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SPATIUM

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Johannes Geiss is a world leader and foremost expert on measurements and interpretation of the composition of matter that reveals the history, present state, and future of astronomical objects. With his Swiss team he was first to measure the composition of the noble gases in the solar wind when in the late 1960s he flew the brilliant solar wind collecting foil experiments on the five Apollo missions to the moon. Always at the forefront of the art of composition measurements, he with his colleagues determined the isotopic and elemental composition of the solar wind using instruments characterized by innovative design that have provided the most comprehensive record of the solar wind composition under all solar wind conditions at all helio-latitudes. He discovered heavy interstellar pickup ions, from which the composition of the neutral gas of the Local Interstellar Cloud is determined, and the "Inner Source" of pickup ions. Johannes Geiss played a key role both in the in-situ measurements and modelling of molecular ions in comets, and the interpretation of these data. He and co-workers measured the composition of plasmas in the magnetospheres of Earth and Jupiter. Here we highlight Johannes Geiss' many discoveries and seminal contributions to our knowledge of the composition of matter of the Sun, solar wind, interstellar gas, early universe, comets and magnetospheres. The first landing on the moon by humans on July 20, 1969, marked a historic milestone in space exploration. It was also a milestone in the research of Johannes Geiss. At 03:35 UT on July 21, several hours after touchdown, Apollo 11 astronaut Aldrin deployed the Swiss Solar Wind Composition (SWC) experiment four meters from the nearest footpad of the Lunar Module on the soil in Mare Tranquilliatis (Fig. 1). After a 77-minute exposure to the solar wind, the astronauts rolled up the solar wind collection foil and stored it in the lunar sample box. The foil was returned to Earth, and, after having been released from quarantine, shipped back to Switzerland where the composition of the solar wind trapped in the foil was carefully measured using ultra-high vacuum mass spectrometers in Geiss' laboratory at the Physikalisches Institut of the University of Bern. There were four more exposures of the SWC foil as part of the Apollo program, with the last on Apollo 16 in April 21, 1972, lasting for more than 45 hours. This brilliant experiment, so expertly designed, extensively calibrated and tested, and flawlessly executed, illustrates Johannes' skill and perseverance in pursuing all of his experiments. He set out to measure the composition of noble gases, and in particular the $^{3}He/^{4}He$ ratio in the solar wind, to settle the question raised by the puzzling measurements in the "solar noble gas component" of certain meteorites of $^{3}He/^{4}He$ ratios that were an order of magnitude lower than predicted from the D/H ratios measured in sea water and meteorites (Geiss et al. 1966). Geiss with his co-investigators P. Eberhardt and P. Signer then conceived the idea of a controlled solar wind collection experiment, selecting it as the best method for isotopic measurements, and in a short time he and co-workers performed extensive laboratory research and engineering to prove the feasibility of the technique, and to select the proper foil materials. He concluded that the Apollo mission offered the only opportunity at that time to expose his experiment to the solar wind and to return it back to Earth, and thus proposed to NASA a solar wind composition experiment to be deployed at the lunar surface as part of the Apollo scientific program (Geiss et al. 1966). Despite the risks involved in collecting solar wind ions at the surface of the moon due to possibly major solar wind perturbations in the lunar environment (exposure of the SWC foil on the way to or from the moon would have been ideal, but was not feasible), Johannes Geiss was successful in convincing NASA to select his experiment for six lunar landing missions, including the very first one, Apollo 11, that landed in Mare Tranquillitatis in July 1969. To assure that the SWC experiments would be flown and properly executed, Geiss spent nearly a year prior to the Apollo 11 mission at the Manned Spacecraft Center (MSC) in Houston, Texas, interacting with the flight crew and engineers, instructing them on how and where to deploy the foil and explaining

Science First

Editorial

This issue of *Spatium* is devoted to Professor Johannes Geiss, co-founder of PRO ISSI and *spiritus rector* of ISSI, on the occasion of his 85th anniversary on 4 September 2011.

