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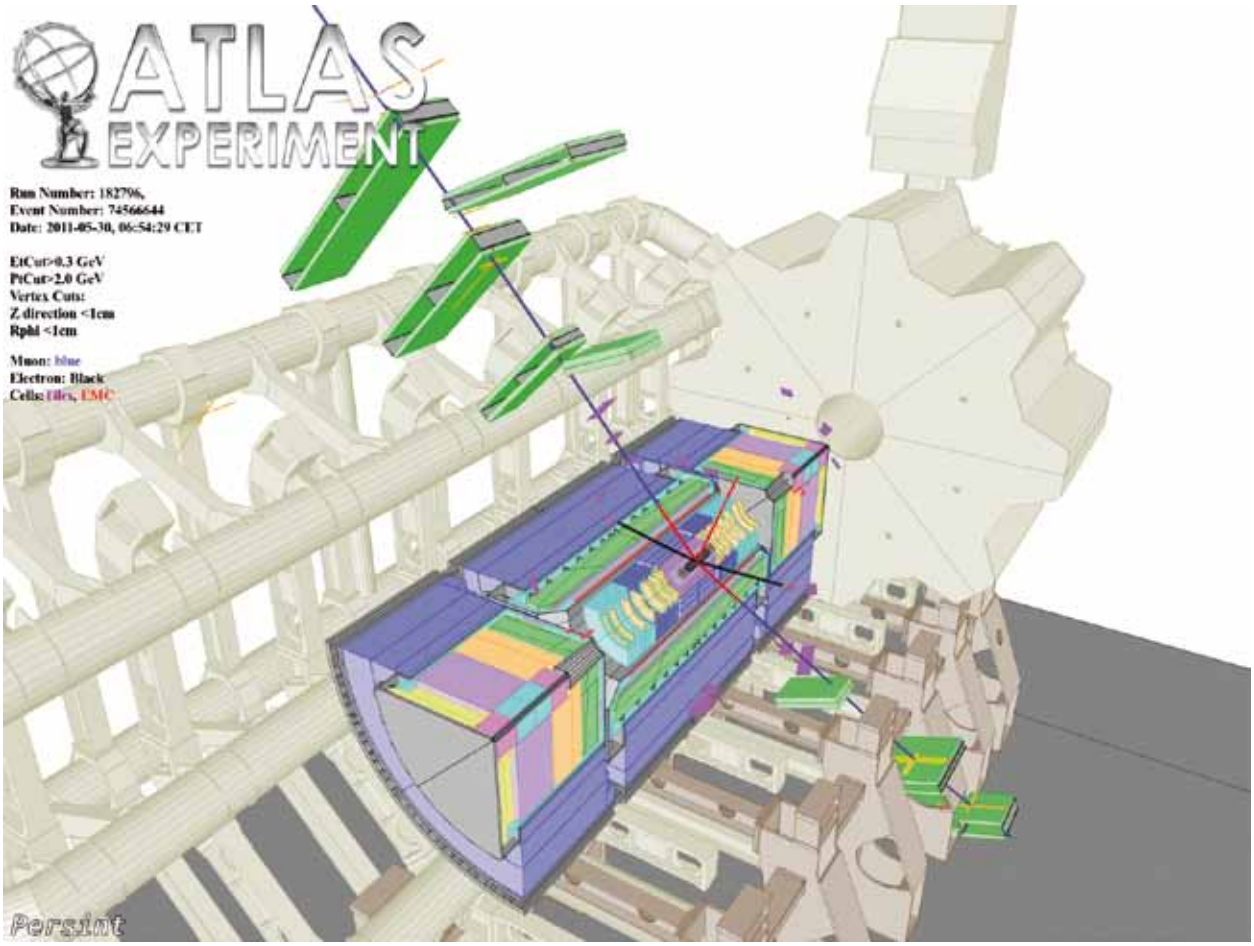
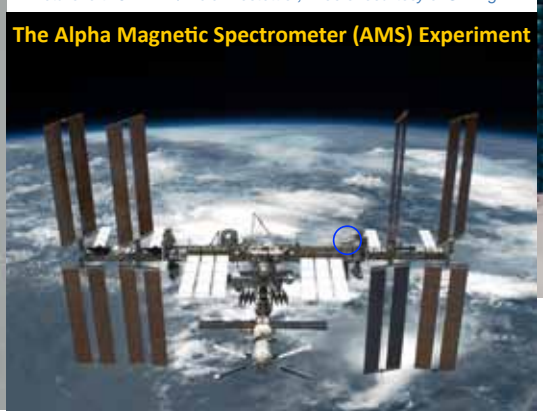
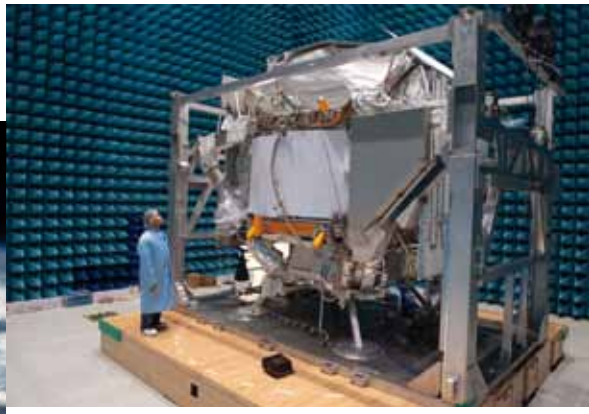


Event displays of a Higgs boson candidate decaying into 2e2μ with a total mass of 124.3 GeV. The masses of the lepton pairs are 76.8 GeV and 45.7 GeV. ATLAS experiment © 2012 CERN

Nobel Laureate Samuel C. C. Ting presenting the spaceborne Alpha Magnetic Spectrometer (AMS) at the SPS annual meeting

Picture left: © ETHZ / Heidi Hostettler; middle: courtesy of S. Ting





AMS-02 inside the ESTEC Test Centre's Maxwell electromagnetic radiation chamber for electromagnetic compatibility and interference testing in February 2010. © ESA

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Review of the Annual Meeting in Zürich

This year's annual meeting took place on 21-22 June 2012 at the Hönggerberg campus of the ETHZ, jointly organized with the four National Centers of Competence in Cesearch (NCCR) MaNEP, MUST, Nano and QSIT as well as with the Swiss Society for Crystallography. More than 550 persons attended the meeting. The scientific program was rather dense with 237 talks distributed over 14 parallel sessions and with 170 posters.

Christophe Rossel, SPS President, during his welcome note. SPS honorary member Jürg Fröhlich gave the first plenary talk.

The plenary session of Thursday morning was opened by Jürg Fröhlich (ETHZ) who presented in details the "Gauge theory of states of matter"- a unified formalism based on the Landau's theory of order parameters- and its applications to the analysis of the 2D electron gas exhibiting the quantum Hall effect and to the theory of topological insulators. This theoretical session was completed by a lively talk of Thierry Giamarchi (Uni GE) who took his audience in the exotic world of one dimensional systems such as quantum magnets, organic superconductors, carbon nanotubes or quantum wires and even cold atom systems.

To celebrate the birth of crystallography in 1912, Dieter Schwarzenbach (EPFL) reviewed the history of X-ray diffraction and the developments of the theoretical and experimental methods in crystallography. He presented also the novelties in the modern techniques and tools for the determination of the most complicated crystal structures.

This first plenary session was followed by the Prize Ceremony and the General Assembly of the Society (cf. details on p. 8 ff. and 12 f.).

After the afternoon parallel and poster sessions, a grandiose public lecture was given by the Nobel laureate Samuel C.C. Ting (CERN, MIT) on the space-borne Alpha Magnetic Spectrometer (AMS), a state-of-the-art particle physics detector deployed on the ISS by the last space shuttle. He explained in a very entertaining presentation to a full auditorium, the saga of the multi-billion AMS experiment, which uses the unique environment of space to search for antimatter and dark matter, and collect information from cosmic sources emanating from stars and galaxies millions of light years beyond the Milky Way.

In the Friday morning plenary session, Jörg Peter Kotthaus (LMU München) demonstrated the increasing importance of nanomechanical resonators operating at radio frequencies to measure the smallest masses and displacements. He addressed in particular the issues and challenges related to the coherent control of nanomechanical motion and of the switching between bistable states. Majed Chergui (EPFL) gave then a broad review on their work on charge, spin and structural dynamics of molecular systems investigated by ultrafast optical and X-ray spectroscopy.

At noon, a well attended public tutorial on Ultrafast Biology, organized by NCCR MUST and ETH FAST, was given by Gebhard F. X. Schertler (ETHZ, PSI).

The scientific exhibition with 21 exhibitors was organized in the main hall and attracted much attention from the participants. Posters and a model explaining the development status of the future X-ray free electron laser (XFEL) at PSI were also on display. In addition, the "SELF" module, designed by EMPA and EAWAG as a living area and workplace for two persons, independent of external energy and water supplies, was installed in front of the main entrance. SELF is 7.7 meters long, 3.45 meters wide and 3.2 meters high and 5 tons heavy container aimed also to test innovative technologies and materials.

This meeting evidenced again the high level and the diversity of the scientific research in the Swiss universities and

research organizations. It was also very satisfying to observe a large participation of young enthusiastic physicists sharing their research results and their experiences in a lively manner. It is worth mentioning the successful session of the new section "Earth Atmosphere and Environmental Physics" with several topics ranging from climate models, ionizing radiation effects on our environment to energy demand and resources.

I would like to thank here all my colleagues who contributed to the success of this SPS annual meeting by helping at the local organization and in setting up an interesting scientific program. Special thanks also to the D-PHYS of ETHZ for their valuable support before, during and after the conference. The SPS acknowledges the support and active contribution of the main Swiss NCCRs in physics that made again this event 2012 very attractive. Of course the SPS is also grateful to the long time financial support of the two academies SCNAT and SATW, of our sponsors ABB, IBM, Oerlikon for the SPS prizes and of our associate members. We are looking forward to another great conference, next year in Linz, Austria.

Christophe Rossel, SPS Vice-President

Annual Meeting of the Swiss Society for Crystallography

The annual meeting of the Swiss Society for Crystallography was held jointly with that of the Swiss Physical Society. 48 SSCr registrants along with some of the over 550 from the SPS enjoyed scientific sessions focussing on a historical review of some of the milestones in crystallography since the first diffraction patterns were observed 100 years ago in 1912.

Dieter Schwarzenbach presented a plenary lecture where he described the initial experiments of Max von Laue and his team. The discovery of diffraction was revolutionary as it provided a method to study the geometry of matter at atomic resolution and opened up a field of crystallography that is so essential today. Dieter further described some of the fundamental notions about structure determination that were worked out within the first 10 years. Some key events like methods for structure solution were critical, but also important was the development of instrumentation and computers to do the calculations which can today be accomplished in a few seconds, compared with the years of hand calculations done in the early days. Dieter closed with some remarks about some of the specialist areas of crystallography, such as the study of aperiodic and quasi crystals and charge densities.

This was followed by a very well attended joint microsymposium on "100 Years of Diffraction". Michael Glazer enthralled us with details of lives of the Braggs, from their time in Australia, the insight leading to the deduction of Braggs Law and their later scientific activities. Jost Lemmerich described the life of Max von Laue, his later life and his interaction with many prominent colleagues of his time. Larry Falvello focussed on the origins and development of macromolecular crystallography, the key people involved in the early years, such as Astbury, Bernal, Hodgkin, Bragg, Pauling, Kendrew & Perutz, to name just a few, and the rapid rise in the number of macromolecular structure determinations being conducted today. Ton Spek rounded off a fascinating session by describing the life of Bijvoet and the development of the use of anomalous dispersion to determine absolute structure.
The final session of the afternoon focussed on current and new developments in crystallography. There was strong interest in the progress with the SwissFEL, the upgraded materials science beamline at the SLS, new methods for investigating disordered systems, high resolution X-ray diffraction applications and a status report on SINQ. These were supplemented by interesting talks on the use of charge flipping for structure solution from powder diffraction data, nanosized intercluster compounds and Brazil twinning in quartz.
The day finished with an evening poster session, where 12 interesting, well presented SSCr posters could be viewed –

congratulations to Laure Guenee, Geneva, on winning the poster prize kindly sponsored by ScNAT. Those hardy souls who remained for the grill party afterwards were treated to a very spectacular thunderstorm!

Tony Linden, Inst. of Organic Chemistry, University of Zürich

History of Physics Session

The 2012 session of the SPS History of Physics section took place on the afternoon of June 21. There were 6 talks scheduled, to which one should add the two historical talks that were included in the Crystallography session celebrating the hundredth anniversary of the discovery of X-ray diffraction by Max von Laue. As previous year, collaborators from the History and Philosophy of Science Unit of Geneva University used the opportunity of the session to present their current results on the history of Western Switzerland physics: Jan Lacki presented a scientific portrait of the Freiburg University professor Albert Gockel, a key character in the discovery of cosmic radiation of which 2012 marks also the hundredth anniversary of discovery by the Austrian Victor F. Hess, while Régis Catinaud introduced the audience to the early history of the Lausanne engineering school Ecole Speciale which, after being absorbed by Lausanne University to become one of its Faculties, gave eventually birth to Lausanne's Ecole Polytechnique Fédérale.

Adrien Vila Vals from the University of Lyon, working currently on a Ph.D. thesis devoted to the French reception of Quantum Mechanics discussed the complex paternity of the Proca equation which was separately investigated by three key figures of quantum physics, Lanczos, Proca and de Broglie. Vila Vals used the opportunity of this episode to clearly characterize the difference of theoretical styles between these three theoreticians.
Prof Thomas Wesolowski from the University of Geneva gave quite an original contribution discussing some of the current trends in his field, the Density Functional Theory of Quantum Chemistry. In an insightful way, he showed how the same theoretical situations linked to the necessity of a pertubative approach to the electronic density functional received in past years different names and were associated different meanings, mirroring the varying scientific traditions and communitarian preferences of the scholars involved in the field.

Another Ph.D. student from Geneva, Araceli Sanchez Varela presented her most recent results on the intricate policy of the energy upgrades of CERN's previous accelerator LEP, showing quite convincingly how it affected the very last LEP search for the Higgs boson which took place just before LEP's closure in 2000.

Finally, Prof. Jean-François Loude from Lausanne discussed the fruitful partnership between the instrument makers of the Haag-Streit enterprise and the physicist and meteorologist Heinrich Wild, illustrating the importance of multilateral links between science, technology and industry.

As mentioned above, there were two historical talks given in the special History of Crystallography session organized in partnership with the History of Physics section. Prof. Michael Glazer from Oxford Clarendon Laboratory gave a very entertaining talk devoted to father and son Bragg, while Dr. Rolf Lemmerich from Berlin, editor of von Laue correspondence, introduced the audience to the life and times of the German Nobel prize winner.

Participation to the History of Physics session was fair, with people joining all along the session but it could have been certainly better. As in previous years, the majority of the attending were young people: this confirms the potential of the History of Physics section as a way for the Swiss Physical Society to reach young members.

Jan Lacki, Uni Genève, SPS-HoP

Everything was ready for a nice grillparty in the garden. A very heavy thunderstorm, just in time for the buffet opening, forced the moe than 150 hungry guests to flee into the mensa instead.

Particle, Astro- and Nuclear Physics Session

The TASK session of the 2012 annual meeting again saw an increase in the quantity and quality of contributed papers. Close to 40 were presented orally, with 11 additional ones presented as posters.
As was to be expected by the strong participation of Swiss groups in LHC experiments, more than half of the contributions concerned new results from ATLAS, CMS and LHCb. Several aspects of Standard Model physics at the LHC were covered, while many presentations concerned the search for new phenomena. In addition, the performance of the experiments and details of the physics analysis methodology were presented.

In addition to this dominant theme, new results from PSI and progress on the production and usage of ultracold neutrons received a lot of attention. Progress in neutrino experiments and in the search for Dark Matter using noble liquid detectors was reported. One of the highlights on the theoretical side was a talk by Oleg Ruchayskiy presenting work performed with Micha Shaposhnikov on the Neutrino Minimal Standard Model, which promises new insight into the matter-antimatter asymmetry, the nature of Dark Matter and neutrino masses. As far as astroparticle physics is concerned, the meeting discussed progress reports on ground-based and space-born detectors with Swiss participation or leadership, like AMS, POLAR and FACT.

Celebrating the 100th anniversary of the discovery of Cosmic Rays by V. Hess, Nobel laureate Samuel C.C. Ting gave a well-attended public lecture on his Alpha Magnetic Spectrometer experiment, taking data since May 2011 on the International Space Station. After a very personal and inspiring account of the challenges presented by precision experimentation in the hostile space environment, he reminded the audience that most discoveries in particle physics were indeed made by experiments aiming at entirely different goals. “Exploring a new territory with a precision instrument is the key to discovery,” Ting concluded.
(The presentation and a movie shown during the talk is available on www.sps.ch .)

As observed in previous meetings, the quality of talks and posters at the annual SPS meetings is in constant progression. It is to be expected that future TASK sessions must either be longer or more parallel to accommodate the wealth of contributions. I would like to thank all contributors, especially the PhD students, their advisors and group leaders, for excellent talks, the session chairs and the whole audience for their continued interest in the TASK sessions and the lively discussions.

Martin Pohl, Université de Genève, SPS-TASK

Magnetism at Interfaces

This session focused on magnetic phenomena at interfaces in systems with different length scales ranging from thin films to nanostructures and molecules. The session took place over two days and contained 3 invited and 17 contributed talks as well as a poster session. The contributions covered fields such as magnetic properties of molecules, clusters and nanoparticles coupled to surfaces as well as interfacial effects in thin films and multilayers producing novel electronic properties and spin structures. The participants reported about both static and dynamic phenomena, including thermal- and laser-induced effects. The mixture of internationally well-recognized invited speakers on the one hand and contributions of young scientists on the other hand both from theoretical and experimental studies resulted in a very stimulating atmosphere throughout both days with many interesting discussions. This successful session reflects the active role of the Swiss community in this field and their strong connections to international efforts on this topic.

