemischer Energieträger.

Sie zeigt, dass die aus Tabelle 1 übernommenen 16 bis 21 TWh der Stromlücke pro Wintersemester, wenn sie durch thermische Kraftwerke bei einem Wirkungsgrad von 60% geschlossen werden soll, dann 27 bis 35 TWh Speicherbedarf erfordern würde. Zusätzlich sind laut Studie langfristig Lagerkapazitäten für Brenn- und Treibstoffe aus erneuerbaren Quellen für die Industrie und den Verkehr notwendig mit einem geschätzten Jahresbedarf von (16 + 4) = 20 TWh/a, sowie für Flugtreibstoffe von 10 TWh/a, also pro Wintersemester 10 TWh und respektive 5 TWh in Tabelle 2. Um somit die Versorgungssicherheit im Wintersemester 2050 im gleichen Ausmass wie in 2025 zu sichern, sind insgesamt Vorräte für Brenn- und Treibstoffe von 42 TWh für Pfad A bzw. 50 TWh für Pfad B erforderlich.

Generell ist dies eine sinnvolle Strategie, bisherige Installationen zu erhalten und sie kontinuierlich auf moderne Energieträger umzurüsten. Das sollte auch in den meisten Fällen prinzipiell möglich sein, wobei in jedem Einzelfall technische Modifikationen unerlässlich sein werden. So ist zum Beispiel in vorhandenen Pipelines oder Tanks, wenn sie von Erdgas auf Wasserstoffgas umgestellt werden, die grössere Metallsprödigkeit der Dichtungen und somit die höhere Leckrate einschliesslich des Explosionsrisikos ein ernst zu nehmendes, aber auch zu lösendes Problem.

Gasturbinen CCGT

Generell sind *Combined Cycle Gas Turbine* CCGT als Puffersysteme sinnvoll besonders im Arbeitsbereich von 0.1 bis 40 MW_{th}, wo sie innerhalb weniger Minuten auf Volllast hochgefahren werden und somit ideal die Leistungsschwankungen erneuerbarer Energiequellen ausgleichen können. Das auf dem Betriebsgelände von General Electric in der Gemeinde Birr (AG) installierte und seit März 2023 betriebsbereite, aber nicht weitergeführte Reservekraftwerk mit 8 Modulen von je 30 MW_{th} Leistung erbrächte während eines Wintertrimesters bei 24/7 Vollbetrieb ein Energiebeitrag von lediglich 0.75 TWh, bzw. etwa 1 TWh pro Wintersemester. Das zeigt, dass CCGT in dieser Leistungsklasse gut sind für den Einsatz bei einer kurzfristigen Strommangellage in lokal begrenzter Umgebung, zum Beispiel einer Stadt oder eines Kantons, aber nicht zur Beilegung des hier diskutierten nationalen Defizits von 16-25 TWh [9]. Aber sie sind dennoch attraktiv wegen ihrer hohen Flexibilität nicht nur bei der Leistungsabgabe, sondern auch bei der Wahl des Brennstoffmittels, da sie neben gasförmigen Brennstoffen auch mit flüssigen Brennstoffen inklusive synthetischen Brennstoffen betrieben werden können. Das erlaubt, das aktuell kostengünstigste Betriebsmittel einzusetzen. Nur sollte man die CCGT dann permanent in die Versorgung einbinden und nicht nur für Notfälle bereithalten, was kein privater Investor je machen würde. Für CCGT spricht auch, dass der Verbrauch wie auch der CO_2 Ausstoss, der bereits heute nur noch 0.4 t_{CO_2}/MWh verglichen zu dem eines normalen Kohlekraftwerks mit 1 t_{CO_2} /MWh beträgt, in den kommenden Jahren signifikant reduziert werden wird, sei es durch modernes Abgasmanagement wie auch durch direkte CO_2 Absorptionstechnik.

Nuklear

Man wird in den verbleibenden 25 Jahren nicht um die Kernkraft herumkommen. Falls bis 2050 zwei neue KKWs mit je 1.4 GW in Betrieb gingen, hätte man pro Wintersemester bei 24/7 Betrieb, also bei 4300 h, etwa 12 TWh, zwar immer noch keine eine vollständige Eliminierung der Stromlücke, aber einen massiven Gewinn an Sicherheit in der Versorgung.