All past twenty-six issues have been dedicated to the outcome of research activities in the field of space science. Those endeavours are being undertaken by men and women on their way to a deeper understanding of Nature. Only incidentally have we mentioned the persons behind the activities, and never did we ask about their motivation, nor what it needs to reach scientific excellence.

Today, we make an exception: we are going to paint the picture of an outstanding scientist, to try to learn about what motivated him and his secrets of success. From whom could we learn this better than from Johannes Geiss who, during a long life time, has been active in so many scientific fields in numerous places in the world.

I met Johannes Geiss for the first time at the University of Bern in 1994. It was with impressive eloquence that he presented his ideas for founding a space science institute in Switzerland. This was at the age of 68, when his coevals were used to look for repose and rest. In contrast, he was about to crown his career by creating ISSI.

During all the years since, while Pro ISSI, and later ISSI came into being, I came to appreciate Johannes greatly, while he in turn did not let up trying to convert me from an engineer to a scientist, and, within the limits of what is possible, he succeeded. He got me fascinated about space and its implications on our lives, and he motivated me to produce the *Spatium* series to convey some of this captivation to you, dear reader.

In this sense, the present issue of *Spatium* is not merely the Pro ISSI association's *festschrift* for Johannes' birthday, but also the personal homage of one of his students. It is the result of numerous personal encounters, e-mails, and telephone calls regularly beginning with a telling *to make it short* and lasting at least one hour, which altogether provided me with the colours for painting the picture of a great scientist, and a grand human alike. Thank you, Johannes, and thank you also, Carmen! My thanks go also to ISSI's directors, Silvia Wenger and generally the staff for supporting me all the time.

Hansjörg Schlaepfer
Cinuos-chel
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Science First

The Pro ISSI association's homage to Johannes Geiss on his 85th birthday, 4 September 2011, by Hansjörg Schlaepfer

Rotterdam, 1955

The Sun stands high in the sky of Rotterdam that afternoon early September 1955. Nearly imperceptibly, the *MS Maasdam* begins her long voyage to New York. Passengers lean against the reeling, saying goodbye to the silhouettes of the harbour that slowly fade away in the haze. Amongst those passengers is a newly married couple from Bern: Carmen and Johannes Geiss. He has just finished a temporary job at the university there, and decided to go to Chicago, where he has obtained employment as a research associate with Nobel Prize laureate Harold Urey at the Institute for Nuclear Studies: no doubt, it will be an outstandingly stimulating environment for both.

Outer Pomerania: The Youth

Johannes Geiss was born in 1926. He grew up on his father's estate, Kornburg, situated some 60 km south of the Baltic Sea, **Fig. 1.** After two years of education by a private tutor, he went to the public school in the nearby Schwessin. At the age of 10, he entered a grammar school at Stolp, now Slupsk. He learned English, Latin and some French, although his favourite subjects turned out to be mathematics, history and sports.

The peaceful youth in Kornburg ended abruptly: on 1 September 1939, Germany invaded Poland. World War II broke out. In 1944, Johannes received a *Not-Abitur,* an emergency qualification intended to grant university entrance because he was drafted into the army. Due to extended training, he did not get into combat. He was fortunate to end the war as a British prisoner of war in Schleswig Holstein. After a few weeks, he was released, and soon found his family, who had fled from Outer Pomerania, in a small town near Kassel. His father was lucky to find a job managing the large farm of a wealthy banker, which in turn allowed the Geiss's to earn their living.

Food was scarce in post-war Germany. In order to obtain decent rationing cards, his sister worked as a gardener while Johannes worked at felling trees, and other odd jobs. Yet, not only food was scarce in those days: Johannes was hungry intellectually, and eagerly read all the books he was able to get hold of, especially those on modern physics. A textbook on quantum mechanics developed in the 1920s by Max Born, James Franck, Werner Heisenberg and other physicists at the University of Göttingen, attracted his special interest, and studying physics at that university became his supreme desire.