Armin Kleibert, PSI Villigen

NCCR MUST Session

For the first time NCCR MUST was a part of the two-day SPS Annual Meeting.
The focus in MUST (Molecular Ultrafast Science and Technology) is to create new experimental and theoretical tools and to apply them to understand how matter functions at the electronic, atomic and molecular level. In particular in MUST we want to find out how matter changes its structure during a reaction and how quanta of energy are transported on a microscopic spatial and ultrafast time scale. MUST is embedded in the vision that we can contribute to important challenges such as alternative energy sources and improving health. MUST takes a broad view through basic research – see www.nccr-must.ch . The network started mid 2010.
MUST organized a one day session with talks and posters within the meeting. 20 members of the MUST network gave presentations on their recent scientific results. Group members displayed their work on 27 posters during both days which were very well attended.

Majed Chergui (EPFL) in his invited plenary talk reviewed the recent progress in ultrafast X-ray spectroscopy which greatly benefited from the femtosecond hard X-ray slicing source at PSI in Villigen. Ultrafast molecular magnetism dynamics could be resolved for the first time (see picture).

Gebhard Schertler (PSI) gave the public an invited tutorial on the "Importance of ultrafast processes in biology" which was given the lunch break (see picture).

Peter Hamm (Uni Zürich) presented one of the highlights within MUST with the invited talk on "Multidimensional IR spectroscopy of water". The rest of the invited talks were given by our new PI member (Johnson) and some of our junior PIs: Hans Jakob Wörner (ETH Zürich) on "Probing electronic valence shell dynamics in molecules", Steven Johnson (ETH Zürich) on "Femtosecond dynamics of atomic structure in solids" and Fabrizio Carbone (EPFL) on "Non-retarded pairing interaction in a high-T_c cuprate".

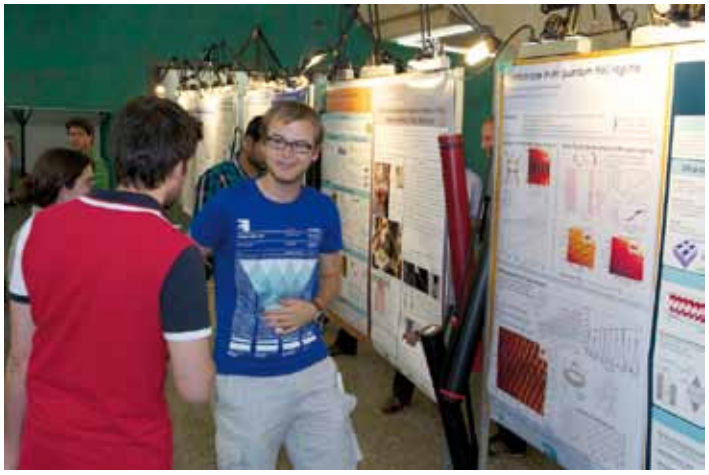
Ursula Keller, ETH Zürich, NCCR MUST director
Rainer Sigg, ETH Zürich, NCCR MUST scientific officer

NCCR QSIT Session

During this year's meeting of the Swiss Physical Society the NCCR QSIT (Quantum Science and Technology) organized one of the sessions in cooperation with the other physics-related NCCRs.

One highlight on Thursday was the SPS prize ceremony. One former QSIT student, Dr. Johannes Güttinger, who is now a postdoc in Barcelona, shared the SPS Award in General Physics, sponsored by ABB for his pioneering PhD work on graphene quantum dots. (see p. 8 for details and picture.)

The QSIT talks took place on Friday and started with a plenary presentation by Prof. Kotthaus from Univ. Munich. The talk gave a fantastic overview about recent developments in nanomechanical systems. A sequence of speakers from various groups participating in NCCR QSIT reported about their results in quantum optics, noise-spectroscopy in self-assembled quantum dots, graphene connected to superconducting electrodes in the quantum Hall regime, graphene three-terminal dots, as well as the observation of the strong coupling regime in a two-dimensional electron gas coupled to photonic crystal structures with resonance frequencies below 10 meV.



The poster session in combination with the lunch buffet was used for discussion between groups. A variety of topics was presented by the members of QSIT, the other NCCRs and numerous other young Swiss physicists.

Klaus Ensslin, ETH Zürich

Session: Careers for Physicists

The meeting included a session on "Careers for Physicists", which was organized in collaboration with the "Physikalische Gesellschaft Zürich" (PGZ). Similar to last year the session was very well attended especially by younger physicists, who wanted to know more about career opportunities outside the academic field. Speakers from different fields talked about their work and what makes it interesting for them, but also what skills are important.

Lukas Mahler from Sensirion showed how physicists contribute with their knowledge in different fields to the success of a startup company. Thomas Christen from ABB Corporate Research talked about his work as a theoretical physicists in a larger company and how modeling is important there. Florian Weissbach from Fair GmbH presented the area of research management and its importance in connection with the European funding agencies. Finally Thierry Oggier from Mesa Imaging AG presented how 3D imaging technology helped in a real world application.

The talks lead to discussions with the speakers even after the session. The good attendance showed that information on career perspectives are of great interest to students and that first hand information from people working in different areas is helpful to them.

Kai Hencken, SPS-INDU, ABB Baden

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The winners of the SPS Awards 2012

The SPS Award committee, presided by Prof. Louis Schlapbach, had this year again the interesting task to choose the best from all the submitted, high quality canditatures. For the first time, an award had to be shared between two different candidatures, since it was just not possible to decide, which one was better.
The winners each had the opportunity to present their outstanding work in the course of the annual meeting in a 30 min talk. The laudationes (written by L. Schlapbach) and summaries (written by the respective authors) are printed below.

SPS Award in General Physics, sponsored by ABB

Alexander Eichler is awarded with the SPS 2012 Prize in General Physics for his excellent contribution to the understanding of vibrational properties of carbon based materials entitled Nonlinear damping in mechanical resonators made from carbon nanotubes and graphene. He found that the quality factors of doubly clamped resonators made from carbon nanotubes or graphene depend strongly on the applied driving force (and thus the mechanical amplitude). This result is in contradiction to the commonly used model for nanoresonators in vacuum, which considers only a linear damping force. Alexander Eichler and the co-authors showed that the measurements can be understood in the framework of a nonlinear damping force that dominates over the linear damping force. They back up their surprising result with an extensive set of data to demonstrate the robustness of the amplitude-dependent quality factor. The findings have profound consequences. They entail that many predictions for NEMS resonators, e.g. concerning tests of quantum mechanics in extended bodies, ought to be revised when applied to nanotube/graphene resonators since they were calculated assuming linear damping. In addition, the results provide a simple method to increase the mechanical quality factor in nanotube/graphene resonators, a matter of great importance for many applications.

Johannes Güttinger and Alexander Eichler

Nonlinear damping in mechanical resonators made from carbon nanotubes and graphene

Nanoelectromechanical resonators are of great interest due to their potential applications for on-chip radio-frequency signal processing, sensing experiments with unprecedented sensitivity (mass spin, force, charge), and tests of quantum mechanics in extended bodies. Carbon-based resonators, in particular, appear very promising owing to their low mass, high structural quality, and high Young modulus.

Damping is central to the physics of nanoelectromechanical resonators; for instance, it lies at the core of quantum and sensing experiments. Damping has been successfully described by a linear damping force for all the mechanical resonators studied so far in vacuum, whose dimensions span many orders of magnitudes down to a few tens of nanometres.

In our work [1], we report that the linear damping scenario breaks down for resonators made from carbon nanotubes and graphene sheets, whose transverse dimensions are on the atomic scale. Indeed, we find that the damping in these resonators is much better explained by a nonlinear damping force.
Our finding has profound consequences. It entails that many predictions for NEMS resonators, e.g. concerning tests of quantum mechanics in extended bodies, ought to be revised when applied to nanotube/graphene resonators (since they were calculated assuming linear damping). In addition, our work provides a simple method to increase the mechanical quality factor in nanotube/graphene resonators, which is a matter of importance for many applications.

[1] A. Eichler, J. Moser, J. Chaste, M. Zdrojek, I. Wilson-Rae, and A. Bachtold, Nature Nanotech. 6, 339 (2011)

Johannes Güttinger is awarded with the SPS 2012 Prize in General Physics for his pioneering PhD work on graphene quantum dots. He fabricated graphene quantum dots by etching mono-layer flakes into small islands with narrow connections to contacts, serving as tunneling barriers for transport spectroscopy. Quantum confinement of electrons in graphene quantum dots was observed by measuring Coulomb blockade and transport through excited states. Measurements in a magnetic field perpendicular to the sample plane allowed to identify the regime with only few charge carriers in the dot and the crossover to the formation of the graphene specific zero-energy Landau level at high fields. Johannes Güttinger also prepared a graphene quantum circuit, where a graphene dot was capacitively coupled to a neighboring graphene constriction. This way he realized charge detection and extended this technique to time-resolved single electron transport measurements in

graphene, a promising fact for future more complex quantum circuits in view of the implementation of spin qubits. In spite of his young age Johannes Güttinger is well known in the community for his contribution to charge and spin states in graphene quantum dots. Already during his PhD he was invited to speak at conferences or at other research institutions. Johannes has done a PhD far above average in terms of scientific impact, number of publications and citations, international visibility, and groundbreaking physics results.

Graphene Quantum Dots

We report transport experiments through graphene quantum dots and narrow graphene constrictions. In a quantum dot, electrons are confined in all dimensions, offering the possibility for detailed investigation and controlled manipulation of individual quantum systems. The recently isolated two-dimensional graphene is an interesting new material to study quantum phenomena. Due to its novel electronic properties and the expected weak interaction of the electron spin with the atomic nuclei, graphene quantum dots have been proposed as promising hosts for spin based quantum bits.

As graphene is a zero gap semiconductor, tunable carrier confinement poses a challenge. We fabricate graphene quantum dots by etching mono-layer flakes into 60-350 nm sized islands with narrow constrictions to the leads. Transport through the constrictions is suppressed around the electron-hole crossover and they can be used as tunable tunneling barriers for transport spectroscopy of the dot. Electron confinement in graphene quantum dots is observed by measuring Coulomb blockade and transport through excited states, a manifestation of quantum confinement [1].

In order to understand the spectrum of a quantum dot it is usually necessary to reach a regime with only one or two electrons in the dot. Measurements in a magnetic field perpendicular to the sample plane allow identifying the electron-hole transition regime via the crossover to the graphene specific zero-energy Landau level at high fields. After rotation of the sample into parallel magnetic field orientation, Zeeman spin-splitting with a g-factor of approximately two is measured. A g-factor of two is expected in the absence of spin-orbit interaction. The filling sequence of subsequent spin states showed no signatures of shell filling so far. This is attributed to the non negligible influence of exchange interactions among the electrons and low energy edge states [2]. These studies open the way for a more advanced understanding and control of spin states in graphene quantum dots.

[1] J. Güttinger, „Graphene Quantum dots" Ph D thesis, ETH Zurich (2011)
[2] J. Güttinger, T. Frey, C. Stampfer, T. Ihn, and K. Ensslin, „Spin States in Graphene Quantum Dots" PRL 105, 116801 (2010)

SPS Award in Condensed Matter Physics, sponsored by IBM

Fabian Mohn is awarded with the SPS 2012 Prize in Condensed Matter Physics for his excellent scientific work "Imaging the charge distribution within a single molecule" published in Nature Nanotechnology. The work represents an important milestone in the use of the Kelvin Probe Force Microscopy (KPFM) technique combined with STM and AFM as it demonstrates for the first time imaging of the charge distribution within a single molecule with sub molecular resolution. The choice of a planar molecule (naphthalocyanine) favors switching between two symmetric charge distributions without significant change of topography between the conformal states what allows KPFM difference images showing directly the different charge distribution along the arms of the molecule. This work paves the way for future studies on charge distribution and charge transfer in molecular systems at high lateral resolution, a crucial information for the understanding of chemical bond formation and breaking and in particular of single-molecular electronic devices.

Andreas Schopper (now SPS President), Fabian Mohn and Christophe Rossel (now SPS Vice President). Photo © ETHZ / Heidi Hostettler

Imaging the charge distribution within a single molecule

Scanning probe techniques, such as scanning tunneling microscopy (STM) and atomic force microscopy (AFM), have been used to study both the electronic and the structural properties of molecules on surfaces with submolecular resolution [1,2]. However, the charge distribution within a molecule is not directly accessible with these techniques. Kelvin probe force microscopy (KPFM, a special mode of AFM), on the other hand, can be used to measure the local contact potential difference between the scanning probe tip and the surface, a quantity closely related to the charge distribution on the surface, but no submolecular resolution had so far been reported. The goal of our work was to combine the charge sensitivity of KPFM with the high resolution of STM and AFM, and thereby image the charge distribution within a molecule.
We investigated the molecule naphthalocyanine on an ultrathin insulating NaCl film on Cu(111) with a combined low-temperature STM and AFM setup. Naphthalocyanine consists of four lobes that give it a cross-like shape, and it has two hydrogen atoms at its center that can be switched between two different configurations in a process called tautomerization switching.

Using STM and AFM in combination with density functional theory calculations, we found that the lobes parallel to the inner hydrogen atoms exhibit a lower electron density than the other two lobes. We were then able to show that this charge asymmetry clearly manifests itself in an asymmetric appearance of submolecularly resolved KPFM images. Also, the possibility of switching the tautomerization state of the molecule helped us exclude that the contrast is affected, for example, by an asymmetric shape of the scanning probe tip. We were able to identify the electric field generated by the inhomogeneous charge distribution within the molecule as the source of contrast in our KPFM images. Furthermore, we found that functionalizing the scanning probe tip with a single carbon monoxide molecule greatly enhanced the KPFM resolution, enabling for the first time the imaging of atomic-scale variations of the local contact potential difference over a molecule.
Our findings open up the possibility of directly imaging the charge distribution within charge-transfer complexes, which hold promise for future applications such as solar photoconversion or energy storage. Furthermore, it will now be possible to investigate how charge is redistributed when individual chemical bonds are formed between atoms and molecules on surfaces.

[1] J. Repp, G. Meyer, S. M. Stojkovic, A. Gourdon, and C. Joachim, Phys. Rev. Lett. 94, 026803 (2005).
[2] L. Gross, F. Mohn, N. Moll, P. Liljeroth, and G. Meyer, Science 325, 1110 (2009).

SPS Award in Applied Physics, sponsored by OC Oerlikon

Adrian Chirilă is awarded with the SPS 2012 Prize in Applied Physics for his excellent contribution to overcome the international challenge of achieving high photovoltaic conversion efficiency flexible and sustainable photovoltaic cells of the Cu(In,Ga)Se_2 - or shortly CIGS-type. His skillful work on compositionally graded CIGS layer growth at low temperature, interface engineering and in-depth understanding of the properties of other constituent layers and interfaces of the heterojunction solar cells, eventually led to a series of breakthroughs resulting in continuous increase in the world record efficiency to 18.7% (independently certified by ISE-FhG Freiburg). This progress puts the efficiency of flexible solar cell comparable to the high efficiency of poly-Si wafer and CIGS on glass substrate solar cells, but with additional advantages of lightweight and flexibility. The impact of his resaerch - when implemented on industrial scale - would enable further reduction in the manufacturing cost of solar cells and installed systems.

Photo © ETHZ / Heidi Hostettler

Highly efficient Cu(In,Ga)Se_2 solar cells grown on flexible polymer films

Photovoltaics, the direct conversion of light into electricity, is a promising source of renewable energy to provide low cost solar electricity in a safe and sustainable manner. Among various thin film technologies, solar cells based on Cu(In,Ga)Se_2 absorber layers have yielded highest conversion efficiencies. While most of the R&D is carried out on rigid glass substrates, the use of flexible polymer foils as a substrate offers several advantages for lowering manufacturing and installation costs, as well as opening up new applications of lightweight flexible solar modules. However, as the conversion efficiency is an absolutely important factor for cost-competitiveness, it is necessary to obtain similar efficiencies on flexible substrates as on rigid ones, which up to now has not been achieved. The main reason has been that "high-quality" absorber layers were grown at rather high substrate temperatures of about 600°C, while polymer foils restrict the applicable growth temperature to well below 500°C. Lower substrate temperatures during absorber deposition have generally resulted in significantly lower efficiencies on polymer foils, and it was previously unknown which critical issues restrict the performance of such solar cells.

In this work, the composition gradient along the absorber layer, which is directly connected to the electronic band gap structure of the solar cell, has been identified as the main reason for inferior performance of such solar cells grown on plastic substrates at low temperature. For that purpose a specially designed multistage growth process has been invented which enables tuning of the composition grading and thereby engineering the band gap structure of the solar cell. Solar cells grown by this method exhibited similar conversion efficiencies as compared to devices that typically could only be obtained on rigid glass substrates and much higher growth temperatures. Adjustment of the compositional grading in an appropriate manner was found to be key to remove an electronic barrier for the minority carriers which otherwise results in enhanced recombination and reduced device performance. A best conversion efficiency of 18.7% was achieved on polyimide substrate which is a world-record for any type of solar cell grown on a flexible substrate. This achievement could have a broad impact on future PV manufacturing and holds great potential for a paradigm shift in the use of effective solar electricity production.

[1] A. Chirilă, S. Buecheler, F. Pianezzi, P. Bloesch, C. Gretener, A. R. Uhl, C. Fella, L. Kranz, J. Perrenoud, S. Seyrling, R. Verma, S. Nishiwaki, Y. E. Romanyuk, G. Bilger, and A. N. Tiwari, Highly efficient Cu(In,Ga)Se_2 solar cells grown on flexible polymer films, Nature Materials 10, 857–861, 2011.
[2] A. Chirilă, P. Bloesch, S. Seyrling, A. Uhl, S. Buecheler, F. Pianezzi, C. Fella, J. Perrenoud, L. Kranz, R. Verma, D. Guettler, S. Nishiwaki, Y. E. Romanyuk, G. Bilger, D. Brémaud, and A. N. Tiwari, Cu(In,Ga)Se_2 Solar Cell Grown on Flexible Polymer Substrate with Efficiency exceeding 17%, Prog. Photovolt.19, 560-564, 2010.