Energieimporte und Energiehandel

Importe und ihre vertragliche Absicherung sind weiterhin notwendig, aber man muss sich in der Politik darauf einstellen, dass eine über einen längeren Zeitraum vereinbarte Gültigkeit nicht mehr gewährleistet werden kann. '*Pacta servanda sunt*' wird weiterhin in Normalzeiten gelten, aber nicht mehr in Krisenzeiten. Also braucht es auch hier Flexibilität und neue Ansätze. Im juristischen Sinn wäre eine börsenähnliche Vorgehensweise wert, näher betrachtet zu

8 Effizienzfaktor 60%

9 CCGT sind technisch ausgereift, haben einen hohen Wirkungsgrad, sind kurzfristig im Handel erhältlich und lassen sich gut in bestehende lokale Infrastrukturen integrieren. Es gibt auch verschiedene CCGT-Varianten mit einer Leistung von bis zu etwa 350 MW, die jedoch eher für den Dauerbetrieb vorgesehen sind.
https://en.wikipedia.org/wiki/ Combined_cycle power_plant

werden, so wie es zwischen dem Nicht-EU Land Norwegen mit viel Wasserkraft und dem EU-Land Niederlande mit viel Windkraft seit Jahrzehnten erfolgreich praktiziert wird. Dort wird täglich der Stromfluss je nach Bedarf und Angebot über das auf eine Leistung von 700 MW ausgelegte und 580 km lange Seekabel ***NorNed*** geregelt, wobei die aktuelle Transportrichtung auch vom Strompreis abhängt. Der permanent optimierte Stromaustausch reduziert in beiden Ländern Erzeugungs- und Bedarfsschwankungen, stabilisiert die Netze und führt in beiden Ländern nicht nur zu mehr Versorgungssicherheit, sondern beschert ihnen auch beachtliche Einnahmen, wenn durch das EU-Land Niederlande überschüssiger Strom an die EU verkauft werden kann.

Eine Vorgehensweise à la NorNed wäre interessant für die Schweiz, um nicht nur passiv den von den EU-Nachbarstaaten diktierten Bedingungen ausgeliefert zu sein, sondern selber die täglichen Einstellparameter der Stromversorgung mit mehreren EU oder Nicht-EU Ländern fein zu justieren. Die Schweiz könnte dabei vorteilhaft die Tatsache nutzen, dass wichtige Strom- wie Gasleitungen in allen vier Windrichtungen durch das Land führen, so dass sie nicht nur Agentur wäre, sondern auch physisch Zugriff zu den Netzen hätte.

PID-Empfehlung für 2050

Der bewährte Ansatz, für eine kurz-, mittel- und langfristige Stabilisierung dynamischer Abläufe in einem System zu sorgen, ist das Konzept des PID-Reglers [10]. Hier in unserem Fall beinhaltet das sowohl die zeitliche Konstanz der Versorgungsleistung von Tag zu Tag, wie auch die Kompensation des zu erwartenden Stromdefizits in den Wintermonaten. Es ist daher notwendig, eine Reihe von technischen und administrativen Instrumenten bereitzustellen, die es der Politik und den Stromkonzernen ermöglichen würden, die jeweils optimale PID-Vorgehensweise zu realisieren. Aus technologischer Sicht sind dies all die Massnahmen, die darauf abzielen, bestehende Energieträger und ihre Infrastruktur weiter auszubauen. Dazu zählen neben der Wasserkraft auch die Kernkraft, sowie die Nutzung vorhandener stationärer Infrastrukturen wie Tanklager, die jedoch an neue Energieträger wie Wasserstoff angepasst werden müssen. Um die Leistungsfähigkeit der Stromnetze voll auszunützen, sind sie von den unvermeidlich täglichen Schwankungen der Stromerzeugung durch Solarstromquellen und vom volatilen Bedarf der Konsumenten zu entlasten. Massnahmen wie dezentrale Stromspeicher, die flächendeckend im Land verteilt sind, sind dazu gut geeignet. Dazu gehören auch mehr und mehr Abnehmer von Kühlleistungen in Haushalten und Lebensmitteldepots im Sommer in direkter Analogie zu den Heizleistungen im Winter.

10 Ein PID-Regler (Proportional-Integral-Differential) reagiert auf die Abweichung eines Soll- vom Istwert und unterscheidet zwischen der aktuellen Differenz (P), der Drift (I) und der Änderungsgeschwindigkeit (D).