Würzburg, 1946: Entering the World of Science

When the universities prepared to reopen, Johannes went to Göttingen in the British occupation zone to enquire about his prospects to study at the Georg-August-University. His chances, however, stood dim at best: his *Not-Abitur* was not acknowledged, additional courses were required to complement it. Even worse: the University of Göttingen was in high demand prompting it to impose a strict *numerus clausus.* Such, however, were not the kind of obstacles that could discour-

Fig. 1: Kornburg 1999 (credit: Hans-Ulrich Kuchenbäcker)

age Johannes; he quickly enrolled for the supplementary courses in Hannoversch Münden, a beautiful small town near Göttingen that the war seemed to have bypassed. Spring 1946 saw him with the exams passed, which should then have opened the doors to Göttingen. Yet, the *numerus clausus* was still in force there; and Johannes had to make a further intermediate step towards reaching his ultimate dream: he registered at the University of Würzburg.

Würzburg, an old town on the River Main, had suffered heavily from bombardment during the war. The small, ancient physics institute though, where Wilhelm Roentgen had discovered X-rays in 1895, had remained unharmed. Johannes studied mathematics and physics five days a week, one day he – like all his fellow students – was required to shovel away debris of destroyed buildings, a modest contribution to rebuilding Germany. After one semester, one day out of the blue he got the chance to exchange his place at Würzburg with one at Göttingen, where, in fall 1946, he started studying mathematics, soon making, however, what he calls an adiabatic transition to physics with mathematics and chemistry as minor fields. Finally, Johannes was where he wanted to be, and now did what he wanted to do: study physics at the world-famous Georg-August-University of Göttingen.

Göttingen 1946: The Study Years

The University of Göttingen was founded in 1737, and the liberal academic spirit associated with Wilhelm von Humboldt's name has survived there up to today. Famous mathematicians and physicists such as Carl Friedrich Gauss, Bernhard Riemann, David Hilbert or Max Born taught there. During the national-socialist regime, this university lost some of its best teachers, who, after the war, were followed by new excellent scholars from the East. It was in Göttingen also that the *Max-Planck-Gesellschaft zur Förderung der Wissenschaften*[1] was founded as a successor organization to the former *Kaiser-Wilhelm Gesellschaft*. This brought luminaries like Max von Laue, Werner Heisenberg or Friedrich von Weizsäcker to teaching at the university. In short, Göttingen offered the young man from Outer Pomerania an exciting environment into which Johannes immersed himself completely. The teaching style in Göttingen and the university's spirit became his models when, much later, he himself became a faculty member at the University of Bern.

Fig. 2: Johannes Geiss's intellectual fathers: from left to right: Max von Laue[2], Wolfgang Paul[3], and Harold C. Urey[4]

To conclude his studies, Johannes had to look for a diploma thesis opportunity, which in view of the numerous fellow students turned out to be far from easy. One day, unexpectedly, Professor Becker called him to the Physics Institute offering an opportunity for a diploma thesis with Max von Laue on London's theory of superconductivity. *I thought you were the right one for the task,* Becker said, adding quickly: *since you are such a formalist!* The opportunity to work for the Nobel Prize laureate was an honour and a challenge at the same time, and Johannes generously repressed the non-complimentary qualification. He gladly accepted, and – within a year – finished his work which was well received. It even would have allowed him to earn a doctorate with his prominent teacher, but Johannes decided to leave the sublime spheres of theoretical physics, and return down to earth to experimental physics with Prof. Wolfgang Paul.

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1 The Max Planck Society.
2 Max von Laue, 1879, Koblenz, Germany – 1960, Berlin, German physicist, Nobel Prize in Physics, 1914.
3 Wolfgang Paul, 1913, Lorenzkirch, Saxony – 1993, Bonn, German physicist, Nobel Prize in Physics, 1989.
4 Harold Clayton Urey, 1893 – 1981, American physical chemist, Nobel Prize in Chemistry, 1934.