3 EPL Poster Prizes at the SPS Annual Meeting 2012

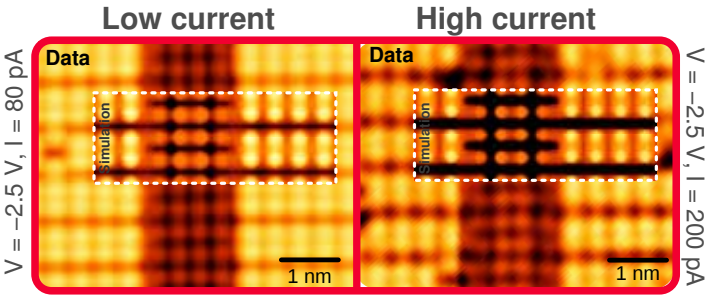
This year the European Journal EPL inaugurated a prize awarded to the three best posters presented at the SPS annual meeting. Each winner received a watch stamped at the name of EPL together with a check of 200.- CHF.

Excerpts of the winning posters:

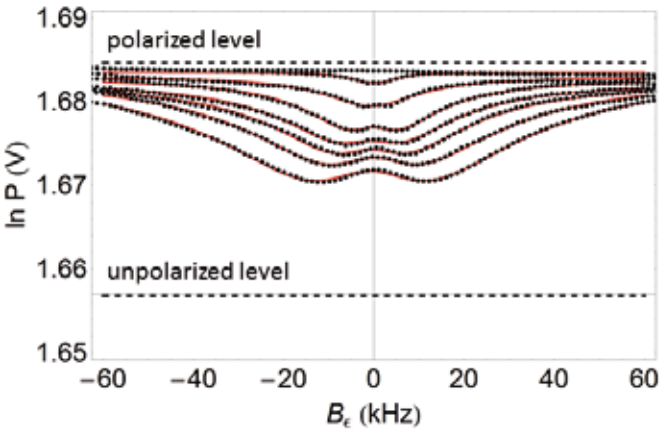
François Bianco, Dépt. de la Matière Condensée, Université de Genève

One-dimensional nanolines and single atom chains on Si(001)

Filled state constant current scanning tunnelling micrograph (STM) of a silicon 1D nanoline embedded in monohydride silicon taken at 77 K, with a tip bias V = 2.5 V, at 80 pA (left) and 200 pA (right). The parts within the dashed rectangle are STM simulations based on integration of density functional theory results. There is a strong matching between data and theoretical modelling. These nanolines are promising candidates for a 1D model system to probe physics at low dimensions.



Evelina Breschi, Dépt. de Physique, Université de Fribourg



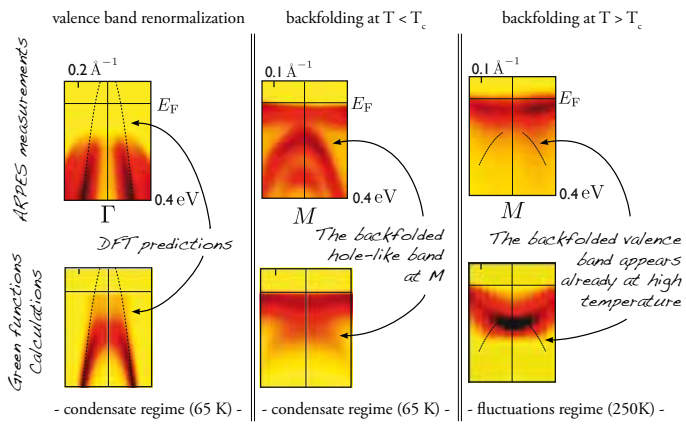
Ground State Hanle effect based on atomic alignment: theory and experiment

Comparison of theoretical (red lines) and experimental (dots) lineshapes of the longitudinal ground state Hanle resonances in room temperature cesium vapour for a discrete set of transverse magnetic fields. The resonance contrast is determined by the degree of atomic alignment calculated from the linear absorption spectra of polarized and unpolarized atoms.

Gaël Monney, Dépt. de Physique and Center for Nanomaterials, Université de Fribourg

Electron-hole instability in $TiSe_2$

Comparison between ARPES measurements and calculations explaining the bands renormalization due to electron-hole instability in the charge density wave compound $TiSe_2$.



News from the General Assembly

The General Assembly was held at the SPS Annual Meeting on June 21. The President reminded the audience of the success of the last Annual Meeting in Lausanne, June 2011, a joint venture with the Austrian physics societies, totalizing 470 contributions.
The number of SPS members has increased by 10% and we gained several "associate members", in particular university physics departments, research organisations and, very importantly, seven Swiss student associations. The new bylaws, in which "associate members" replaced the old term "collective members", were accepted. The annual accounting report was presented by the treasurer and accepted by the assembly. The total fortune of the SPS has yet again found a rising trend. The new section "Earth, Atmosphere and Environmental Physics" has been founded, and held sessions at the conference.
Among other projects, let us mention the 3-day annual meeting 2013 in Linz, Austria, again joint with the Austrian societies. The "Swiss Physics Olympiad" and the "Swiss Young Physicists Tournament" will again take place in 2013. Switzerland will host the "International Young Physicists Tournament" (IYPT) in 2016.
Apart from Andreas Schopper (President) and Christophe Rossel (Vice-president), 4 new committee members have been elected, presented below.

The new President, Andreas Schopper, thanked and congratulated Christophe Rossel for his accomplishments. Under his direction and enthusiasm, the Swiss Physical Society has increased the number of its sections from five to nine and the relation to young physicists was given a particular emphasis. He created a favourable climate to stimulate many forces, encouraging them to join and contribute in making the SPS an attractive and well-recognized organisation. The Swiss Physical Society is very grateful for his dedication and accomplishments.

Antoine Pochelon, SPS-Secretary

New SPS Committee Members

Dr. Pascal Ruffieux (Treasurer)

Pascal Ruffieux studied at the University of Fribourg where he received the diploma in physics in 1997. For his Ph.D. thesis joined the "solid state physics" group, investigating the interaction of hydrogen with sp^2-bonded carbon materials with a main focus on the influence of local carbon topology on the the chemical binding of hydrogen on the local electronic effects induced by the chemisorption of hydrogen. For his Ph.D. thesis he received the Charmey prize Swiss Working Group on Surface and Interface Science in 2002. In 2003, he joined the newly established "nanotech@surfaces" laboratory at EMPA, which was founded with the aim of linking the fundamental understanding of nanostructured surfaces with the design and understanding of specific material properties. The main focus during this initial phase and a research stay in 2003 at the "Freie Universität Berlin" was the investigation of structural and electronic properties of molecular nanostructures and their interaction with nanostructured surfaces.
Since 2010 he is leading the activities related to the synthesis of atomically defined carbon nanostructures via the bottom-up approach with surface-assisted coupling reactions. For the synthesis of atomically defined graphene nanoribbons he received the EMPA research prize 2011. From 2010 to 2012, Pascal Ruffieux has been auditor of the SPS.

"*Die SPG ist eine Organisation mit einer Vielzahl pulsierender Grenzflächen, welche den Austausch zu Industrie, zu den verschiedenen Bildungs- und Forschungsinstitutionen, innerhalb der Fachbereiche, aber auch zu internationalen Partnern als Kernaufgabe sieht. Um an diesen Grenzflächen einen effizienten Austausch erreichen zu können braucht es entsprechende Plattformen, welche die SPG tatkräftig erhält und ausbaut. Die dazu nötigen organisatorischen Strukturen mit meinem Einsatz im Vorstand als Kassier zu unterstützen, ist mir eine besondere Ehre.*"

Dr. Christian Rüegg (Chair of the KOND Section)

Christian Rüegg studied experimental physics at ETH Zürich and received his PhD from the same institution in 2005. Subsequently, he moved to the UK where he continued his scientific career as a postdoctoral research associate at the London Centre for Nanotechnology of University and Imperial College London. In 2008 he was awarded a University Research Fellowship by the Royal Society and tenured positions as lecturer and later reader at the Department of Physics and Astronomy of the University College London. He returned to Switzerland in 2011 and since then is the head of the Laboratory for Neutron Scattering (LNS) at Paul Scherrer Institute. The LNS team of 40 scientific staff, postdocs and PhD students is responsible for the operation and development of the neutron diffraction and spectroscopy instruments at the Swiss Spallation Neutron Source SINQ and runs a diverse research program in a number of fields including fundamental and more applied condensed matter physics, soft matter, and all aspects of material science e.g. for energy storage, energy conversion, and health care. Christian Rüegg is an honorary professor at University College London and is affiliated with the Department of Condensed Matter Physics at the University of Geneva.

Christian Rüegg's main research interests are in quantum

phase transitions in strongly correlated systems and model magnets, in the spin dynamics of low-dimensional and frustrated quantum magnets, in the physics of novel materials including metal-organics, heavy electron systems, and superconductors, and in the development of new neutron scattering methods and instrumentation. For example, he has done experimental work on a number of canonical model materials, including low-dimensional arrays of quantum spins, so called spin dimer and ladder systems, and achieved the observation of BEC of magnons, the identification of the elementary quasi-particles that drive the transition between a quantum spin liquid and a classical antiferromagnet, and, most recently, the study of spin Luttinger-liquid physics in quantum spin ladders. For his research he is typically using a combination of neutron and X-ray scattering techniques with measurements of bulk magnetic and thermodynamic properties. He is collaborating very closely with synthetic chemists working on the discovery of new materials and with leading theorists contributing to the quantitative interpretation of the experimental results. For this work Christian Rüegg was awarded a number of prizes including the Medal of ETH Zürich in 2005, the SPS Award for General Physics in 2006, the Nicholas Kurti European Science Prize in 2010, and the Erwin Felix Lewy-Bertaut Prize in 2011.

Prof. Gian Michele Graf (Chair of the Theory Section)

Gian Michele Graf studied physics at ETH Zürich, receiving his diploma in 1986. At the same institution and under the advice of W. Hunziker he earned his PhD in 1990 on a subject in mathematical physics, thereby proving asymptotic completeness of many-body scattering in quantum mechanics. The following two years he was assistant professor of mathematics at the California Institute of Technology, and later of theoretical physics back at ETH. In 1998 he was offered a chair there, which he still holds.

Graf's research is in the general area of mathematical physics, with emphasis on quantum mechanics and its applications. Over the years the focus has shifted among subjects like scattering and resonance theory, large quantum systems, disordered systems, supersymmetric matrix models, aspects of quantum Hall physics, the Casimir effect, mesoscopic physics, open quantum systems and, most recently, topological insulators.

Since a few years Graf is a representative of the Swiss Physical Society on the board of the "Annales Henri Poincaré", a fairly successful journal in mathematical physics which the SPS partly owns. It is a great pleasure to him that he has now been elected to the Society's own board. He believes that theoretical physics is an endeavor which progresses not only by exchanges with experimental physics, but also between the diverse areas of theoretical physics itself. The annual meetings provide a good way to foster such exchanges, in continuation of the efforts made by Dionys Baeriswyl. More generally the Theoretical Physics section of the SPS could offer an opportunity to strenghten the role of theory in Switzerland.

Dr. Stéphane Goyette (Chair of the Earth, Atmosphere and Environmental Physics Section)

Dr. Stéphane Goyette main research interests are related to the parameterization of physical processes in climate models in order to improve the accuracy of the simulations. These models, similar to those used for Numerical Weather Predictions (NWP), are based on differential equations developed on the fundamental laws of physics, fluid motion, and chemistry formulated to be solved numerically.

Prior to his main involvements in climate research and lecturing, Stéphane Goyette obtained his B.Sc. in Physics at the University of Montréal, Canada. Then, he studied Atmospheric Sciences at the Physics department of the "Université du Québec" in Montréal. During his Masters studies, he has been hired as a summer student twice in Toronto in the modelling division of *Environment Canada*, the Canadian Federal office producing the weather forecasts and climate predictions. There, he participated in the development of the second generation of the Canadian Global Climate Model (GCM). During his doctoral studies in atmospheric sciences in Montréal where he obtained his Ph. D. in 1995, he developed a physically-based regional interpolator for off-line downscaling of GCM and participated in the development of the first version of the Canadian Regional Climate Model (RCM). He was then granted a fellowship and moved to Victoria, British Columbia, where he conducted post doctoral studies during two years at the Canadian Climate Centre for modelling and analysis division aiming at the development and application of a lake model to the Laurentian Great Lakes region. Then, he was appointed, as a visiting scientist, to the “Centre National de Recherches Météorologiques” in Toulouse, France, where he tested a number of parameterizations for the representation of surface hydrology in GCM and NWP models. He then moved to Switzerland in 1998 and worked at the University of Fribourg where he wrote his Habilitation thesis ((Privatdozent) on "Climate modelling: from lecturing to research", and was afterwards hired as a senior scientist at the University of Geneva in 2006 where he applied the Canadian RCM at very high resolution in order to test the ability of numerical model to reproduce the main field variables over the complex terrain of Switzerland. Presently, his main fields of research are related to mid-latitude storms, the representation of surface wind gusts and their impacts, and to the coupling of the lower atmosphere with large fresh water bodies. He is co-convening the session "Climate extremes and impacts" during the European Geophysical Union General assembly since 2001. He also supervises the work of a number of Ph. D. and M. Sc. students.

Ausschreibung der SPG Preise für 2013
Annonce des prix de la SSP pour 2013

Auch im Jahr 2013 sollen wieder SPG Preise, die mit je CHF 5000.- dotiert sind, vergeben werden.

- SPG Preis gestiftet vom Forschungszentrum ABB Schweiz AG für eine hervorragende Forschungsarbeit auf allen Gebieten der Physik

- SPG Preis gestiftet von der Firma IBM für eine hervorragende Forschungsarbeit auf dem Gebiet der Kondensierten Materie

- SPG Preis gestiftet von der Firma OC Oerlikon für eine hervorragende Forschungsarbeit auf dem Gebiet der Angewandten Physik

En 2013, la SSP attribuera à nouveau des prix de CHF 5000.- chacun, à savoir:

- Le prix SSP offert par le centre de recherche ABB Schweiz AG pour un travail de recherche d'une qualité exceptionnelle dans tout domaine de la physique

- Le prix SSP offert par l'entreprise IBM pour un travail de recherche d'une qualité exceptionnelle en physique de la matière condensée

- Le prix SSP offert par l'entreprise OC Oerlikon pour un travail de recherche d'une qualité exceptionnelle dans le domaine de la physique appliquée

Die SPG möchte mit diesen Preisen junge PhysikerInnen für hervorragende wissenschaftliche Arbeiten auszeichnen. Die eingereichten Arbeiten müssen entweder in der Schweiz oder von SchweizerInnen im Ausland ausgeführt worden sein. Die Beurteilung der Arbeiten erfolgt auf Grund ihrer Bedeutung, Qualität und Originalität.
Der Antrag für die Prämierung einer Arbeit muss schriftlich begründet werden. Die Arbeit muss in einer renommierten Zeitschrift publiziert oder zur Publikation angenommen sein. Wenn mehrere Publikationen eingereicht werden, um die Leistungen des Kandidaten umfassender darzustellen, muss genau gesagt werden, welche Publikation für die Preisvergabe in Betracht gezogen werden soll.
Der Antrag muss die folgenden Unterlagen enthalten:

Begleitbrief mit Begründung, Lebenslauf des Kandidaten mit Publikationsliste, die zu prämierende Arbeit und ein Gutachten.

Diese Unterlagen werden elektronisch im "pdf"-Format direkt an das Preiskomitee eingereicht (große Dateien bitte komprimieren (zip)):

La SSP aimerait saluer l'excellence d'un travail scientifique effectué par de jeunes physiciens ou physiciennes. Les travaux soumis à candidature doivent avoir été effectués en Suisse ou par des Suisses à l'étranger. L'évaluation portera sur l'originalité, l'importance et la qualité des travaux.
La candidature soumise à nomination doit être justifiée par écrit. Le travail doit avoir été publié dans une revue renommée ou être accepté pour publication. Si plusieurs publications sont présentées, dans le but de mieux décrire la performance du candidat, il faut préciser laquelle est à prendre en considération pour l'attribution d'un prix.
Le dossier de candidature doit comporter les documents suivants:

une lettre de motivation, le curriculum vitae des auteurs, une liste de publications, le travail proposé et une lettre de recommandation.

Ces documents seront envoyés électroniquement en format "pdf" directement au comité de prix (svp. comprimez des fichiers très grands (zip):

awards@sps.ch

Einsendeschluss: 28. Februar 2013
Délai: 28 février 2013

Die Preise werden an der gemeinsamen Jahrestagung 2013 in Linz überreicht.

Das Preisreglement befindet sich auf den Webseiten der SPG: *www.sps.ch*

Les prix seront attribués à la réunion annuelle commune qui se tiendra en 2013 à Linz.

Le règlement des prix se trouve sur les pages Web de la SSP: *www.sps.ch*

Progress in Physics (30)

New heavy boson discovered by the LHC experiments

Martin Pohl, Uni Genève

On July 4th 2012, shortly before a detailed presentation at the biannual International Conference on High Energy Physics, ICHEP 2012, the two LHC experiments ATLAS [1] and CMS [2] jointly announced the discovery of a new particle, compatible with being the long-sought Higgs boson [3]. By interaction with this ubiquitous particle, quarks and leptons as well as the weak force carriers (the W and Z vector bosons) are prevented to move with the speed of light, as they otherwise would. Mass is thus not an intrinsic property, like electric charge, but a dynamical property of particles. This mechanism, proposed by Peter Higgs (Figure 1) and others a long time ago, reconciles gauge symmetry, the basis of the Standard Model of electroweak and strong interactions, and massive particles. It thus explains, why the Standard Model is indeed renormalizable [4] and able to make the high precision predictions confirmed by equally high precision experiments for decades.