Fazit

• Jede technische Möglichkeit, erratische Schwankungen bei Stromerzeugung und -verbrauch durch Zugriff auf kurzfristig verfügbare Speicher zu reduzieren, macht Übertragungs- und Speicherkapazität der Netze frei, die vorteilhaft genutzt werden kann zu volatilen, jedoch gesteuerten Stromflussoptimierungen à la NorNed.

• Der Fokus der Studien auf die Stromversorgungsdefizite in den immer kälter werdenden Wintermonaten sollte nicht vergessen machen, dass ähnlich gravierende Versorgungsprobleme in den immer heisser werdenden Sommermonaten in den kommenden Dekaden zu erwarten sind. Ist es im Winter der erhöhte Heizungsbedarf, so im Sommer der private wie öffentliche Bedarf an Kühlleistung. Ist das Problem im Winter die ungenügende Leistungsabgabe der PV, so ist im Sommer zu befürchten, dass die Wasserkraft massiv an Bedeutung verlieren wird, wenn Flüsse wie geschehen zu Rinnsalen werden.

Abschätzung von Variante 2

Schweiz (in 2050) (TWh_{el})	**Winter-monat**	**Wintertrimester** (November bis Februar)		
Strombedarf (2025)	5.8	23.2		
Zusätzlich			**Stromerzeugung**	
Wärme [1]	1.5		Laufwasser	4
Mobilität [2]	1.2		Speicherseen	7.5
Bevölkerungs-wachstum	0.75		Ausbau	1.5
Summe	**3.45**	**13.8**	Solar	5.4
			Wind	1.8
			KVA	0.2
Strombedarf (2050)	**9.25**	**37**	**Summe Stromerzeugung**	**20.4**
Defizit (Wintertrimester)		**17**		

1 64 TWh mit Faktor 2 (wegen Renovation) und Faktor 3.5 (wegen WP) = 9.5 TWh/a

2 6.5 Mio PKW (2025) ⇒ 5 Mio PKW(2050) · 12'000 km/a · 20 kWh/100 km · 1.2 = 1.2 TWh/m

Physiklaborant/in EFZ – wo Forschung auf Präzision trifft

Cornel Andreoli, Präsident der Arbeitsgemeinschaft der Lehrmeister von Physiklaboranten

Wer Freude an Technik, Physik und praktischer Arbeit hat, findet im Beruf Physiklaborant/in EFZ eine spannende und abwechslungsreiche Tätigkeit. Physiklaborantinnen und Physiklaboranten arbeiten an der Schnittstelle von Wissenschaft und Technik: Sie unterstützen Physiker und Ingenieurinnen bei Experimenten, Messungen und Analysen, entwickeln Aufbauten für Versuchsanlagen und tragen wesentlich dazu bei, dass aus Ideen handfeste Innovationen werden. Sie sind in zahlreichen Bereichen tätig – von der Forschung und Entwicklung über Materialprüfung bis hin zur Qualitätssicherung. Ihr Arbeitsalltag verbindet feinmechanische Arbeit, moderne Messtechnik und wissenschaftliches Denken – und macht sie zu unverzichtbaren Fachpersonen in der experimentellen Physik und Technik.

Ausbildung

Die Grundbildung zur Physiklaborantin bzw. zum Physiklaboranten dauert vier Jahre. In den ersten zwei Jahren erwerben die Lernenden ein solides Fundament in mechanischer Werkstoffbearbeitung, Messtechnik, Werkstoffkunde, Werkstoffprüfung und Klebetechnik. Ein Teil der Grundausbildung findet in fünf überbetrieblichen Kursen statt, in denen die Lernenden praxisnah zentrale Kompetenzen aufbauen. Nach der Teilprüfung am Ende des zweiten Lehrjahres folgt die Ausbildung in den Schwerpunktstechnologien, die das breite Spektrum dieses Berufs verdeutlichen. Jetzt können die Lernenden entscheiden, welche Fachrichtung der modernen Physik ihnen besonders liegen würde und wo sie sich eine spätere Tätigkeit als Assistent von Physikern vorstellen könnten. Die Schweiz bietet attraktive Möglichkeiten nicht nur an den Universitäten, sondern auch in der Raumfahrtindustrie, bei Medizinal- und Pharmafirmen, in der Informatik und der Vermessungstechnik mit eigenen Entwicklungslabors. So können sie aus folgenden Schwerpunkttechnologien der Lehrbetriebe mind. 3 auswählen:

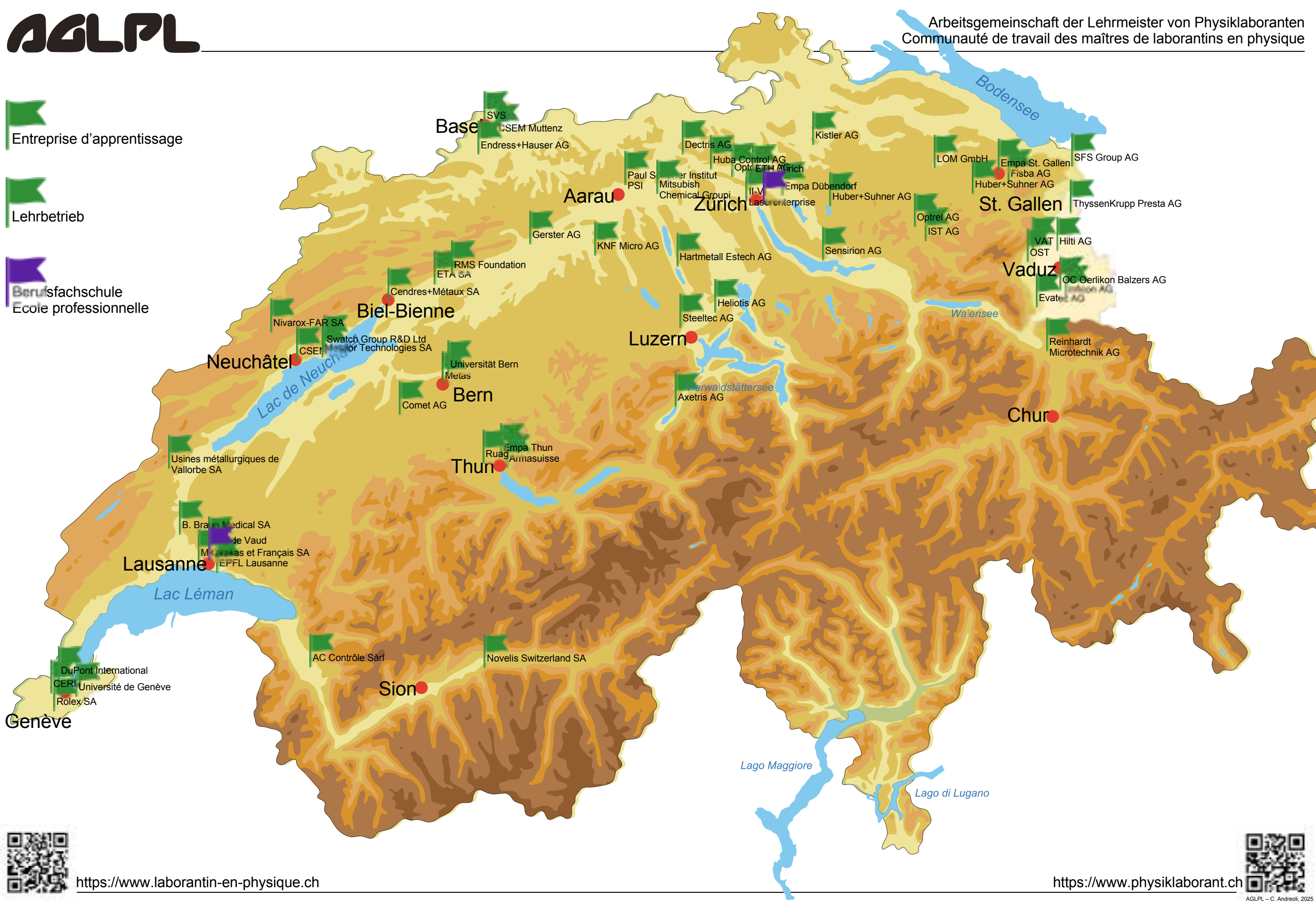
- Optik, Thermometrie, Mikroskopie,
- Technische Bildanalyse,
- Elektronik, Sensortechnik, Steuerungs- und Regelungstechnik,
- Materialografie, Instrumentelle Analytik, Mechanische Prüfverfahren,
- Mikro- und Nanotechnologie, Vakuumtechnik, sowie Konstruktion und Tribologie.

Die Ausbildungsinhalte werden mindestens alle fünf Jahre überprüft und angepasst, um sicherzustellen, dass sie den aktuellen Anforderungen von Forschung und Industrie entsprechen. So bleibt der Beruf stets am Puls der technologischen Entwicklung.