The doctoral thesis was an important cornerstone in both Johannes' private and professional life: for the first time he got in touch with mass spectrometry. Together with Rolf Taubert, another doctoral candidate of Wolfgang Pauls', he designed and built such an instrument. More precisely, they assembled two units: one for Paul's group, and one for the University of Bern. With the first instrument, Johannes determined the isotope ratios of lead to estimate the model age of the respective lead sulphide deposits. Such measurements were a tedious affair at the time. Runs of a single sample could easily take hours, but Johannes managed somehow to motivate Carmen, a pupil at the nearby gymnasium, to write down the numbers he read off the galvanometer scales **(Fig. 3)**, while he in turn helped her with her homework in mathematics.

Bern 1953: Ushering in Mass Spectrometry

In 1952, Friedrich Georg Houtermans was elected professor for experimental physics and director of the *Physikalisches Institut* at the University of Bern **(Fig. 4)**. Son of an Austrian mother and a German father, Houtermans had studied physics at Göttingen. His political credo forced him to leave Germany when the Nazis took over. He went to Great Britain, and then followed a call by the University of Charkov, Ukraine. Soon, however, he saw himself arrested. Two gruelling years in prison followed. The Non-Aggression Pact between Stalin and Hitler, 1939, brought him back to Germany, where, after a variety of intermediate stations, he found shelter in the physics institute at the University of Göttingen. Here, he began applying nuclear physics methods to Earth sciences. Then, he received a call from the University of Bern, and went to Switzerland. Intending to continue his research there, he had ordered the second mass spectrometer at Göttingen.

Fig. 3: Reading off the scales of a mass spectrometer, ca. 1952.

Fig. 4: Physikalisches Institut, University of Bern ca. 1953.

After receiving the doctor's degree at the University of Göttingen, Johannes packed up all the components of the second instrument, and sent them to Bern. He arrived here in August 1953. Assisted by Peter Eberhardt, a diploma candidate at the *Physikalisches Institut,* he assembled the instrument **(Fig. 5)**, and continued the lead isotope measurements initiated in Göttingen. The news got around quickly that at Bern they were performing very accurate measurements of the lead isotopes in natural specimens. Geological services from remote countries sent them galena[5] samples to determine their model ages. This earned them not only some important publications, but also helped to enhance the institute's scarce finances.

Fig. 5: The mass spectrometer Susanna 2 installed at the *Physikalisches Institut* in Bern, around 1954.

To extend the mass spectrometer group's scope of work, Johannes started a cooperation with Wilfried Herr of the Max Planck Institute for Chemistry, Mainz, that continued after his return from Chicago. Herr's group separated certain rare elements such as ruthenium, osmium and lithium from old African mineral deposits and from meteorites, while the group in Bern made the isotopic analyses. From these investigations, they concluded that natural technetium does not exist on Earth, and that lithium was not produced at the time the solar system was formed. The osmium isotope data were used by Don Clayton and Willy Fowler in Pasadena to derive the nuclear age of the Milky Way. Peter Eberhardt, Bernhard Hirt, Ernest Kopp, and Hans Balsiger earned their PhD and Anita Eberhardt her physics diploma for their contribution to these studies.