Figure 1: Peter Higgs (right) attending the CERN seminar on July 4th 2012. © CERN

Prior to this discovery, it had been know from experiments at the Large Electron Positron collider LEP that the Higgs mass would be beyond, but not much beyond the experimental limit of 114.4 GeV at 95% confidence level [5]. Precision measurements of electroweak parameters limited its mass from above at 152 GeV [6]. Experiments at the Tevatron proton-antiproton collider of the Fermi National Laboratory had in vain tried to find a signal [7], excluding only a narrow mass range between 162 and 166 GeV. This left the LHC experiments to search in a mass range, where many decay channels can contribute, including at the per mill level the decay into two photons.

The two experiments conducted a dedicated search for the characteristic decay processes of the Higgs boson, mostly using the data collected in 2011 and 2012. "*The search is more advanced today than we imagined possible*," said ATLAS spokesperson Fabiola Gianotti. "*We observe in our data clear signs of a new particle, at the level of 5 sigma, in the mass region around 126 GeV. The outstanding performance of the LHC and ATLAS and the huge effort of many people have brought us to this exciting stage.*" Swiss groups from ETHZ and PSI participate in CMS, researchers from Bern and Geneva collaborate on the ATLAS project.

Since this announcement, both collaborations have refined their results and published them, in two detailed papers [8] simultaneously submitted to Physics Letters B on July 31, 2012. The results are based on a total of about 10 fb^{-1} integrated luminosity, collected by each experiment at 7 and 8 TeV center-of-mass energy during the last two years. Each experiment observes a signal for the new particle with a local significance between 5 and 5.9 standard deviations, corresponding to a probability for a background fluctuation of a few parts per billion. As expected, the most significant signals are observed among candidates for the Higgs decay into two photons (Figure 2) or two Z bosons (Figure 3), which present the best mass resolution. A clear bump is seen in the invariant mass distribution of two photons between 120 and 130 GeV (Figure 4). The mass of the new particle is found to be 126.0±0.4±0.4 GeV by ATLAS, 125.3±0.4±0.5GeV by CMS, where the first error is statistical, the second systematic. The observation of the decay into two photons proves that the new particle is indeed a boson with a spin different from 1. The rates observed in the different decay channels are compatible with those pre-

1 See http://www.atlas.ch

2 See http://cms.web.cern.ch/

3 F. Englert and R. Brout, *Broken symmetry and the mass of gauge vector mesons*, Phys. Rev. Lett. **13** (1964) 321; P. W. Higgs, *Broken symmetries, massless particles and gauge fields*, Phys. Lett. **12** (1964) 132; P. W. Higgs, *Broken symmetries and the masses of gauge bosons*, Phys. Rev. Lett. **13** (1964) 508; G. S. Guralnik, C. R. Hagen, and T. W. B. Kibble, *Global conservation laws and massless particles*, Phys. Rev. Lett. **13** (1964) 585; P. W. Higgs, *Spontaneous symmetry breakdown without massless bosons*, Phys. Rev. **145** (1966) 1156.; T. W. B. Kibble, *Symmetry breaking in non-Abelian gauge theories*, Phys. Rev. **155** (1967) 1554.

4 G. 't Hooft and M. Veltman, *Regularization and Renormalization of Gauge Fields*, Nucl. Phys. **B44** (1972) 189.

5 ALEPH, DELPHI, L3, OPAL Collaborations, and LEP Working Group for Standard Model Higgs Boson Searches, *Search for the standard model Higgs boson at LEP*, Phys. Lett **B 565** (2003) 61

6 ALEPH, CDF, D0, DELPHI, L3, OPAL, SLD Collaborations, the LEP Electroweak Working Group, the Tevatron Electroweak Working Group, and the SLD Electroweak and Heavy Flavor Groups, *Precision Electroweak Measurements and Constraints on the Standard Model*, CERN PH-EP-2010-095 (2010). For most up-to-date constraints, see http://lepewwg.web.cern.ch/LEPEWWG/plots/winter2012/.

7 CDF and D0 Collaborations, *Combination of Tevatron Searches for the Standard Model Higgs Boson in the W^+W^- Decay Mode*, Phys. Rev. Lett. **104** (2010) 061802, arXiv:1207.1707, arXiv:1207.6436, and FERMILAB-PUB-12-406-E.

8 The CMS Collaboration, *Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC*, arXiv:1207.7235v1. The ATLAS Collaboration, *Observation of a New Particle in the Search for the Standard Model Higgs Boson with the ATLAS Detector at the LHC*, arXiv:1207.7214v1.

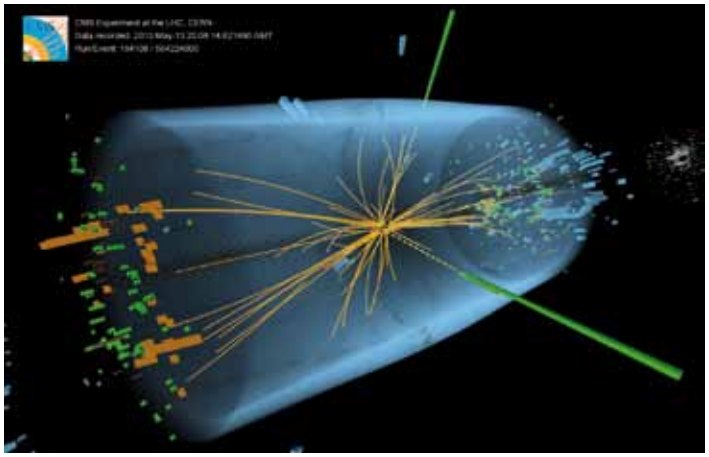


Figure 2: Candidate for a Higgs boson decay into two high energy photons (green) from the CMS experiment. © CERN

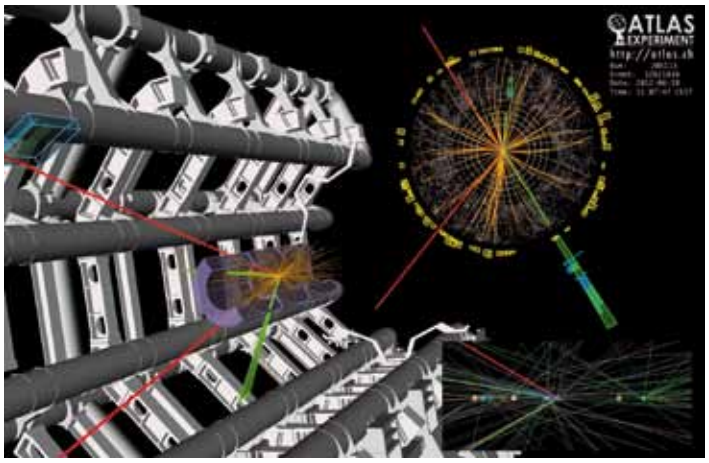


Figure 3: A candidate for Higgs boson decay into two Z bosons, one of which decays into a pair of muons (red), the other into a pair of electrons (green). © CERN

dicted by the Standard Model Higgs mechanism, within the rather limited statics available to date.

In the future, vast amounts of new data will be required to firmly establish the properties of the new boson and confirm that it is indeed responsible for dynamically generating all masses, including its own. For that, its couplings to various more rare or difficult to identify decay products like tau leptons and b quarks need to follow the predicted mass-coupling relation. One must also see if the new boson is the only one of its species or if several exist, as e.g. foreseen in supersymmetry. While supersymmetric Higgs bosons may be found at LHC if they exist, the precision study of Higgs couplings may be beyond its capabilities. This latter aspect of Higgs physics may then well require the construction of a new accelerator to firmly conclude.

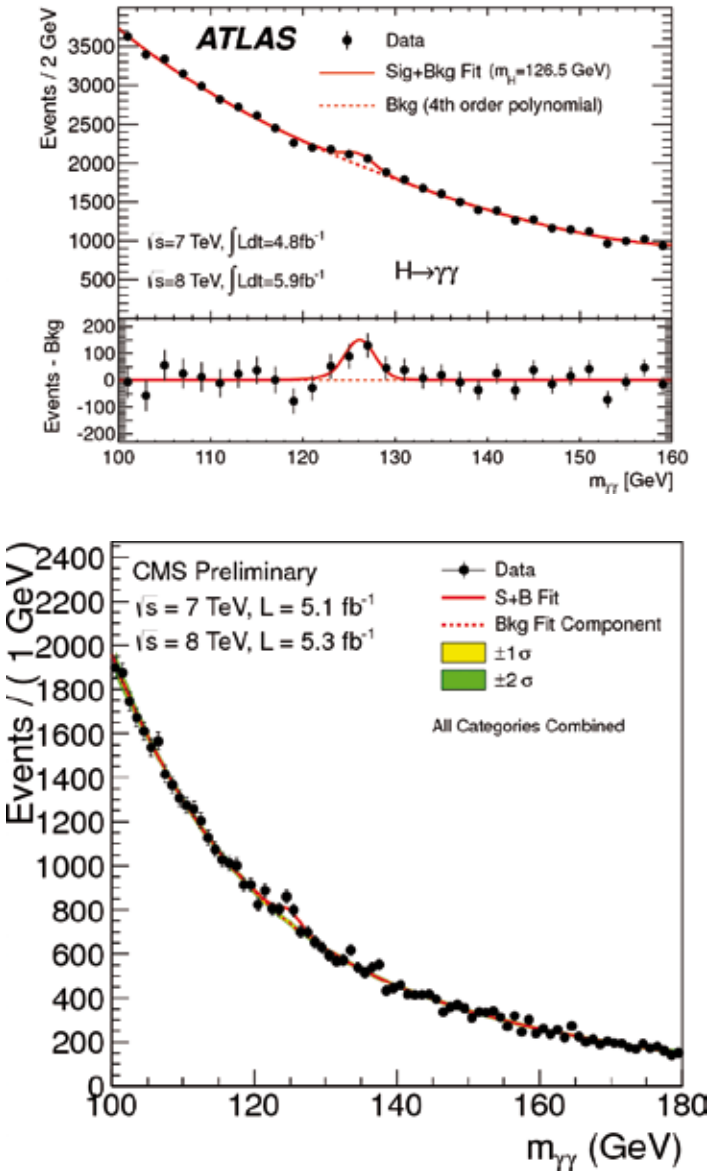


Figure 4: Two photon mass distribution for Higgs candidates from the Atlas and CMS experiments. A small but significant bump is seen on top of a smooth background distribution.

Photonics in Switzerland

In the following the scientific results of the NCCR Quantum Photonics (QP), a continuation of the earlier Swiss priority programs "Optique I/II" of the ETH-Board, are presented. While in those fore-running programs physicists from university & industry worked together on both research fundamentals & technology developments, QP focussed mainly on basic research topics due to exciting new phenomena in quantum optics. Based on the excellent QP-outputs, a NCCR follow-up program MUST, which covers the field of short laser pulse physics, was started 2010 and first reports were presented at the SPS Annual meeting 2012, see p. 6 in this issue. On the other side, an effective and efficient knowledge transfer to the established and global acting optical industry is missing. A professional transfer program like the national priority programs is needed to bridge the gap. How such a program should be structured and managed, is described in the article "Nationale Förderinitiativen zur Stärkung des Wissentransfers zwischen Hochschule und Industrie", SPS-Communications no. 36, page 21.

Bernhard Braunecker

NCCR Quantum Photonics: 20 Years of Optics Research in Switzerland

Christoph Harder and Karl Knop, member of the NCCR QP Direction Committee and the SNSF Review Panel, respectively

Swiss Optical Programs

The NCCR Quantum Photonics will finish next year after 12 years of intensive research. It was installed in 2001 by the SNSF as basic research follow-up program to the applied priority program "Optique I and II", which ran from 1993-95 and 1996-99, respectively. These first seven years of intensified support of optics research through the "Optique" initiatives created quite some momentum in Switzerland, which together with abundant money flowing in venture enterprises, had pushed the country into a leading position for modern optics by the end of last century. NCCR QP was designed to make this early success sustainable. The director of Optique II, Marc Ilegems from EPFL became the new director of NCCR QP until his retirement in 2003.

The first four year phase of NCCR QP turned out to become a most difficult time. On one hand, the applied "Optique" effort was moved over to a basic research NCCR QP programme. On the other hand, the "dot-com bubble" collapsed in 2000 and 2001 completely. Attractive industrial partners for common projects with public research either disappeared or did run out of research money. The whole program of NCCR QP went through a massive metamorphosis over its first active period. When Benôit Devenaud-Plédran took over as director, the program was with few exceptions streamlined towards high-level quantum optics research with an application horizon, which typically exceeding the duration of the NCCR QP. Despite this reorientation, management of the NCCR QP never gave up in promoting technology transfer and can be proud of a number of success stories. The well done website (*http://nccr-qp.epfl.ch/*) cites six SMEs and start-ups closely linked into the NCCR QP programme.

Remarkable Highlights

The main achievements of the NCCR QP, however, can be found in an astonishing number of outstanding basic research results, ranging from pure quantum optics to new quantum devices and advanced light sources. While the sheer number of publications matches the amount of public money, the very high number of highly cited papers is impressive. Again, it is worthwhile to consult the website for a complete review. Picking just a few examples may demonstrate the high level of research. In addition, more than 300 physicists and engineers had to opportunity to complement their education through a doctoral or post doctoral programme in world leading effort in quantum photonics.

At EPFL the group of Benôit Devenaud-Plédran with the theoretical support of Vincenzo Savonas group could demonstrate for the first time that Polaritons, which are quasi particles made up of electrons, holes and photons, exhibit so-called Bose-Einstein condensation, possibly even at room temperature. This experimental set-up offers completely new insights into the optical quantum state.

The group of Nicolas Gisin in Geneva made substantial progress in a technique called quantum-cryptography. The basic idea is to send information using single photons or pairs of photons, which are encoded in specific quantum states along the classical optical fibres network. Using a pair of entangled photons to teleport a quantum state from one location to the other inherently prevents counterfeiting. Some of these world leading results have found their way into commercial products. These results manifest also, that photonics is the ideal playground to demonstrate generic quantum physics effects; entanglement of quantum states has been so demonstrated over distances of 250 km !

NCCR QP was also effective in attracting young highly talented scientists. With Tobias Kippenberg the new field of Cavity Quantum Optomechanics was installed at EPFL. In small optical cavities with extremely high quality factors photon pressure can build up to deform the cavity. Although the mechanical amplitudes are extremely small, typically in the fm range, they may be used for interaction with mechanical devices, such as cantilevers with potential application in metrology or laser cooling of large object up to 1 kg (e.g. for gravity wave experiments).

The projects in the field of advanced light sources produced some exciting results, which may be closer to an industrial application than most results from the other areas. For instance, UV and blue laser devices based on GaN material

have been developed by Nicolas Grandjeans group at EPFL and are currently commercialized by the spin-off company Novagan. Also the work on Quantum Cascade Lasers by the group of Jerome Faist at ETHZ made continuous progress towards practical use in a variety of applications, ranging from spectroscopy, biosensorics to data communication. Finally, Ursula Keller (ETHZ) with her work on ultrafast laser pulses invented the "attoclock" with electron tunnelling on an attosecond timescale, which paves the way to applications in biology and physical chemistry.

Part of this work will be continued in the NCCR MUST (Molecular Ultrafast Science and Technology). It was launched by the SNF in 2010 and can be seen as the seamless continuation of the Swiss optics research support, as it started in 1993 with the Optique I Priority Programme.

Final Event "Photonics without Frontiers"

On 14-15 June 2012, EPFL celebrated the successful completion of the NCCR QP with a conference on "Photonics without frontiers". High-level speakers, amongst them three Nobel-laureates, addressed key topics of Quantum Photonics from the past and the present (Figure 1). Over 200 participants attended the conference, 36 posters were presented by PhDs students and post-docs and 10 startups/SMEs and industrial partners had demonstration booths. It was a very enjoyable two day event illustrating the outstanding progress in Swiss optics over the past 20 years. It is no exaggeration to say, that together with semiconductor electronics it is photonics who makes our world today.

Figure 1: Second row, front: Theodore Hänsch (Nobel-Prize 2005 "optical frequency comb technique"). First row, front: Claude Cohen-Tannoudji (Nobel-Prize 1997 "laser trap for atoms"). First row, third: Marc Ilegems (Director of Optique I and II, and first director of NCCR QP)

Critical Questions

At this point a few critical questions may be allowed. Are priority programs, characterized by a strong focus on a particular theme and generously financed by public money (SNF and hosting institutions) an efficient scheme to advance science and technology ? Does it make sense to direct R&D money for 8-12 years into one and the same field of science ? And does such a big program need a professional administration ?

Amongst the members of the SNSF Review Panel, which periodically had to evaluate the results of NCCR QP, there is a wide consensus that this form of research funding is best suited of efficiently spending money. However, there is also great risk that things get on a wrong track or one reacts too slowly if new ideas arise. The key to success is the proper management ! It is primordial to engage a director, who not only understands science but also has management experience, especially for people management. For the science part a Scientific Advisory Board may help to get the act together. In the case of NCCR QP such a board was only installed at a later state. For the classical management part (unfortunately usually not the strength of academic people) an equivalent body was missing. The challenges in managing such a big program are manifold, ranging from the motivation of young people in the most important time of their post graduate education to the psychological handling of situations if the funding of a group work could not be extended after 4 years.

Another topic which deserves some critical review is the technology and knowledge transfer. NCCR QP management undertook quite some efforts to bring applied results into products. Some encouraging results have been mentioned above. Obviously the biggest impact happens by those physicists who completed their education within the NCCR QP and joined industry or other research institutes. It is recommended to keep track of them and periodically bring them back to refresh their networking and their knowledge. However, the true highlights of the program remain those results published in high-ranking scientific journals like Physical Review.