Qualifikationsverfahren

Das Qualifikationsverfahren (ehemals LAP) besteht aus drei Teilen:

- ***Teilprüfung:*** Am Ende des zweiten Lehrjahres werden die grundlegenden Fertigkeiten und Kenntnisse überprüft.
- ***Individuelle Praktische Arbeit (IPA):*** Eine praxisorientierte Projektarbeit, die mindestens eine Schwerpunkttechnologie umfasst. Diese Abschlussarbeit dauert zwischen 36 und 120 Stunden und wird vom Lehrbetrieb definiert.



- ***Abschlussprüfung:*** Ergänzend erfolgen theoretische Prüfungen an der Berufsfachschule.

Diese Kombination aus praktischer, projektbezogener und theoretischer Beurteilung gewährleistet, dass die Lernenden umfassend auf ihre berufliche Tätigkeit vorbereitet sind.

Lernende und Lehrbetriebe

In den letzten Jahren ist die Zahl der Lehrverhältnisse erfreulich gestiegen. Aktuell beginnen jährlich rund 32 Lernende in der Deutschschweiz und etwa 8 in der Westschweiz ihre Ausbildung. Auch die Zahl der Lehrbetriebe wächst stetig – derzeit sind es rund 45 in der Deutschschweiz und 18 in der Westschweiz (siehe Karte).
Besonders erfreulich ist der Anteil an Frauen: Rund ein Drittel der Lernenden sind Frauen – ein im technischen Bereich überdurchschnittlich hoher Wert. Diese Entwicklung zeigt, dass der Beruf nicht nur technisch anspruchsvoll, sondern auch attraktiv und zukunftsorientiert ist.

Organisation und Qualitätssicherung

Die Arbeitsgemeinschaft der Lehrmeister von Physiklaboranen (AGLPL) ist der Berufsverband für Physiklaboranten und -laborantinnen in der Schweiz. Die AGLPL organisiert und koordiniert die Ausbildung, entwickelt den Beruf laufend weiter und sorgt für die hohe Qualität der Ausbildung. Die AGLPL arbeitet eng mit Betrieben, Schulen, Fachhochschulen, der Industrie, den Kantonen und dem Bund zusammen, um sicherzustellen, dass die Ausbildung den Bedürfnissen der Praxis entspricht und zukünftige Fachkräfte bestens vorbereitet sind.

Perspektiven nach der Lehre

Nach der Lehre stehen Physiklaboranten und -laborantinnen viele Wege offen. Dank ihrer breiten technischen Ausbildung finden sie rasch eine spannende Anstellung – sei es an Hochschulen, Forschungsinstituten oder in der Industrie. Typische Arbeitsfelder sind Forschung und Entwicklung, Versuchstechnik, Messtechnik oder Qualitätssicherung.
Viele Absolventen setzen ihre Ausbildung nach einigen Jahren Berufserfahrung fort – zum Beispiel mit einem Studium an einer Fachhochschule oder, nach der Passerelle, an der ETH Zürich oder einer Universität. Damit bleibt der Beruf nicht nur ein solides Fundament, sondern auch ein idealer Einstieg in eine weiterführende wissenschaftlich-technische Laufbahn.

Resumé

Der Beruf Physiklaborant/in EFZ verbindet Handwerk, Wissenschaft und Innovation. Mit einer fundierten Ausbildung, grosser Themenvielfalt und hervorragenden Perspektiven bietet er jungen Menschen die Möglichkeit, die Welt der Physik und Technik aktiv mitzugestalten – präzise, neugierig und zukunftsorientiert.

Fragen und weitere Infos

Fragen beantwortet gerne der Autor (*mail@aglpl.ch*). Weitere Infos: *www.physiklaborant.ch* und *www.aglpl.ch*

Kurzmitteilungen - Short Communications

Rätsel der modernen Physik

Was wir wissen – und was wir noch nicht verstehen

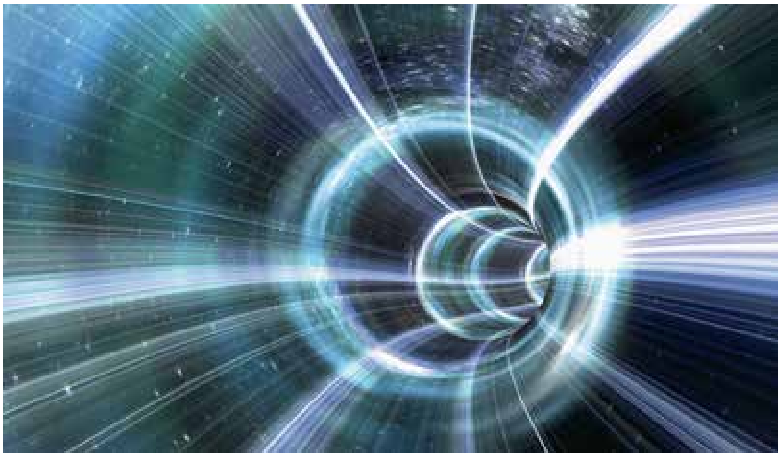
Neue Ringvorlesung der Volkshochschule Zürich