Houtermans had brought a lead chloride sample from a trip to Italy, which yielded unexpected results. The specimen from Mount Vesuvius was highly radioactive, and the isotopic composition of the lead was altogether anomalous. In order to back-up their tentative conclusions, Johannes and Friedrich Begemann, a PhD candidate, who had followed Houtermans from Göttingen, travelled to Italy to collect some further samples of the Southern Italian volcanic ores. As no guide was willing to climb Mount Stromboli, they decided to

[5] Lead ore (PbS)

do it on their own **(Fig. 6)**, but unfortunately did not find any lead chloride deposits there. After hearing the telling rumbling of the still active volcano, they rushed down as quickly as their feet allowed them. Back at Naples, they met the Vesuvius expert, Professor Parascandola. Initially though, communication turned out to be difficult, as the *professore* preferred to speak Latin instead of Italian, or at least Neapolitan. Fortunately, Carmen was at hand: as the Neapolitan dialect is not too far from Spanish, one of Carmen's native tongues, the initial hurdles were quickly overcome.

Fig. 6: Friedrich Begemann on Mount Stromboli, 1954.

The next day, the trio took up quarters in a small hotel near Mount Vesuvius, from where they climbed up to the rim of the volcanic crater every day. A few steps down to the inside of the crater, they placed some rocks into a fumarole, to find, sure enough, the next morning thin whitish deposits on the surface. The deposits were distinctly radioactive, as the Geiger counter attested. Subsequent chemical analyses and isotopic measurements showed that those deposits were pure lead chloride with essentially the same isotopic signature as the sample they had investigated earlier. They concluded that the isotopic anomaly was due to the loss of lead from the magma below the Southern Italian volcanoes, over a period of more than 10 million years.

On 5 May 1955, Carmen and Johannes got married, and in August, they followed an offer from Harold C. Urey to work at the Institute of Nuclear Studies (now Enrico-Fermi Institute) of the University of Chicago. A pleasant journey aboard the *MS Maasdam* from Rotterdam to New York became the young couple's first journey to the new world.

Chicago 1955: Entering Solar System Research

Nuclear physics had culminated in 1949 when the shell model describing the quantum mechanical structure of atomic nuclei was discovered. Physicists now moved on to elementary particle physics, cosmic rays, nuclear fission reactors, or to applications in astro- and geophysics. At that time, the University of Chicago was the world's foremost place for applying isotopic methods to Earth sciences and solar system research. Groups led by Harold C. Urey, Willard F. Libby[6], and Mark G. Inghram[7] pursued a broad spectrum of research in this fascinating new field.

At Urey's laboratory, Johannes' task was to assure the first-rate quality of the mass spectrometers, the backbone of the geophysical work there. For his personal research, he measured the argon/potassium ages of meteorites[8]. That was still a few years before Sputnik, the first human venture into space, when meteorites were unique messengers from the outside world. Johannes found that the ages of all but one meteorite were at least 4 billion years. This was consistent with the prevailing idea that meteorites are fragments of asteroids that formed and cooled down during the early history of the solar system. The one exception was Shergotti, a meteorite of a rare class of achondrites that fell in India in 1865: it showed an age of only a few hundred million years. This result was difficult to reconcile with an asteroidal origin. Did the Shergotti meteorite come from the Moon, or even from Mars? It was only 18 years later that the two US Viking spacecraft on Mars could certify their Martian origin.

[6] Willard F. Libby, 1908, Colorado, USA – 1980, Los Angeles, USA, Nobel Prize laureate in Chemistry, 1960.
[7] Mark G. Inghram, 1919, Livingston, USA – 2003, Holland, USA, one of the first scientists to combine measurements on meteorites and Earth to find the Earth's own age.
[8] See *Spatium* no. 23: Meteorites, by Beda Hofmann, February 2009.

Friedrich Begemann had arrived in Chicago a year before Johannes to work in Willard Libby's laboratory. He investigated the global transport of water in the Earth's atmosphere by measuring natural tritium, and tritium released by nuclear tests. With Libby's help, Carmen obtained a green card, allowing her to work in Begemann's group. As a lab assistant, she had to enrich deuterium and tritium in water by electrolysis. One day, Begemann got hold of a piece of the Norton County meteorite that had fallen in Kansas in 1948. Together with Johannes, he determined its tritium and ^{3}He content, which in turn enabled them to estimate the cosmic-ray exposure age[9] of this meteorite. This was an entirely new type of age, which is useful to estimate the moment when the meteorite is liberated by an impact event from its parent body, be it an asteroid, a moon, or a planet. Many years later, when astronauts returned lunar rocks, the exposure ages attained new significance for determining the ages of lunar craters.