In conclusion, the greatest impact of 20 years of focused R&D funding in Optics and Photonics is that a community of researchers at universities and in industries have been brought together in an organized way, which otherwise would have met only occasionally. This community will survive, also by the many young people who have moved from academia to industry, even when focused funding will diminish or move to higher level, e.g. European funding within Horizon 2020, where Photonics is one of the five Key Enabling Technologies.

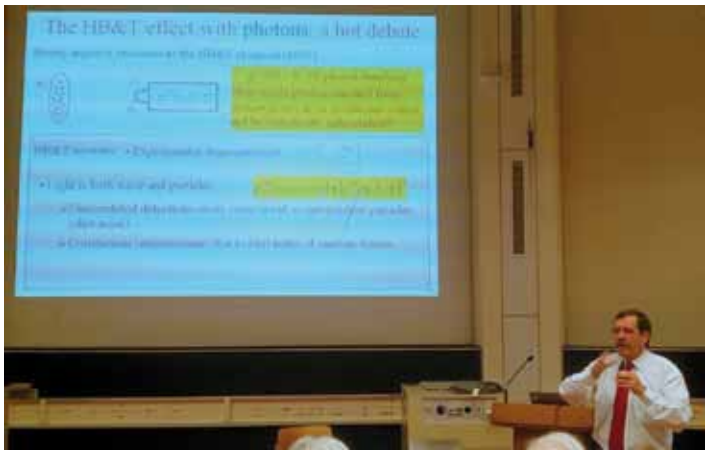


Figure 2: Alain Aspect, well known for his experimental work disproving the Bell-inequalities, discussing another hot topic in quantum optics, the Hanbury Brown and Twiss (HB&T) Effect.

Physik Anekdoten (16)

Hans Zincke-Sommer (1837–1922) / Physiker und Komponist

Bernhard Braunecker und Reinmar Wagner

Einleitung

In der Physik wie auch in anderen "exakten" Wissenschaften spielt die Intuition eine wichtige Rolle, sei es im Erahnen von Zusammenhängen, im Abschätzen von Möglichkeiten oder auch im Anzweifeln von Sachverhalten, wenn gewisse Erhaltungssätze nur mühsam erkennbar sind. Meist liegt man mit seinem guten oder unguten Bauchgefühl gar nicht so falsch. Diese Tugend erwirbt man spätestens im Physikstudium, wenn man lernt, ganzheitlich und in Analogien zu denken. Es ist daher nicht verwunderlich, dass bei mancher Physikerin und manchem Physiker auch künstlerische Tätigkeiten - und hier speziell die Musik - eine wichtige Rolle spielen. Man muss nicht unbedingt an das viel strapazierte Violinspiel Einsteins denken, aber Max Planck, Wolfgang Bothe, Max Born, Werner Heisenberg - um nur einige zu nennen -, waren anscheinend nicht nur begabte Pianisten, sondern auch kenntnisreiche Musiktheoretiker. Hingegen sind Physiker als Komponisten in der Öffentlichkeit eher selten zu finden, von Ausnahmen wie William Herschel abgesehen.

Hans Sommer (ca. 1890)

Das bringt uns zum Mathematiker/Physiker Hans Zincke-Sommer aus dem 19/20. Jahrhundert, der als Komponist ein umfangreiches Oeuvre nach seiner aktiven Zeit als Wissenschaftler geschaffen hat. Reinmar Wagner, Redakteur der in Zürich erscheinenden Zeitschrift "Musik & Theater", wird uns anhand einer neu erschienenen CD das weitgehend unbekannte kompositorische Werk von Hans Sommer schildern. Parallel dazu wollen wir auf Sommers wissenschaftliche Tätigkeit kurz eingehen. Mehr Information findet man auf der Internetseite des "Vereins zur Förderung der Forschung am Hans-Sommer-Archiv, Berlin e.V." (*http://www.hans-sommer.de/kontakt.html*).

Die Entdeckung eines Liedkomponisten

"Die Lieder sind freilich sehr dramatisch gehalten, aber mit Verstand und Geschmack. Fahren Sie nur so fort!" So aufmunternd antwortete Franz Liszt einem hoffnungsvollen Komponisten, der ihm seine ersten Werke zur Begutachtung geschickt hatte. Sein Name: Hans Sommer, geboren 1837. Sein Alter zu diesem Zeitpunkt: 47. Also kein Jungtalent mehr, sondern ein gestandener Mann mit einer untypischen Biographie: Als Stiefsohn des Optik-Herstellers Voigtländer studierte er Physik und Mathematik, forschte und lehrte in Braunschweig und liess sich - für jene Zeit fast undenkbar - frühpensionieren. Denn sein Herz hatte schon immer für die Musik geschlagen, und mit 47 machte er ernst mit diesem Wunsch.

Schon im Alter von zehn Jahren hatte Hans Sommer erste Kompositionsversuche unternommen, wiederholt nahm er Unterricht, etwa beim Musikwissenschaftler Adolf Bernhard Marx, beim Schumann-Freund Julius Otto Grimm oder beim Braunschweiger Hofmusiker Wilhelm Meves. Die wohlwollende Antwort Liszts war der Eintrittsbrief in die Meisterklasse des in Weimar lehrenden Komponisten.

Liszts Ermunterung bezog sich auf Sommers Opus 6, "Sapphos Gesänge" auf einen Text der rumänischen Königin Elisabeth zur Wied (unter dem Pseudonym Carmen Sylva publiziert). Auf Anraten Liszts unternahm Sommer im selben Jahr 1884 eine Orchesterbearbeitung der bis dahin vom Klavier begleiteten Lieder. Diese Fassung hat es nun auf eine CD (siehe Abbildung) geschafft. Und man staunt einfach nur beim Hören: Diese Orchesterlieder stehen auf der Höhe eines Hugo Wolf, gehen diesem aber Jahre voraus. Noch eine Stufe gelungener sind die späten Goethe-Lieder, die Hans Sommer in den Jahren 1919-1921 schrieb. Man höre sich nur seine wunderschöne Version von "An den Mond" oder das innig-warme "Mailied" an: Das ist sowohl in der Führung der Singstimme wie im Einfallsreichtum der orchestralen Umspielungen auf dem Niveau von Richard Strauss.

Diese Entdeckung eines bisher weitgehend unbekannten Liedkomponisten verdanken wir drei engagierten Interpreten: Der aufstrebenden österreichischen Mezzosopranistin Elisabeth Kulmann, die schon mit einigen intelligenten Lieder-CDs aufgefallen ist, dem gestandenen Bariton-Routinier Bo Skovhus und dem opernerfahrenen Dirigenten Sebastian Weigle an der Spitze der Bamberger Symphoniker. (Erschienen 2012 beim Label Tudor. Nr. 7178).

Im Umkreis von Wagner, Liszt und Strauss

Das kompositorische Oeuvre von Hans Sommer umfasst neben zahlreichen Liedern nicht weniger als zehn Opern. Instrumentalmusik dagegen findet sich kaum: Bloss zwei Klaviertrios und ein Klavierquartett sind als gewichtige Werke überliefert. In seinen Liedern zeigt sich Sommer zuerst von Schumann und Loewe, dann von Wagner beeinflusst. Bemerkenswert sind seine Bestrebungen, die Tradition Schuberts und Schumanns mit der deklamatorisch-dramatischen Textbehandlung und der harmonisch kühnen Musiksprache Wagners zu verbinden. Ab Mitte der 1880er Jahre war Hans Sommer als Liedkomponist sehr erfolgreich, zum Beispiel verkauften sich seine Editionen über 17'000 Mal und wurden oft im Konzert aufgeführt. Sommers Biograf Erich Valentin verortete ihn 1939 "zeitlich unmittelbar vor Hugo Wolf". Und schrieb weiter: "in ihm berühren sich - man möchte fast sagen: zum ersten und einzigen Male - die Linien, die von Schumann und Liszt ausgehen".

Bedeutsam war Hans Sommer auch für die Entwicklung des orchesterbegleiteten Lieds. Angeregt von seinem Mentor Liszt orchestrierte er "Sapphos Gesänge" 1884 und nahm damit die Blüte der Gattung ab den 1890er Jahren, mit wichtigen Werken von Strauss, Mahler, Reger oder Schönberg voraus. Seine zunehmend raffinierteren Fähigkeiten in der Instrumentierung, gipfelnd in den 1920/21 entstandenen Goethe-Liedern, zeigen Sommer als versierten Kollegen von Richard Strauss, mit dem er sich im Sommer 1889 angefreundet hatte.

Bereits 1865 wurde Sommers erste Oper "Der Nachtwächter" in Braunschweig erfolgreich aufgeführt. Weitere neun Opern entstanden sukzessive, oft mit historisierenden komischen Sujets oder im Zug der romantischen Märchen-Opern wie die wagnerianisch angehauchten "Loreley". Wiederum am Puls musikalischer Entwicklungen finden wir Hans Sommer in seiner Konversationsoper "Saint Foix" von 1892/93 (uraufgeführt im Jahr darauf in München), einer Subgattung in der sich vor allem Eugen d'Albert in jener Zeit einen Namen machte. Die Figuren des Stückes führen auf durchkomponierter symphonischer Grundlage eine lebhafte Konversation mit allen Feinheiten der Rede. Auf Verständlichkeit des gesungenen Wortes ist grosse Sorgfalt verwendet; die Instrumentierung ist ohne signifikante Verringerung des um 1890 üblichen Orchesterapparats entsprechend durchsichtig gehalten. Hans von Wolzogens Libretto führt in die Zeit Louis' XIV. und spiegelt die typische Verwechslungskomödie des 18. Jahrhunderts. Sommer hatte sich bei Stoffwahl und Vertonung an eigenen gattungsgeschichtlichen Forschungen orientiert und Verdis bezüglich der Textbehandlung vergleichbaren "Falstaff" erst nach Drucklegung des eigenen Werkes (1893) durch eine Weimarer Aufführung im März 1894 kennen gelernt.

Als 1875 Richard und Cosima Wagner Braunschweig besuchten, stand Hans Sommer an der Spitze der Empfangs-Delegation. Kurz darauf gründete er den Braunschweiger Patronat-Verein (Richard-Wagner-Verein) und initiierte mit Schauspielern des Braunschweiger Hoftheaters die literarische Erstaufführung von Wagners "Parsifal"-Dichtung (April 1882). Er blieb vor allem Cosima Wagner freundschaftlich verbunden (so schrieb sie in ihren Briefen an Strauss später gelegentlich von "unserem Freund Sommer"). Dennoch pflegte er eine gesunde Distanz zum Bayreuther Kreis der Wagner-Jünger.

Schon in den Jahren davor gingen wichtige Impulse für das lokale Musikleben von Hans Sommer aus: 1863 gründete er den "Verein für Konzertmusik", 1865 führte er Händels "Samson" nach der Originalpartitur auf. Wegweisend war auch seine Schrift "Die Werthschätzung der Musik" von 1898, die mit ein Anstoss war zur Gründung der "Genossenschaft Deutscher Komponisten" einer Vorläufer-Organisation der heutigen Verwertungsgesellschaft GEMA (analog zur schweizerischen SUISA).

Wegbereiter der modernen Optikindustrie

Hans Sommer studierte in Göttingen bei R. Dedekind und P. Dirichlet Mathematik und bei W. Weber Physik und wurde 1866 im Alter von 29 Jahren Professor für Mathematik am 1745 gegründeten Braunschweiger Polytechnikum "Collegium Carolinum", das er in seiner Funktion als Rektor von 1878-1881 in die "Herzogliche Technische Hochschule Carolo-Wilhelmina" überführte, die heutige Technische Universität. Seine Forschungsinteressen galten der angewandten Optik und hier der Berechnung von Linsensystemen. Damit gewann er grossen Einfluss auf die von seinem Stiefvater Friedrich Voigtländer geführten optischen Werke "Voigtländer & Sohn" in Braunschweig, die bereits damals zu den weltweit renommiertesten Fotokameraproduzenten gehörten. Sommer und Voigtländer, Theoretiker und Praktiker, bildeten ein ähnlich erfolgreiches Paar der Gründerjahre wie Ernst Abbe und Carl Zeiss in Jena, wobei in ihrem Falle die Erfolgsgeschichte in Wien begann.

Dort lehrte ab 1820 an der Universität Andreas Freiherr von Ettingshausen (1796 - 1878), Professor der Mathematik und Physik, der sich ab 1840 auch mit der gerade aufgekommenen photographischen Bildaufzeichnung, der Daguerreotypie befasste, die er 1839 bei ihrer erstmaligen Vorstellung in Paris kennengelernt hatte. Da damals die Objektive von einer Optikwerkstatt meist durch Probieren aus vorhandenen Linsen zusammengebaut wurden, war ihre Abbildungsqualität entsprechend ungenügend und zwang zu starker Abblendung. Da auch die Photoplatten noch sehr lichtunempfindlich waren, benötigte man für Porträtaufnahmen 20-30 Minuten Belichtungszeit. Ettingshausen ermunterte deshalb 1840 seinen Kollegen Josef Max Petzval, ebenfalls Professor für Mathematik an der Universität Wien, ein lichtstärkeres Objektiv zu entwickeln. Petzval berechnete als erster die Form der Linsen und deren Aufbau zum Objektiv auf der Grundlage der optischen Gesetze, was als Durchbruch des Einsatzes der Mathematik in der Physik gesehen wird. Noch im selben Jahr präsentierte er ein Objektiv mit F-Zahl 3.5, das 16x lichtstärker war als die

bis anhin verwendeten Objektive und das somit Porträtaufnahmen unter einer Minute ermöglichen sollte. Als Hilfe für die mühseligen Strahldurchrechnungen mit Sinus- und Logarithmentabellen bekam er eine Gruppe von Artilleriemathematikern zugeteilt.

Der industrielle Durchbruch gelang, als Petzval den ebenfalls in Wien ansässigen, einer seit 1756 aktiven Optikerfamilie entstammenden Peter Wilhelm Friedrich Voigtländer (1812 - 1878) beauftragte, diese neuen Optiken zu bauen. Das erforderte neue Arbeitsprozesse in der Glas- und Metallbearbeitung, da Voigtländer zusätzlich zum Objektiv auch ein neuartiges Kameragehäuse aus Vollmetall konstruierte. Zusammen mit der gesteigerten Abbildungsleistung, der höheren mechanischen Robustheit sowie der deutlich verbesserten Handhabung war der kommerzielle Erfolg eingeleitet, aber auch der unschöne Streit mit Petzval, der Urheberrechtsverletzungen sah. Anscheinend war die Situation so ausser Kontrolle geraten, dass Voigtländer 1862, vermutlich im Benehmen mit seinem Stiefsohn Sommer, die Fabrikation nach Braunschweig verlagerte, wo er bereits 1868 das 10'000ste Foto-Objektiv ausliefern konnte.
Hans Sommer als Chefoptiker verbesserte für Voigtländer nicht nur alle Objektive für Fotokameras und Ferngläser, sondern berechnete und konstruierte auch die besonders lichtstarke Objektivserie "Euryscop". Eine Firmenchronik von 1916 beschrieb das etwa von 1877 an produzierte "Euryscop" (Abbildung) "welches vielleicht noch mehr als das erste Voigtländer-Petzval-Objektiv [Voigtländers] Ruhm in alle Weltteile trug und durch viele Jahre hindurch ‘das’ Objektiv für alle Fach- und Amateurphotographen war." Die Firma Voigtländer wurde 1925 in eine Aktiengesellschaft umgewandelt, 1929 von Schering, 1958 von Zeiss, 1982 von Rollei und 1997 von Ringfoto übernommen.

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Euryscop, Privatbesitz www.horst-reimer.de

Reinmar Wagner studierte Musikwissenschaft, Geschichte und Kunstgeschichte an der Universität Zürich. Seit 1994 ist er Redaktor bei der Schweizer Kulturzeitschrift "Musik & Theater". Zudem arbeitet er als Musikjournalist für diverse Medien im In- und Ausland, unter anderem häufig für "Die Südostschweiz". Gelegentlich veröffentlicht er Beiträge in musikwissenschaftlichen Publikationen und Programmheften, die er manchmal auch redaktionell betreut.

Physik und Gesellschaft

Die heutige stabile ökonomische Situation der Schweiz basiert auf den Pionierleistungen, die Ingenieure und Naturwissenschaftler in den letzten Jahrzehnten erbracht haben. Das gelang aber nur, weil in der Schweiz ein durchgängiges Bildungssystem mit vielen Zugangsmöglichkeiten, aber strengen Qualitätsmassstäben praktiziert wird. Dabei spielt die Physik eine wichtige Rolle, wenn es gilt, erlerntes Basiswissen auch über Fachgrenzen hinweg in Anwendungen einzubringen. Nun zeigt sich aber in der Schweiz wie auch in anderen westlichen Ländern die Gefahr einer schleichenden Desindustrialisierung, auf die BR Schneider-Ammann im März 2012 warnend verwiesen hat und die im folgenden Artikel vom bekannten Sozialwissenschaftler und Publizisten Beat Kappeler genauer analysiert wird. Es gilt dem Industriestandort Schweiz wieder vermehrt Aufmerksamkeit zu schenken, auf die Stärken moderner Produktionsmethoden zu setzen und nicht nur das Feld asiatischen Massenproduzenten zu überlassen. Das erfordert, dass dem Ingenieurwesen, den Naturwissenschaften und letztlich der Physik wieder die Pionierrolle zugewiesen wird, die sie in der Vergangenheit hatten und die zur heutigen Prosperität führte.