An sechs Abenden ergründen wir fundamentale Rätsel der Physik: Warum existiert mehr Materie als Antimaterie und wie entwickelt sich das Universum und weshalb läuft die Zeit nur vorwärts? Wir diskutieren die Herausforderungen der Kernfusion, die Entstehung von Komplexität in lebenden Systemen sowie das Verständnis von Chaos und Turbulenz. Die Vortragsreihe gibt Einblick in den aktuellen Stand der Forschung und zeigt, welche offenen Fragen unser Bild der Welt weiterhin prägen.

Vortragsthemen:

- Ursprung der Materie – Das Rätsel der Baryon-Asymmetrie
  Prof. Dr. Rainer Wallny
- Die Entwicklung der grossen Strukturen im Universum
  Prof. Dr. Ruth Durrer
- Wie tickt die Zeit? Der Zeitpfeil im physikalischen Kontext
  Prof. Dr. Renato Renner
- Die Physik komplexer Systeme
  Prof. Dr. Christoph Aegerter
- Kontrollierte Kernfusion
  Prof. Dr. Sibylle Günter
- Die Physik lebender Systeme
  Prof. Dr. Karsten Kruse

Die Vorträge finden an folgenden Daten an der Universität Zürich Zentrum von 19:00 bis 20:15 Uhr statt: 27.04., 04.05., 11.05., 18.05., 01.06., 08.06.2026. Aufgrund des hy-



briden Formats können die Vorträge auch bequem von zu Hause oder unterwegs via Zoom verfolgt werden.

Weitere Informationen und Anmeldung:
https://www.vhszh.ch/physik

Bücherecke - Le coin aux livres - Book Corner

Celine Broeckaert, Frank Verstraete

Pourquoi personne ne comprend rien à la physique quantique

(alors que tout le monde pourrait) *

EPFL Press, Editions Quanto, 2025, ISBN 978-2-88915-727-3

1. Scope and readership

The book is the result of a collaboration and dialogue between Celine Broeckaerts, a specialist in Roman languages, author and playwright, and Frank Verstraete, an internationally well-recognized quantum physicist (incidentally, the two are married). This is an interesting approach to making a contemporary view of quantum physics accessible to a non-specialist readership, emphasizing both its high intellectual appeal arising from its conceptual and philosophical implications and its importance as a key field of technological development [1]. The extent to which this approach is successful will be answered in the end.

The scope of the book is impressive, covering the first and second quantum revolutions, many consequences of quantum physics that go beyond the standard topics of popular physics books, and reflections on several fundamental questions in physics. I will now discuss some illustrative examples in more detail.

2. Some highlights

Of course, the book covers the classical topics of quantum physics (blackbody radiation, photoelectric effect, matter waves, atomic structure, quantum indeterminacy and probability, etc.), and while these are necessary in a work of this kind, another book devoted solely to them would not have been needed. But more recent developments are also well covered, in particular the second quantum revolution. This includes contributions concerning the interface between quantum information theory and many-body physics, where Verstraete is an internationally leading expert.

The book also goes beyond usual "popular" books on quantum physics by including an entire chapter on chemistry with and its profound quantum roots, without which we would have no understanding of colour, molecular stability and structure, chemical energy (e.g. in combustion and digestion), and related phenomena. Although some accessible books go further on the quantum foundations of chemical and biochemical substances and their properties [2], I see this as a well-written, informative contribution to scientific literacy (by the way not necessarily taught in school).