Fig. 7: Johannes Geiss in front of the apartment in Chicago, 1956.

In 1956, Friedrich Begemann and Johannes followed an invitation to report on their research results at the 20th International Geological Congress in Mexico City. Begemann owned a car, and he and his fiancée Margarethe invited the Geiss's to join them to travel across the entire United States down to Mexico City. After the congress, they returned via the Pacific Ocean coast to California, visited the Grand Canyon, and reached Chicago, after some 5,000 km in Begemann's car.

One of the research associates in Harold Urey's lab was Cesare Emiliani[10]. He explored ocean temperature variations during the ice ages from the oxygen isotopes in micro-shells of deep-sea cores. In autumn 1956, Emiliani and Johannes received offers to join the Marine Laboratory of the University of Miami as Associate Professors to building up a paleo-climate research laboratory[11]. Less than a month later, Friedrich Houtermans sent Johannes a letter asking him to return to Bern to take charge of the mass spectrometer laboratory again. What to do now? Cesare Emiliani and Johannes decided to order the components for the mass spectrometer from the workshop of their institute in Chicago. Then, Emiliani would go directly to Miami, while Johannes would return to Bern, and join him when the mass spectrometer components had arrived there.

9 The cosmic-ray exposure age is the time the meteorite was underway in space.

10 Cesare Emiliani, 1922, Bologna, Italy – 1995, Palm Beach Gardens, Florida, Italian-American geologist and micro-paleontologist, founder of paleo-oceanography.

11 Paleo-climatology is the study of the Earth's past climate. It uses a broad variety of proxy methods from the earth and life sciences such as tree rings, corals, shells and microfossils to reconstruct the past states of the Earth's climate.

Bern 1957: Introducing Meteorite Research

Back in Bern, Johannes initiated meteorite research at the *Physikalisches Institut.* Progress, however, was rather slow, as some equipment had first to be built, bought or borrowed. Simultaneously, he prepared his habilitation thesis with a paper on meteorite ages, and on the interaction of cosmic rays with meteorites. Such interactions occur when high-energy cosmic ray particles impinge on meteorites leading to losses of protons and neutrons from the atomic nuclei of the meteoritic material. This is a natural form of nuclear destruction, called spallation. Johannes derived simple formulae describing the spallation production rates needed for interpreting the isotopic data of noble gases. Soon after, a group at the University of California in La Jolla published a set of radioactive spallation products in a freshly fallen meteorite. From those data and his own results, Johannes in turn concluded that the galactic cosmic rays had been roughly constant over the past several million years. This was important news, as it is the key to estimating the cosmic-ray exposure age of meteorites. Johannes received invitations to report about his results at summer schools and meetings, including the first Space Science Symposium of COSPAR in Nice, January 1960, and the VIII. Conference on Cosmic Rays in Jaipur, India, December 1963 **(Fig. 8).**

Miami, 1958: Starting Paleo-Climate Research

The mass spectrometer components reached Miami in summer 1958: time had come for Johannes to join Cesare Emiliani. The Geiss's travelled to Genoa, and embarked on an Italian freighter for America. It was quite an unusual journey, not only due to the cargo consisting of Fiats, garlic, and a few passengers, but also because the captain used to offer a drink on the bridge when the time came to admire the sunset. The freighter's first stop was in La Guaira near Caracas, where the Fiats were unloaded. After passing-by Jamaica, it landed in Havana. The Geiss's changed to a smaller vessel to go to Fort Lauderdale, where Cesare Emiliani picked them up, and drove them to their studio in the Coconut Grove in the South of Miami.