Bernhard Braunecker

Wie die Schweiz eine Industrienation bleiben kann

Beat Kappeler

Frankreich ist desindustrialisiert, in der Schweiz laufen Güterexporte und Güterproduktion reibungslos. Wie in einem Laborversuch zeigen sich an diesen Ländern die Optionen, welche zerstören oder gestalten, nämlich die Wahl zwischen freiem oder geknebeltem Arbeitsmarkt, zwischen hoher Maturaquote oder dualer Lehre, sowie zwischen Schmusefächern oder Naturwissenschaften und Mathematik. Und leider ist nichts auf Dauer geschenkt, in der Schweiz drohen die gleichen falschen Weichenstellungen.

Vorderhand aber betreibt die Schweiz noch Industrie, während Frankreich sie vertreibt. Tausende von Entlassungen stehen in der französischen Autoindustrie an, ebenso Tausende in der Kommunikationswelt. Der Präsident und sein Industrieminister aber akzeptierten die Reduktionspläne nicht, die Arbeitsgerichte werden, wie schon oft, drei, vier Jahre später enorme Bussen und Lohnnachzahlungen verhängen. Was soll nun eine multinationale Firma, was soll ein französischer Unternehmer machen, falls sie vom französischen Absatzmarkt her expandieren könnten? Sie werden im Ausland investieren und nach Frankreich liefern, und "la désindustrialisation" geht weiter, das Handelsbilanzdefizit klafft tiefer, die Arbeitslosenzahlen steigen an. Und der sozialistische Bürgermeister des bisherigen Peugeot-Standorts wird weiterhin gegen "le grand capital" wettern.

Damit schälen sich die arbeitsmarktlichen Bedingungen für eine gelungene oder verhinderte Industrialisierung heraus. Die Palastarchitektur der Industrialisierung der 60er Jahre hat sich längst aufgelöst, die Firmen machen nicht mehr alles selbst und unter dem gleichen Dach. Sie automatisieren die eigentlichen Produktionstakte vollauf und beziehen alles andere von anderswoher: Teile, Halbfabrikate, aber auch Forschung, Prozesstechnik, Zulieferung und Verteillogistik. Ausgegliedert sind auch die Immobilien, die Hausdruckerei, die Mensa, die Putzequipen, die Kommunikation, die Finanzierung. In den lateinischen Ländern Europas führte dies zum ganz kurzsichtigen Aufschrei der Politiker und Gewerkschafter. Denn am eigentlichen Produktionspunkt verschwand tatsächlich die Arbeit, sie war wegrationalisiert, vollautomatisiert. Doch überall in der vor- und nachgelagerten Stufe tauchten die Tätigkeiten wieder auf, als Dienste, aber hochqualifiziert, rationell, diversifiziert nach Kunden und Geographie. Dies aber wurde übersehen, oder eben als Desindustrialisierung verschrieen. Politiker und Gewerkschafter interpretierten die Fokussierung, die neuen Takte, die weltweiten Wertschöpfungsketten als unternehmerische Schikane. Sie verharrten im Nullsummen-Denken, wonach alles, was der Firma nützt, dem Arbeiter schadet. Deshalb verweigerten sie Flexibilität, Überzeit, Auslagerungen, Kündigungen. Deshalb sind die Arbeitsmärkte Südeuropas heute total verriegelt, verrechtlicht, deshalb stellt niemand mehr fest ein, sondern nur befristet, wenn überhaupt. Deshalb hat sich die Arbeitslosigkeit trotz "Umverteilen der Arbeit" mit massiven Arbeitszeitsenkungen und totalem Kündigungsschutz seither verdoppelt und verdreifacht.

Die Industrie selbst bearbeitet die Materie künftig spektakulär anders. Informatik, Gentechnik und Nanotechnik kehren das Kleinste heraus, die Grossindustrie der Hochöfen wich Verarbeitungen in Laboratorien und mit feinmechanischen Automaten in der Grösse von Kaffeemaschinen. Auch diese Durchbrüche und diese Durchführungen erscheinen oft als "Dienste".

Doch was heute in der Schweiz als "Dienstleistungen" in der Statistik steht, ist immer noch Industrie, nur neu etiquettiert, und reicher, qualifizierter, arbeitsfreundlicher. Vollbeschäftigung herrscht, die Handelsbilanz quillt über.

Dieser pulsierende Arbeitsmarkt braucht allerdings auch die richtigen Leute. Heute beklagen Ausbildungsstätten, von der ETH bis zu Gymnasien, und natürlich die nachfragenden Industrien selbst den Mangel an naturwissenschaftlichen Berufungen. Ein grosser Teil der Forscher des Landes sind aus dem Ausland zugezogen, viele Ingenieure und Kader der Industriefirmen ebenfalls. Es fehlt aber nicht dort, wo die meisten meinen, beim Entscheid der Studienkandidaten mit 20 oder mehr Jahren. Sondern in den drei letzten Jahren der Volksschule entgleiste vor Jahren schon die Naturwissenschaft. Denn Chemie, Biologie, Physik wurden mit Geschichte, Geographie zusammen gelegt im Schmusefach "Natur-Mensch-Mitwelt" und ähnlichen schummrigen Be-

griffen. In diesem Fach fehlen Methoden, fehlen Vorbilder, fehlen Berufsbilder. Unterdessen sind wohl schon die meisten Lehrer ihrerseits durch diese unspezifische Allerweltsausbildung gegangen. Es braucht daher einen gewaltigen Ruck in der Lehrplanerneuerung, in der Lehrerbildung. Die Schüler müssen wieder in spezielle Zimmer der Biologie, Chemie, Physik geführt werden, sie müssen dort merken, dass Naturwissenschaft nicht beliebig aus Sammelthemen wie "Wasser", "Stadt", "Indianer", "Wald", "Holz" gelernt werden kann. Die naturwissenschaftliche Berufung ergibt sich nicht mit 20 oder 25 Jahren, sondern schon zum Ende der Volksschule. Der Berufsentscheid dannzumal weist die Schüler ins naturwissenschaftliche Gymnasium ein, in eine produktionsorientierte Lehre, später in die Fachhochschule. Das zweite, in den meisten Deutschschweizer Kantonen problematische Schwelle liegt in den Übertrittskriterien. Um in die Sekundarschulde zu kommen, um ins Gymnasium zu gelangen, muss man meist zwei gute sprachliche Noten haben – deutsch und französisch – und nur eine Note in Mathematik. Das Schulsystem sortiert gezielt die mathematischen Begabungen weg !

Sorge muss das Land also tragen für gymnasiale und für berufliche Lehrgänge. Heute entscheiden sich eine Mehrheit der Jungen für eine Lehre, und lernen dank der Berufsschule mindestens soviel abstraktes Wissen wie anderswo in den Allerweltsmittelschulen, in welche alle hineinbefördert werden, wie in Frankreich. Dafür sind unsere Jungen mit 20 schon arbeitsmarktfähig. Die duale Lehre ist eine Trumpfkarte, welche die Schweiz noch hat und welche sie verstärken, nicht schwächen muss.

Die unterschiedlich ergriffenen Optionen Frankreichs und der Schweiz liessen sich perfekt verfolgen auf der Seite des "Le Monde" Mitte Juli 2012, welche über die 10'000 Entlassungen bei Peugeot berichtete. Oben, und grösser aufgemacht, triumphierte die Zeitung über die 85% des Schülerjahrgangs, welche jetzt ein "baccaleuréat" machen – eine Vorgabe der Präsidentschaft Mitterrands, die jetzt erreicht sei. Dass das Eine mit dem Anderen in einem gewissen Zusammenhang stehen könnte, die Desindustrialisierung mit der oberflächlichen Akademisierung, wurde nicht erkannt. Die gegenwärtige Krise fehlender Wettbewerbsfähigkeit Südeuropas und Frankreichs zeigt der Schweiz die Optionen und deren Folgen. Falsche Optionen können, wie Südeuropa zeigt, nur mit destabilisierenden sozialen Konvulsionen korrigiert werden, wenn überhaupt. Die Schweiz aber ist und bleibt ein Industriestaat.

Beat Kappeler ist Kommentator für Volkswirtschaft bei der NZZ am Sonntag, und Referent SKU Advanced Management Program.
Seine neueste Publikation: "*Wie die Schweizer Wirtschaft tickt. Die letzten 50 Jahre und die nächsten...*", (NZZ-Verlag, und elektronisch bei Kindle, Apple), ist eine sehr persönliche Sicht, wie das "Modell Schweiz" entstand und wie zukunftsfähig es ist.

continuation from page 7

Teachers Afternoon

With nearly thirty participants the traditional teachers afternoon was a success. The goal of the session was to bring together all Swiss players who develop didactic material in the field of nanoscience together with representatives from high schools. Gymnasium teachers, representatives from universities and universities of applied sciences as well as future teachers got a general overview on the didactic possibilities to integrate nanoscience topics into a traditional physics curriculum at high school level. A large variety of offers has been presented. The offers ranged from downloadable lecture material over lab work packages to invitations to visit Switzerland's most prestigious research institutions. The intense discussions that followed the presentations showed that the interchange between high schools and research institutions has become more and more important during the last decade. Due to the enormous increase of the mediatization of science and research, the demand for ready-to-use didactic material covering recent findings is growing rapidly. For the next years, we will try to meet this demand again through topical sessions covering the integration of actual science into the science curricula of Swiss high schools.

Tibor Gyalog, Uni Basel

Vom Labor ins Warenregal

Marketing und Vertrieb von Innovationen sind der Themenschwerpunkt der 37. DPG-Arbeitstagung "Forschung - Entwicklung - Innovation".

Susanne Friebel, Arbeitskreis Industrie und Wirtschaft (AIW) der DPG

Marketing und Vertrieb spielen auch für Forscher und Entwickler eine wichtige Rolle: "Innovation ist, wenn der Markt 'Hurra' schreit": So hat Thomas Müller-Kirschbaum, Physiker und CTO von Henkel, kürzlich Innovation definiert. Doch wie wird eine Innovation angestoßen? Wer ist eigentlich der Kunde des Entwicklers? Woher kommt das Geld für F&E? Muss ich als Entwickler die Bedürfnisse des Kunden verstehen? Wenn ja, wie mache ich das? Diese und weitere Fragen stehen im Mittelpunkt der DPG-Arbeitstagung "Forschung - Entwicklung - Innovation" (FEI), die mit dem Themenschwerpunkt "Marketing und Vertrieb für Innovationen" vom 4. bis 6. November im Physikzentrum in Bad Honnef stattfinden wird [1].

Über 50 Prozent der Physikerinnen und Physiker arbeiten in den Bereichen F&E und Innovation, die meisten davon unter den Randbedingungen der realen Industrie-Welt. Mit Marketing und Vertrieb haben sie oft wenig zu tun, doch sie sollten wissen, was mit ihren Produktideen passiert, wie sie zu Produkten im Warenkorb der Kunden und damit zu Umsatz und Gewinn des Unternehmens werden.

Viele Innovationen scheitern, und zwar selten an den technischen Umsetzungen, sondern eher an anderen Problemen. Eine naheliegende Herausforderung besteht darin, ideelle und finanzielle Unterstützung durch interne wie externe Stakeholder sicherzustellen. Hier steht man oft den gängigen Problemen gegenüber wie Kannibalisierungsangst, "not-invented here"-Syndrom, allgemeiner Angst vor einem Wandel oder anderen aktiven wie passiven Widerständen. Um das "Silo-Denken" zu durchbrechen und Entwicklern zu ermöglichen, die anderen Parteien zu verstehen, ist eine passende Kommunikation für das Marketing der eigenen Ideen notwendig.

Die Tagung FEI setzt daher in diesem Jahr einen Fokus auf Marketing und Vertrieb. Dabei wird der Bogen vom Marketing der eigenen Ideen und der Analyse des Markts über Marketing- und Vertriebsstrategien bis hin zum konkreten Verkauf der Produkte gespannt. Verantwortliche aus Industrie und Wirtschaft geben Einblick in Innovationsprozesse und -methoden in ihren Unternehmen und vermitteln aktuelle Erkenntnisse und Methoden. Sie zeigen auf, welche Herausforderungen und welche Potenziale in der gemeinsamen Arbeit von Forschung, Entwicklung, Marketing und Vertrieb von Innovationen stecken. Praktische Fallstudien zum Thema runden die Veranstaltung ab. Als Keynote Speaker hat Michael Kaschke, Vorstandsvorsitzender von Zeiss, zugesagt.

Die Tagung FEI, die 1975 unter dem Titel „Forschungsmanagement“ ins Leben gerufen, bietet mit einem maßgeschneiderten Programm von Physikern für Physiker interessante und praxisnahe Einblicke in Innovationsmanagement in Industrie und Wirtschaft sowie ein Forum für den "interdisziplinären" Erfahrungsaustausch. Eine wachsende Zahl von bislang über 300 begeisterten Teilnehmern aus Deutschland, Österreich und der Schweiz schätzt insbesondere die offenen Diskussionen mit hochkarätigen Referenten, den Austausch mit Fachkollegen und nicht zuletzt das Erlebnis der Community der Physiker in der familiären Atmosphäre des Physikzentrums. Dieses spezifische Umfeld ermöglicht authentische Berichte über Erkenntnisse und Erfahrungen abseits von glatt geschliffenen Firmenpräsentationen, Diskussionen in einer Offenheit, wie sie auf Tagungen kommerzieller Anbieter nicht zu finden ist, sowie einen Austausch über wirtschaftliche Themen auf einer Ebene – geprägt durch die Denkweise des gemeinsamen Physikstudiums -, der in dieser Form einmalig ist. Dies bestätigt z. B. Valentin Kahl, Geschäftsführer der ibidi GmbH, der bereits mehrfach teilgenommen hat: "Die Tagung bietet mir ein einmaliges Forum für den Austausch unter Kollegen. Hier konnte ich in familiärer Atmosphäre bereits wertvolle Kontakte knüpfen." Ähnlich äußert sich Josef Römer von Varian: "Die Referenten waren durchweg erstklassig und einem offenen Austausch sehr zugänglich. Ich habe viel mitgenommen".

Physik in der Industrie

Seit 2005 hat auch die SPG eine Sektion "Physik in der Industrie", welche sich als Brücke zwischen akademischer und industrieller Forschung versteht. Da die Mehrheit der Physiker in der Industrie arbeitet und Forschungsergebnisse heutzutage schnell auf industrielle Anwendungen übertragen werden, soll und wird die Rolle der SPG nicht auf akademische Forschung beschränkt.
In den letzen Jahren haben wir eine Reihe von Anlässen organisiert, welche speziell auf Karrieremöglichkeiten für Physiker ausgerichtet waren und den Kontakt von jungen Physikern mit den Forschern ermöglichten. Die SPG bietet ebenso die Möglichkeit, Physiker aus verschiedenen Industriegebieten außerhalb der traditionellen Forschungsnetzwerke zu verbinden.
Wenn Sie mehr über zukünftige Anlässe erfahren möchten, oder sogar aktiv in der Sektion "Physik in der Industrie" mitwirken möchten, wenden Sie sich bitte an Kai Hencken,(*kai.hencken@ch.abb.com*).

1 Die Anmeldung ist bereits möglich unter *www.dpg-physik.de/dpg/pbh/aktuelles/FM.html*

History of Physics (5)

Albert Gockel: from atmospheric electricity to cosmic radiation

Jan Lacki, Uni Genève

The year 2012 marks the hundredth anniversary of the discovery of cosmic rays by the Austrian Victor Franz Hess. It gives the physics community the opportunity to look back at a century of scientific investigations in a field that offered physics some of its most exciting discoveries, making early research in particle physics possible and offering today a way to extend it beyond energies achievable in our accelerators.

As it happened often in the history of discoveries, that of cosmic rays came as a surprise, uncovering a new realm of physical phenomena way beyond what was initially imagined. It was nonetheless the outcome of a sustained effort following a clear rationale. It originated in the field of atmospheric electricity pioneered mainly by Austrian and German investigators at the turn of the 19th century. It was known since at least the observations of Charles Augustin Coulomb (1736-1806) that charged electroscopes loose spontaneously their charge (1785) but the phenomenon went under close scrutiny only a century later. At Vienna University, Franz Exner (1849-1926) established from the middle of the eighties on a successful tradition of research in *Luftelektrizität* while in Germany the fundamental achievements and insights of the remarkable tandem formed by the Gymnasium teachers Julius Elster (1854-1920) and Hans Geitel (1855-1923) inspired the work of many local and foreign researchers [1].

At the beginning of the 20th century, the community of investigators in atmospheric electricity included scholars from most (Western) Europe countries and even beyond (Canada). One of the most noteworthy was Albert Gockel (1860-1927) from Freiburg (CH) University [2]. The *SPS-Communications* featured recently a paper on the initial years of the Freiburg Institute of Physics and in particular the opposition of scientific styles between the Institute long-term director Joseph de Kowalski and his assistant and then colleague Gockel [3]. Here, I want to take a closer look at Gockel's lifelong interest in atmospheric electricity phenomena, and in particular at his substantial contribution to the discovery of cosmic radiation.