Still further beyond the conventional scope of the genre is the treatment of many-body physics, an area with very few other books aimed at a non-specialist audience [3]. There is a considerable breadth of physical concepts, including the indistinguishability of particles, the Hartree–Fock method, Feynman diagrams, and of applications to metals, lasers, superconductivity and superfluidity, and Bose–Einstein condensates, all explained in a non-technical and most often insightful way. As illustration, the combination of the "ridiculously large" dimensions of many-body Hilbert space, on the one hand, and the extremely tiny regions of it that are actually occupied by physical systems on the other hand is well expressed by the following quote [4]: "*Nature, along with everything that allows us to do physics, occupies only an exponentially minute enclave within the exponential immensity of Hilbert space. Only this minuscule corner corresponds to the physical world*". This is, of course, an absolutely fundamental reason why many-body physics is possible at all.

* While the specific edition this review refers to is in French, the review is in English as the book has appeared in 8 languages in total.

What I liked even more is the discussion of the antagonism between emergence and reductionism (some of my friends from particle physics may not agree with the following). The book makes clear that (i) in a system composed of many particles, entirely new laws and phenomena emerge that do not exist at the level of a single or a few particles – simply said, is "more is different" (P. W. Anderson [5])—and that (ii) this richness of physical systems and phenomena, such as those discussed in the book, is a constant theme in the quantum narrative. The authors then go on to describe a historical episode in the early 1990s, with very concrete interests and consequences at stake, namely the public debate around the Superconducting Super Collider (SSC) and the enormous cost of 5 billion dollars at the time, culminating in the emblematic debate between P. W. Anderson and S. Weinberg before the American Congress on this question. Excerpts of this debate are quoted literally in the book, contributing to its spirit to convey the lively and passionate nature of research and scientific debate.

Another enlightening discussion about a foundational characteristic of physics concerns the "*unreasonable effectiveness of mathematics*" (Wigner [6]), and other fields of application of quantum physics addressed in the book include elementary particle physics and quantum relativity as an established and an exploratory field, respectively.

Together, this yields a well-thought, illuminating tour d'horizon of a large number of core aspects of quantum physics, from classical foundations to the most recent developments.

3. Some critical observations

These strengths notwithstanding, three aspects of the book also invite some critical observations. First, there are metaphors and expressions, introduced in an effort to achieve a captivating and vivid language, that nevertheless sometimes appear awkward and not to the point. For instance, in the section on the Bose-Einstein-Condensate (otherwise well-written), we read: "*By cooling a gas of rubidium atoms, one reaches that singular point at which the atoms lose all notion of self. They undergo an existential crisis, then enter a state of quantum grace. [...] Their consciousness is purified, and they find themselves united in the calm nirvana of the absolute ground state.*" Or when the book says about an approach to unify quantum theory and general relativity, that "*one can compare this to an orange: relativity describes what happens inside the fruit, while quantum mechanics is concerned with what takes place in the skin*". For this reader, this is a trivialisation from which nothing follows, and there are several instances of this kind. Finally, I also did not particularly like the epilogue, a somewhat carnivalesque procession of quantum researchers that (for this reader) is neither truly funny nor does it convey further insight.

Second, there are a few formulations and discussions which I find misleading or even incorrect. One example is in the box on the correspondence principle, where it is stated that, to understand the description of light in classical electrodynamics from quantum physics, the number of bosons must be so high that they are no longer individually identifiable; however, bosons are by definition not „individually identifiable", independently of their number. In the same box it is claimed that the classical limit for high particle numbers is a manifestation of the Bohr correspondence principle for high quantum numbers; but particle numbers and (atomic) quantum numbers are quite different quantities, and so are the effects associated with their large-number limits. Another example is the discussion of the Heisenberg microscope, which repeats the "disturbance explanation" of the uncertainty relations, well known from popular or pedagogical expositions, where Big Bad Photon with its q and p uncertainties shakes a Little Electron so hard that one cannot know its position and momentum simultaneously. First, if that is true, where do the photon's q and p uncertainties come from in the first place? This leads to an infinite regress. Second, often elsewhere in the same expository texts, the uncertainty relations are invoked to explain the stability of atoms against electrostatic attraction. So is the stability as intrinsic property of atoms is due to an external interaction and disturbance? But what if there is no such interaction—are isolated atoms then not stable? This is outright contradictory. [7].

Third, there are a few cases where the explanations remain incomprehensible (at least to this reader). One example concerns tensor networks in the chapter on the second quantum revolution, a topic to which Verstraete has made ground-breaking contributions. However, the explanation invokes a whole series of other, scarcely explained concepts, such as the depth of a quantum circuit, the holographic principle, adiabatic change of state, topological states, etc., for which little to no understanding can be assumed on the part of a layperson. Admittedly, this is one of the most advanced and abstract topics addressed in the book, and there may be a limit to what can be explained in plain language. But perhaps the authors, with their commitment and combined mastery of language and physics, could in a second attempt succeed even here.