In order to understand Gockel's achievements one has first to recall what were at the time the research trends and the main issues in the field of atmospheric electricity. After Elster and Geitel concluded that the spontaneous discharge of electrometers was due to the presence of ions in the atmosphere (1900) came the question of the their origin. The recent discovery of radioactivity (1896) and of its ionizing properties on gases led Elster and Geitel to investigate its presence in the air (1901-1902): the radioactive gaseous emanations corresponding to decay products of active minerals they detected made them conclude that it was indeed the primary cause of the conductibility of air. It was the time when one investigated the natural radioactivity of soils, rocks and air: its effects were examined underground, at ground level and in mountain heights, in land and in seas. While one learned more and more about the radioactive substances and their decay products, hypotheses on the location of the sources responsible for atmospheric ionization were getting more precise. When it turned out that the radioactive decay products of the emanations (Radium A, Thorium A and Actinium A) in the atmosphere could hardly account alone for its total ionization, the direct outgoing radiation from the active substances in the Earth crust came to be considered as the next candidate. Contemporary experiments conducted by Canadian teams on ionization of air in sealed vessels showed on the other hand that, in spite of shielding, the enclosed air was still ionized by a very penetrating radiation different from the radiation originating from the vessels walls or nearby artificial or natural formations (1903). For some time it was commonly accepted that the ionizing radiation from substances in the Earth's crust could explain it all. At the very end of the first decade it was realized however that this radiation, given its decreasing strength with distance, could not account for the ionization of the atmosphere at least in its higher layers. After a series of investigations in situations where the effects of the direct radiation from the ground could be ruled out, it became more and more evident that a new source of radiation of non-ground origin was involved. Most remarkably, instead of decreasing rapidly with altitude, the penetrating radiation was found, after an initial albeit slower than expected fall, to rise again. In 1912, Victor Hess brought finally indisputable evidence that the radiation had to come from outside the atmosphere, hence was genuinely of extraterrestrial origin. His series of celebrated balloon observations in 1911-1912 which enabled him to reach this conclusion were preceded by extensive attempts by some other investigators who, to various degrees, reached similar conclusions. Among the latter Albert Gockel deserves particular attention: with

1 For an overview of the history of the discovery of cosmic rays by his main protagonist see V. F. Hess, *The Electrical Conductivity of the Atmosphere and Its Causes*, New York, 1928; see also William F. G. Swann, *History of cosmic rays*, Am. J. Phys., vol. **29** (1961), 811-819; B. Rossi, *Cosmic Rays*, New York, 1964; Y. Sekido and H. Elliot (eds.), *Early History of Cosmic Ray Studies*, Reidel, 1984; Q. Xu and L. M. Brown, *The early History of Cosmic Ray Research*, Am. J. Phys., vol. **55** (1987), 23-33 and L. M. Brown and L. Hoddeson (eds.), *The Birth of Particle Physics*, Cambridge Univ. Press, 1986. For a recent and detailed account see P. Carlson and A. De Angelis, *Nationalism and internationalism in science: The case of the discovery of cosmic rays*, Eur. Phys. J. H, vol. **35** (2010), 309-329. Retracing in particular the early history before Hess' discovery, this article gives due credit to some of usually overlooked scholars who made Hess' discovery possible, with particular emphasis on the work of the Italian Domenico Pacini (to the point of overshadowing a bit other important precursors such as Gockel). I refer the reader to this article for many details only alluded to in the present work.

2 For a brief scientific biography of Gockel see H. Schneuwly, *Albert Gockel et la découverte de rayons cosmiques* in "Défis et Dialogue / Herausforderung und Besinnung", Vol. 13, Editions Universitaires Fribourg, 1991; a further list of publications on Gockel and his work can be found at http://www.unifr.ch/sfsn/pdf/gockel. This useful web site includes links to pdf files of several Gockel's key articles, reports and books.

3 See R. Catinaud, *Which physics for a new institute? Albert Gockel, Joseph Kowalski and the early years of the Fribourg Institute of Physics*, SPS-Communications no. 36 (2012), 24-27.

a series of balloon flights almost two years before Hess', he preceded the Austrian on many key observations. However, due to reasons that will be discussed shortly, it was not given to Gockel to bring forth evidence as strong as Hess'. Lack of material means and support, including from his home institution, ruled him out of the game just when the investigations reached their climax and that first priority claims were issued. Let us have a closer look at Gockel's research and his early conclusions about a penetrating radiation of possibly non-terrestrial origin.

Atmospheric conductivity and more generally atmospheric electric phenomena were Gockel's life-long interest. He devoted to them most of his time from his initial research years till the end of his life with the exception of some circumstantial work he did to obtain his academic degrees or fulfill his institutional duties. Right after his Ph. D. in Heidelberg (1885) Gockel went to teach at the Ladenburg Gymnasium where he initiated a systematic study of atmospheric phenomena with special emphasis on thunderstorms [4]. In 1896 he was hired as assistant in the newly created Physics Institute of the Freiburg (CH) University. Serving under the directorship of Joseph de Kowalski, the applied research oriented almighty head of the Institute, Gockel had certainly less time for his interests because of the work for his habilitation [5]. However, according to his list of publications [6], he managed somehow to still devote time to his favorite investigations following closely the latest developments in atmospheric electricity and related phenomena. Gockel took early an active part in the most advanced research over the ionization of air and natural radioactivity. It was not easy given the adverse institutional conditions that he had to confront because of his non-compliance with the strong local preference for applied research dictated by Kowalski. In spite of his apparently successful career (he became extraordinary professor in 1903 and ordinary in 1910) Gockel worked practically without help and with a severely limited research budget [7]. In spite of this, he managed nonetheless to produce original contributions extending and sometimes going beyond those of the best scholars in the field. Indeed, in the years when cosmic rays were finally discovered, Gockel was one of the most accomplished and among the top *Luftelektrizität* researchers and his contributions, often published in the *Physikalische Zeitschrift* which was then hosting the best publications in the field, were widely known and systematically quoted.

Restricted financial means could seriously hinder one's research as, besides the expenses occasioned by field research at various geographical locations, the techniques and instruments used were sometimes of considerable sophistication. Today one remembers mostly the ionization cavities sitting on top of electrometers, instrumental in the study of the ionizing radiation, but Gockel used, as many others, a broader range of techniques and devices, many resulting from the pioneering attempts of Elster and Geitel [8] and perfected by their followers. To study the distribution of radioactive substances, Gockel used the capture of the positive active ions over extended negatively charged suspended wires: the activity of the deposit was estimated on the basis of the rate of discharge of special electrometers. To investigate the ion density of air, Gockel measured the intensity of the ion current between the plates of condensers: to secure a regular intake of ions, the latter were aspired into the condenser by engine or hand driven air pumps. His investigations of the intensity of the ionizing radiation were finally based on the rate of ion production in ionization cavities containing sealed air: here the issue was to secure as small electrical capacity as possible to make minute charge variations due to ionization as detectable as possible. All of these techniques required often electric batteries as sources of electric potential and, at the final stage of the experimental setups, very sensitive electrometers: Gockel followed the trend from the first electrometers of Elster and Geitel to the much improved devices designed on purpose by Theodor Wulf (1868-1946) for the study of the penetrating radiation (1909). Given the experimental setups involved, one can then better appreciate the challenge that air-borne balloon experimentation represented then: one had to solve problems of restricted space, varying pressure and of large temperature swings.

The dedication of Gockel to his research made him use any opportunity to extend and improve his observations. Gockel's experiments were geographically broadly distributed, not only over a substantial part of Europe, but they covered also Turkey and some countries of North Africa [9]. He did his investigations underground in caves and tunnels (Simplon), in the mountains and glaciers of the Alps (Briener Rothorn, Zermatt [10], Jungfraujoch), in land and water, in lakes (Bodensee) and seas (Mediterranean), etc. But his most important results were obtained studying the ionizing radiation at high altitudes using balloon flights, among the very first to be done with this purpose [11]. Gockel's first flight took place in December 11, 1909, in a time when the hypothesis of ionizing radiation coming from Earth was largely undisputed. The material conditions of the this flight are perfectly illustrative of Gockel's limited research means: he benefited from the generosity of the East section of the Swiss Aeroclub that funded the flight of its balloon, the *Gotthard*, on the occasion of the *International Balloon Week*. Besides the pilot, another scholar, Alfred de Quervain, then research associate at the ETH and associate director of the *Schweizerische Meteorologische Centralanstalt*, took part in the flight. De Quervain, himself a balloon pilot, was familiar with the flight activities of the Aeroclub and, as we shall

4 Gockel's early interests led him to publish in 1895 a book entitled *Das Gewitter* (Commissions-Verlag und Druck von J. P. Bachem, available in pdf format at http://www.unifr.ch/sfsn/pdf/gockel) which brought him at the time some fair recognition.

5 Gockel's habilitations work considered the relation between polarization and conductibility in salts, see Schneuwly's biography of Gockel, *loc. cit.*

6 See the list at the end of Gockel's obituary by A. Reichensperger, in *Bulletin der Naturforschenden Gesellschaft* Freiburg/Schweiz, vol. 28 (1927), 227.

7 See Schneuwly, also Catinaud, *loc. cit*.

8 For some detailed descriptions, see Gockel's survey of techniques and results, *Die Luftelektrizität – Methoden und Resultate der neueren Forschung*, Verlag von S. Hirzel, 1908, available as pdf file at http://www.unifr.ch/sfsn/pdf/gockel.

9 See for instance his extensive report *Luftelektrische Untersuchungen*, Kommissionsverlag der Universitätsbuchhandlung, Freiburg (Schweiz) (1902), to be found at http://www.unifr.ch/sfsn/pdf/gockel.

10 In Zermatt he collaborated with Wulf.

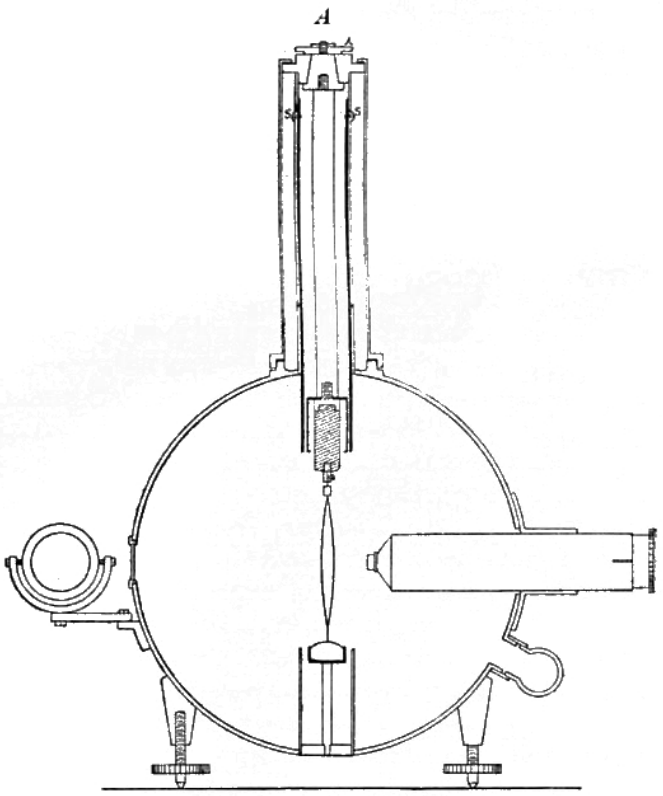
11 For a penetrating analysis of the role of balloon flights in the discovery of cosmic rays, see Ch. A. Ziegler, *Technology and the Process of Scientific Discovery: The Case of Cosmic Rays*, Technology and Culture, vol **30**, (1989), 939-963.

see, proved instrumental in making Gockel's further flights possible [12].

Filled with coal-gas, the *Gotthard* reached a final altitude of 4500 meters before landing after more than four hours of flight. Gockel did measures of ion density but what caused real surprise were his results on the variation of the ionizing radiation with altitude obtained using the standard setup made of Wulf's electrometer coupled to a ionization chamber. Gockel observed initially a decrease in accordance with the hypothesis of radiation originating from ground, but its rate with altitude was much smaller than expected; at higher altitudes Gockel even recorded back an increase. The main conclusion of the account Gockel published some months later in the *Physikalische Zeitschrift* [13], was accordingly that:

Das Resultat der Messungen ist demnach, dass in der freien Atmosphäre zwar eine Verminderung der durchdringenden Strahlung eintritt, aber lange nicht in dem Masse, wie man es erwarten könnte, wenn die Strahlung in der Hauptsache vom Boden ausgeht [14].

This was a startling result to be matched only by the observations that Theodor Wulf obtained on the top of the Eiffel tower during next Easter [15]. It is fair to say that all the ensuing measures and in particular those of Hess were prompted by the need to confirm or disprove Gockel's and Wulf's observations. One could indeed have some doubts about the reliability of Gockel's observations as he himself did not hesitate to spell-out in his report. Because of the circumstances of the flight, Gockel could not rule out systematic errors spoiling his results. In fact, two potential sources of error could account for a slower than expected rate of decrease and (perhaps) the even more surprising increase. During the initial climbing phase, the *Gotthard* went through a layer of clouds that could have caused a deposit of active substances captured by an initial charge that the balloon could have picked up when at ground. Next, the electrical isolation of the electroscope could have been faulty because of the atmospheric conditions met during the flight. Gockel's setup did include a second monitoring device whose isolation could be checked thus giving information about the integrity of his main measuring device. However, as he reported in his paper, the landing took place in dense fog: the balloon landed in a snow covered forest and the passengers went through considerable hardship to unload the scientific devices and bring them to a safe place. When Gockel could at least check the isolation, he found that the monitoring device had been damaged during transportation making a check meaningless. In his paper, Gockel discussed carefully both sources of error and gave rather convincing reasons why his results should be trusted the same in spite of the adverse circumstances. Still he himself did not consider them as sufficiently warranted and felt they needed confirmation. Interestingly enough, in the eighties, a team of Freiburg physicists measured the ionization radiation in a situation comparable to Gockel's using modern techniques. Thanks to their results it could be shown that Gockel's results were consistent with the modern ones provided one corrected for the effect of short range radiation due to the radioactive decay products of Radon present in the air [16] that Gockel did not take away. This is in particular true of the values which corresponded to an increase. He himself preferred not to grant too much significance to the latter because the balloon was then in a phase of rash motion making the measures difficult.



Wulf's electrometer specially designed for the measures of the ionizing radiation (1909), used by Gockel on his second and third flights. The spread of the charged quartz threads is obseved with a microscope inside the cavity where ionzation occurs.

Gockel did two more flights, on October 15th, 1910, and April 2nd, 1911. Again, he was relying on ad hoc arrangements and good will. The October flight was again courtesy of the Zürich Aeroclub section, while the April one was a regular showcase flight of the Aeroclub with five other passenger on board [17]. I refer the reader to Gockel's account for details: suffice it to say here that the results he obtained made Gockel confident about what he observed during the first flight. He wrote [18]:

12 Interestingly enough, de Quervain, better known today for his achievements in geophysics and meteorology, was instrumental in the establishment of the Jungfraujoch scientific station which, as is well known, served also as a cosmic ray laboratory.

13 *Luftelektrische Beobachtungen bei einer Ballonfahrt*, Phys. Zeit. Vol. **11** (1910), 280-282.

14 Bold mine: *The result of the measures is thus that in free atmosphere there occurs indeed a decrease of the penetrating radiation, but by far not of the importance one should expect if the radiation comes mainly from the Earth.*

15 Wulf's Eiffel tower measures albeit at only circa 300m were considered rightly important because of their superior reliability given the stability of the location and altitude of the measuring setup (contrary to balloon observations).

16 See Hansruedi Völkle, *Albert Gockel und die kosmische Strahlung*, Bull. Soc. Frib. Sc. Nat., vol. **97/98** (2008-09), 105-114.

17 Rememberig the delicate experimental setup Gockel used, this tells us much about the less than perfect conditions of his measurements.

18 *Messungen der durchdringendern Strahlung bei Ballonfahrten*, Phys. Zeit., vol. **12** (1911), 595-597.

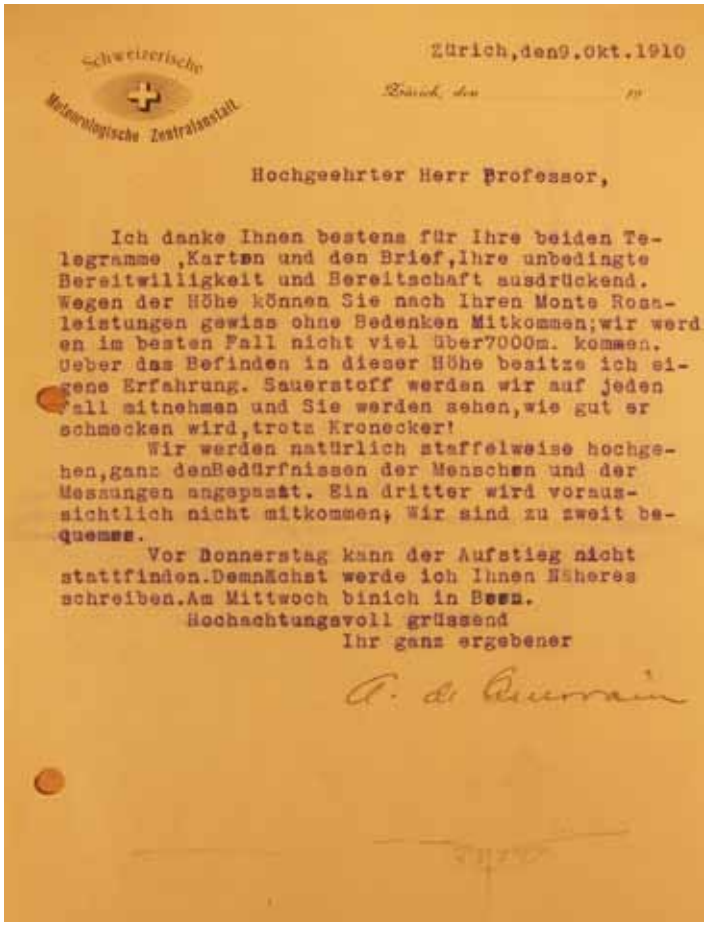
Ich habe schon früher eine Mitteilung veröffentlicht, wonach es sich bei einer Ballonfahrt herausstellte, dass die Gammastrahlung in der Atmosphäre nur in geringem Masse mit der Höhe abnahm. Die damaligen Versuche waren, weil am Schluss die Isolation des Apparates infolge eines Unfalles nicht geprüft werden konnte, nicht ganz einwandfrei. ***Ich habe mittlerweise Gelegenheit gehabt, die Versuche bei zwei weiteren Fahrten zu wiederholen und bin, wie ich hier gleich bemerken will, zu denselben Resultaten wie früher gekommen*** [19].

The same year he wrote in a more assertive way in a contribution to the Bulletin de la Société Fribourgeoise des Sciences Naturelles [20]:

In einem Gefäss dicht eingeschlossene Luft zeigt […] ein gewisses Leitungsvermögen. Dasselbe wird zum grossen Teil durch eine radioaktive Strahlung verursacht, die von aussen kommt. [...] Die verbreitetste Annahme ist die, dass diese Strahlung ausgeht von den radioaktiven Produkten, welche sich im Erdboden befinden. […] Um zu erforschen, wie sich die Intensität dieser Strahlung mit der Höhe ändert, hat der Vortragende bei 2 Ballonfahrten die Intensität dieser Strahlung gemessen. Das Resultat war, dass selbst in Höhen von 4500 m die Abnahme der Strahlung nur sehr gering ist. […] ***Es muss diese Strahlung daher zum Teil entweder aus der Atmosphäre oder von einem Gestirn ausserhalb der Erde kommen*** [21].

A hasty reading of the last sentence could make one reach the conclusion that Gockel preceded Hess in his discovery of the extraterrestrial radiation. I shall come back to this later. For now, let us discuss the circumstances of the second flight.

Gockel's papers and correspondence conserved in the archive of Freiburg University contain some letters from de Quervain that reveal important facts that went until now unnoticed by Gockel's biographers and commentators of his scientific activity. It turns out that the second flight was initially planned to be a hydrogen filled balloon one and could have reached more than 7000m. Indeed, in a letter from Friday, October 7, 1910, de Quervain informs Gockel that a scientific flight up to 7000m will be readily available and that Gockel is offered to use it to his scientific purposes. Reconstructing the context from the somewhat lacunary information provided by de Quervain's letter, it seems that de Quervain and the director Maurer of the *Meteorologische Centralanstalt* were of great help in the organization of the Gordon-Bennet balloon competition which took place in Zürich in the preceding year 1909 [22]. The organizing Swiss


Schweizerische Meteorologische Zentralanstalt

Zürich, den 9. Okt. 1910

Hochgeehrter Herr Professor,

Ich danke Ihnen bestens für Ihre beiden Telegramme ,Karten und den Brief,Ihre unbedingte Bereitwilligkeit und Bereitschaft ausdrückend. Wegen der Höhe können Sie nach Ihren Monte Rosaleistungen gewiss ohne Bedenken Mitkommen;wir werden im besten Fall nicht viel über7000m. kommen. Ueber das Befinden in dieser Höhe besitze ich eigene Erfahrung. Sauerstoff werden wir auf jeden Fall mitnehmen und Sie werden sehen,wie gut er schmecken wird,trotz Kronecker!

Wir werden natürlich staffelweise hochgehen,ganz denBedürfnissen der Menschen und der Messungen angepasst. Ein dritter wird voraussichtlich nicht mitkommen; Wir sind zu zweit bequemer.

Vor Donnerstag kann der Aufstieg nicht stattfinden.Demnächst werde ich Ihnen Näheres schreiben.Am Mittwoch binich in Bern.

Hochachtungsvoll grüssend

Ihr ganz ergebener

A. de Quervain

De Quervain to Gockel, Sunday October 9, 1910, courtesy of the Freiburg University archive.

Aeroclub offered, to thank them, a free flight they could use for their scientific purposes and scheduled to take place sometime in Fall. The whole affair took an exciting turn when it appeared that the Aeroclub balloon *Gotthard* could, for this occasion, be filled with costly Hydrogen (moreso than conventional but heavier coal-gas) because the latter could be decanted from a balloon of the "Luftschiffgesellschaft Luzern" at a reduced price, a filling staying hence in the financial framework of the initial offer of the Aeroclub. In a second letter from Sunday, October 9, de Quervain acknowledges Gockel's readiness to take part in the flight and gives him some details about its planning. In particular, he confirms that the flight will reach in the best case a bit above 7000m altitude, going up in a way adapted to the comfort of the crew and the requirements of the measures, that he and Gockel will be the sole passengers and that oxygen will be brought with. De Quervain indicates also that the flight will happen after forthcoming Wednesday. However, just the next day, in a third and final letter from Monday, October 10, de Quervain informs Gockel that the flight is cancelled because the "Generaldirektion in Paris" has withdrawn its agreement to the Hydrogen filling of the *Gotthard*. Manifesting his frustration, sorry de Quervain proposes Gockel a substitution conventional flight with coal-gas filled balloon to take place in the next days. This is then the second flight from October 1910 that Gockel eventually did and reported about.

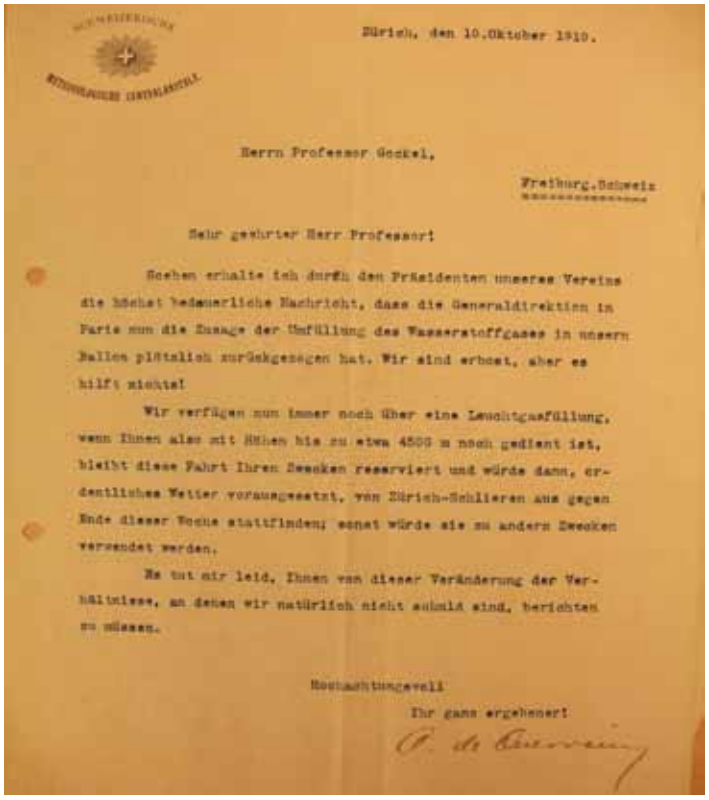
Documents are missing that could disclose with certainty the actors and reasons for this last minute cancellation, to start with the identity of the "Generaldirektion". There are no conserved records in the archives of the *Fédération*

19 Bold mine: *I have had since then the opportunity to repeat my investigations during two other flights and reached, as I shall explain here, the same results as before.*

20 *Luftelektrische Messungen bei einer Ballonfahrt*, Bull. Soc. Frib. Sc. Nat., vol. **19** (1911), 20-28.

21 Bold mine: *This radiation has then to come, in part, or from the atmosphere, or from a body outside the Earth.*

22 The Gordon-Bennet yearly balloon competition consisted in flying with a balloon as far as possible. In 1908, starting from Berlin, a Swiss crew won the competition: in accordance with the rules, the country of the winning crew had to organize the next event and so Zürich was chosen for 1909. Many sources report that manifestation raised considerable popular interest and so contributed to the growth of the Swiss Aeroclub.



Zürich, den 10.Oktober 1910.

Herrn Professor Gockel,

Freiburg.Schweiz

Sehr geehrter Herr Professor!

Soeben erhalte ich durch den Präsidenten unseres Vereins die höchst bedauerliche Nachricht, dass die Generaldirektion in Paris nun die Zusage der Unfüllung des Wasserstoffgases in unsern Ballon plötzlich zurückgezogen hat. Wir sind erbost, aber es hilft nichts!

Wir verfügen nun immer noch über eine Leuchtgasfüllung, wenn Ihnen also mit Höhen bis zu etwa 4500 m noch gedient ist, bleibt diese Fahrt Ihren Zwecken reserviert und würde dann, ordentliches Wetter vorausgesetzt, von Zürich-Schlieren aus gegen Ende dieser Woche stattfinden; sonst würde sie zu andern Zwecken verwendet werden.

Es tut mir leid, Ihnen von dieser Veränderung der Verhältnisse, an denen wir natürlich nicht schuld sind, berichten zu müssen.

Hochachtungsvoll

Ihr ganz ergebener

De Quervain to Gockel, Monday, October 10, 1910, courtesy of the Freiburg University archive.

Aeronautique Internationale which was federating the national aeroclubs [23] nor in those of the *Swiss Aeroclub* or its local branches. However, there are some serious clues: there was indeed at the time in Luzern a recently created successful enterprise of public flights run by the French industrialist Jean Kapférer and the French *Compagnie générale transaérienne* with which Kapférer was associated. It is most probably the "Luftschiffgesellschaft Luzern" mentioned by de Quervain. The *Compagnie* was operating a dirigible named "Ville de Lucerne" during summer which was to return to south of France to be kept safely in winter. During inaugural summer 1910, the dirigible was transporting up to 48 passengers a day, and effected around 60 flights [24]. Winter and a seasonal stop of its operations approaching (scheduled on October 9), was this the source of Hydrogen that de Quervain and Maurer were counting on? There are at present no alternative hypotheses available. Following this thread, a change of plans occurred which made the Paris based general direction of the *Compagnie générale transaérienne* change its mind. One does not have further clues.

One can as well only speculate about what would have happened had Gockel climbed up to 7000m as originally planned. If all had gone well (altitude reached and instruments operational in spite of intense cold) it is likely that Gockel would have observed a strong increase of ionizing radiation, much stronger than in his first flight. What would have been then the impact of this on Gockel's views on the nature of the radiation? Would that have made him precede Hess' strong conclusions that came almost two years after? We shall never know. But we can be sure about one thing: as the cancelled flight episode illustrates, Gockel's scientific agenda was heavily dependent on the courtesy of associations and individuals with no specific scientific interest. Consequently, he could not move on with his research as efficiently as Hess who could rely on firm support from the Austrian scientific authorities. Hubert Schneuwly, the author of a short scientific biography of Gockel hints at the lack of research means as an explanation why Gockel lost the discovery race against Hess, to the effect that his contributions went more and more overlooked in the consecutive years. There are other factors to be considered, but there is no doubt that Gockel suffered from the unfavorable professional context which he could compensate for only with ad hoc initiatives he had no full control on, running the risk of disappointments and slow-downs.

In the last years of the second decade and especially after World War I ended and scientific activity resumed with many new and better equipped competitors around (most notably Hess and the German Kolhörster), Gockel's until then most prominent place in the community started to weaken. This was unfortunate since this was also the time of the first priority conflicts. Worse, Gockel died in 1927 which definitely prevented him to claim his share [25]. Today, with hindsight and knowledge of the context, we can better assess his achievements and their impact. How is one then to evaluate Gockel's role in the discovery of cosmic radiation? It is clear that he deserves to be listed among the main discoverers of a source of ionizing radiation that one cannot ascribe to the Earth's crust. From this point of view, his contribution is unjustly overlooked, even by historians who try today to achieve a historically more faithful account of cosmic rays discovery drawing attention to some of its unsung heroes. This in no way diminishes Hess' merits: in a series of methodically planned and carefully executed experiments, Hess achieved a level of experimental sophistication and accuracy that none of his predecessors reached before him, included Gockel. Hess also stated very clearly and provided decisive evidence that the source of the unknown radiation had to be extraterrestrial and beyond Earth atmosphere. As expressed in some of his later publications, Gockel felt until the end of his life uneasy with the idea of an extraterrestrial source of ionizing radiation and favored rather the hypothesis of a yet unidentified but still intra-atmospheric or solar radiation. Would have the results of his eventually aborted 7000m flight had made him change his later views? No one will ever tell.

Be it as it may, and beyond the cosmic ray discovery affair, Gockel's scientific activity makes him certainly one of the most original Swiss physicists in the first decades of 20th century: it belongs to us to remember and promote his fundamental contributions.

23 It was funded in 1905 with its direction in Paris; it was the organizer of the Gordon-Bennet competition (its name has since changed to *The International Air Sports Federation* based in Lausanne).

24 See *Airship and Balloon News*, August 27, 1910, also *http://flightglobal.com/pdfarchive/view/1910/1910%20-%200699.html*. One can find also some information on *http://www.kamov.net/airline/aero-association-lucerne-next-oldest-airline-after-delag/* and *http://www.cabanus.e-monsite.com/pages/les-dirigeables/histoire-des-dirigeables.html* for some postcard images (content as of August 12, 2012).

25 See Carlson and de Angelis, *loc.cit*.

Review of the symposium "100 Years of Cosmic Particles"

Jan Lacki, Uni Genève

The year 2012 marks the hundredth anniversary of the discovery of cosmic rays by the Austrian Victor Franz Hess. It gives the physics community the opportunity to look back at a century of scientific investigations in a field that offered physics some of its most exciting discoveries, making early research in particle physics possible and offering today a way to extend it beyond energies achievable in our machines. The anniversary gave rise in the recent months to a flurry of manifestations, both popular and scientific. Among the latter, several international meeting were organized. One of the most successful to date was the Joint symposium in honour of Victor F. Hess entitled "100 Years of Cosmic Particles" organized from 1st to 5th of May by Innsbruck University in collaboration with the *Victor F. Hess Society*.

Its first part, devoted to contemporary issues, took place in Innsbruck and was followed by a second autonomous part in Pöllau (Austria) where more historically oriented topics were discussed. The physical location of the second part was the Castle of Pöllau which hosts *Echophysics*, the European Center for History of Physics and the Victor F. Hess Heritage Centre. The audience composed of many Innsbruck partakers was completed by new participants all making up a nice mixture of historians and scientists. All cooperated to provide an insightful perspective on the circumstances which led to the discovery of the cosmic rays, but also on the way the field grew rapidly, fuelled by its own rationale as well as by the needs of early research in particle physics. Further accounts explained how cosmic ray research evolved in the fifties, slowing down when research on particle physics switched to accelerators, but then regaining importance in the last decades given the current issues in the field of astrophysics and elementary particle theory, and fuelling the new domain of astroparticles.

Dr. Peter Schuster, the director of the *Victor F. Hess Society* and head of *Echophysics* arranged a dense albeit very participants friendly program for the Pöllau days. The talks were scheduled over two days, Friday 4 and Saturday 5 May, and were intertwined with some celebrative parts and cultural activities. The scientific committee of the symposium took care to arrange for talks that emphasized the extreme quality of Victor Hess' experimental work showing the rationale behind his startling discovery. Some of the speakers managed however to draw attention to the work of many now overlooked scholars who preceded Hess and paved the way to his discovery. In particular Jan Lacki representing the SPS discussed the contributions of Freiburg (CH) professor Albert Gockel showing how close the latter got to the conclusions reached later by Hess. The talk met a warm reception showing that time is now ripe to go beyond the conventional (slightly hagiographic) approach to the history of the discovery of cosmic rays centered predominantly on the activity of the Nobel prize winner Hess. This impression was confirmed by the sessions of another recent symposium held in Bad Saarow, Germany, where Victor Hess landed after his 7th flight. Gathering some of the same people that took part in the Pöllau event, the German symposium displayed the same spirit of historical objectivity showing a broader and more complex picture of the early research in atmospheric electricity and in the causes of the ionization of the atmosphere. In summary, both symposia helped to put on the forefront such important characters as the Italian Pacini, the Swiss Gockel, or the German Kolhörster, adding much novelty to an up to now too simplistic picture.

The Pöllau as well as the Bad Saarow talks prompted lively exchanges where many of recent actors of research on cosmic rays could revive their memories and convey their still intact passion for the topic. Although Pöllau is a small place, the evening public lecture on cosmic rays and past and contemporary research attracted many people outside from the scientific circles. One could measure the success of the organizational activity of Peter Schuster also by the number of officials who managed to attend or at least to drop by, including the Austrian minister of Education and Science who addressed the participants with some clever words of encouragement.

Last but not least, the Pöllau meeting gave the participants the opportunity to visit the local Victor F. Hess Heritage Centre with its impressive collection of material devoted to the history of cosmic rays and the work of Victor Hess.

Kurzmitteilung

Friedrich-Karl Thielemann Träger des Lise-Meitner-Preises für Physik

Mit dem Lise-Meitner-Preis 2012 wird Prof. Friedrich-Karl Thielemann, Professor für Theoretische Physik an der Universität Basel, zusammen mit dem deutschen Physiker Prof. Karlheinz Langanke von der TU und GSI Darmstadt ausgezeichnet. Damit ehrt die Sektion Kernphysik der Europäischen Physikalischen Gesellschaft ihre ausserordentlichen Beiträge zur Beschreibung von Kernreaktionen in astrophysikalischen Objekten, die unser heutiges Verständnis der Entwicklung von Sternen, von Sternexplosionen wie z.B. Supernovae, und der damit verknüpften Entstehung von Elementen und ihren Isotopen im Universum massgeblich beeinflusst haben. Ihre Arbeit bildet eine Brücke zwischen Astrophysik und Kernphysik. Die Identifikation von wichtigen Reaktionen sowie dem notwendigen Wissen über Eigenschaften extrem instabiler Isotope hat wesentlich zum Forschungsprogramm bestehender und zukünftiger Grossbeschleuniger beigetragen. Der Preis wird alle zwei Jahre vergeben und am 20. September bei der EPS-Konferenz in Bukarest überreicht. Die SPG freut sich über die ehrenvolle Auszeichnung ihres Mitglieds und gratuliert sehr herzlich.

125 Jahre Physikalische Gesellschaft Zürich

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Referate

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André Stefanov	**Relativistische Effekte auf Atomuhren**

Ende 1915 formulierte Einstein die endgültige Fassung der Allgemeinen Relativitätstheorie: wie kam Einstein dazu? was sind möglichen Konsequenzen der Theorie in der Astrophysik und Kosmologie? inwiefern ist sie getestet worden? gibt es schon praktische Anwendungen? Das sind einige Fragen, die an dieser Veranstaltung von führenden Wissenschaftlern auf diesem Forschungsgebiet diskutiert werden.

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