4. By way of conclusion

I begin with a thought that comes to mind in connection with the last point. The dialogue between the two co-authors remains hidden from the reader; it appears only in the form that the final exposition and explanations take. One might consider, at certain places, following the example of other dialogues between a physics expert and a non-expert, e.g. Jauch's "Are quanta real?" [8] (of course modelled on the great example of Galileis' *Discorsi*), where the explicit evolution of the (fictitious) dialogue, with its obstacles, misunderstandings, and clarifications, provides excellent support for understanding.

A second last comment concerns text features. Footnotes, excursions into interesting historical or physical background (e.g. on Mme de Chatelet and other female researchers), and a glossary are helpful and enriching. Less positive is the perception of the illustrations, which are below the quality of the rest of the book; if one compares, for example, to M. Pohl's book on particle physics for a non-expert audience [9] with its excellent illustrations, one is somewhat astonished that the publishing house did not better support the authors in finding good visuals, which are today so easily available from Creative Commons and AI sources.

And finally, was the interesting co-authorship experiment of this book successful, all in all? In view of the breadth of concepts and topics treated and well explained, I would say mostly yes. In some cases there is room for improvement, which could be realized in a revised edition that, in my view, the book clearly deserves.

Andreas Müller, Université de Genève

[1] International Year of Quantum Science and Technology; https://quantum2025.org/
[2] Gribbin, J. (1995). In search of the double helix: quantum physics and life. London: Penguin Books.
[3] Leggett, A. J. (2006). Problems of Physics (Oxford classic texts in the physical sciences). Oxford: Oxford University Press, ch. 4
[4] Translations to English AM
[5] Anderson, P. W. (1972). More is different. *Science*, **177** (4047), 393-396.
[6] Wigner, E. P.: 1960, 'The Unreasonable Effectiveness of Mathematics in the Physical Sciences'. In: T. L. Saaty and F. J. Wey (eds.), The Spirit and Uses of the Mathematical Sciences, McGraw-Hill, New York, 1969, pp. 123-140.
[7] For a discussion of that issue, see e.g. Brown, H. R., & Redhead, M. L. (1981). A critique of the disturbance theory of indeterminacy in quantum mechanics. *Foundations of Physics*, **11**(1), 1-20
[8] Jauch, J. M. (1989). Are quanta real? A Galilean dialogue. Bloomington: Indianapolis University Press
[9] Pohl, M. (2021), Particles, fields, space-time: From Thomson's electron to Higgs' boson. Boca Aton: CRC Press; https://sps.ch/en/articles/book_corner/particles_fields_space-time

LICHTENSTEIG
MINI.STADT IM TOGGENBURG

Int. Jost Bürgi-Symposium
Lichtensteig

9. Internationales Jost Bürgi-Symposium

Samstag, 25. April 2026

Kronensaal, Hauptgasse 2, 9620 Lichtensteig SG

Freuen Sie sich auf spannende Vorträge zur Geschichte und Zukunft der Vermessung – von den Karten der Renaissance über grosse Tunnelbauten bis hin zu moderner Sensorik und KI. Erleben Sie das Symposium live vor Ort in Lichtensteig oder online. Die Vorträge sind öffentlich und kostenlos; eine Anmeldung ist erwünscht.

Programm

10.10–11.00 Uhr **«Jos Murer (1530 - 1580) – Pionier der Schweizer Kartographie»**
Referent: Martin Weiss

11.00–11.45 Uhr **«Eisenbahn Tunnelvermessungen – Grundlagennetze und Absteckungen in den Jahren 1869 bis 1911»**
Referent: Beat Sievers

Mittagspause (Verpflegung am Super Saturday Lichtensteig)

13.15–14.00 Uhr **«Multisensorik im Wandel der Zeit, von Bürgi bis heute»**
Referent: Bernhard Braunecker

14.00–14.45 Uhr **«Herausforderungen an die Vermessung beim Bau des Gotthard-Basistunnels»**
Referent: Adrian Ryf

Kaffeepause

15.15–16.00 Uhr **«Die Zukunft der Vermessung – von Sensorfusion zu humanoiden Robotern»**
Referent: Burkhard Böckem

Mehr Infos & Anmeldung
www.jostbuergi.com/symposium-2

Partner
MACHERZENTRUM · SPS · satw it's all about technology · SAG SAS

Mini. Kultur