The life style in Florida was quite different from that in Chicago, not least thanks to the wonderful climate: it was much more relaxed, and Carmen and Johannes enjoyed it to the full. They got Florida driver's licenses, and bought their first American car, a hardtop Studebaker. Her green card enabled Carmen to work for Pan American Airways on Miami Beach. In their leisure time, the Geiss's visited the Everglades or the Florida Keys, or went sailing with friends.

At the Marine Laboratory, Cesare Emiliani and Johannes built up the paleo-climate research laboratory. Johannes assembled the mass spectrometer. Searching for a glass-blower to produce the vacuum holding parts, he found one to the north of Miami, who, unfortunately, only knew about blowing Christmas tree balls. As Johannes had gained some experience in this type of craftwork in Bern, he instructed the glass blower appropriately and together they were able to produce

Fig. 8: Visiting the Taj Mahal, India 1963. From left to right: Charles McCusker, Johannes Geiss, and Jacques Labeyrie.

the required parts for the mass spectrometer. When everything was in place, measurements could start. Emiliani and Johannes analysed the $^{18}O/^{16}O$ ratio in the shells of *Globigerinoides sacculifer,* a single celled organism characterised by the absence of any tissues and organs. This simple form of life lives close to the ocean surface, and, upon dying, sinks down to the sea floor, where over thousands of years it forms entire strata holding the history of seawater temperature at the surface. This allowed them to derive the evolution of the surface water temperature during the later part of the Pleistocene, the epoch of periodical glaciations.

Parallel to their experimental work, Emiliani and Johannes published a paper "On Glaciations and their Causes" (1). A theory that was quite popular at the time interpreted the sequence of glaciations as a self-sustained oscillation, however, they considered this view wrong. Instead, they preferred Milankovich's proposal that variations of the summer insolation at Northern latitudes resulting from periodic perturbations of the Earth's motion by the planets and the Moon had triggered the glaciations. Indeed, the Milankovich mechanism was the only theory to provide for a time-scale, which in turn corresponded roughly to the data extracted from the deep-sea cores, and other global climate indicators.

After returning to Bern, Johannes presented the Miami results in a variety of summer schools and scientific meetings. Roger Revelle[12] and Gustaf Arrhenius[13] invited him to report at the First International Oceanographic Congress held at the United Nations Headquarters in New York, September 1959. They even organised his transport by the US Military Air Transport System.

Bern: Scientist, Teacher and Faculty Member

The Scientist

After a wonderful year in Miami, the Geiss's returned to Bern. Johannes took up the meteorite research programme, and with some effort, obtained meteorite samples from many sources, including museums in Washington, Vienna and Moscow, and the Geological Services of Afghanistan and Sudan of

Fig. 9: With the same assiduity as demonstrated when estimating the age of meteorites, the physics team at the University of Bern participated in university championships. This picture shows on the front row from left to right: Johannes Geiss, Otto Eugster, Hans Wyniger, Ernst Lenggenhager, Hans Balsiger, and on the back row Arthur Liener, Heinz Hofstetter, Kurt Marti, Peter Eberhardt, Ernest Kopp, Fritz Bühler, Friedrich Begemann.

12 Roger Randall Dougan Revelle, 1909, Seattle, Washington – 1991, San Diego, California, Director, Scripps Institution of Oceanography, San Diego, California, one of the first scientists to study global warming and the movement of Earth's tectonic plates.

13 Gustaf Olof Svante Arrhenius, 1922, professor at the Arrhenius Laboratory, Scripps Institution of Oceanography in La Jolla, California.

which he, together with Hans Oeschger[14], determined the exposure ages. Besides his scientific activities, Johannes began teaching at the university, and taking up increasingly challenging university functions.

To enhance their measuring capabilities, the workshop of the *Physikalisches Institut* built several mass spectrometers based on a design by Peter Eberhardt; this design was especially suited for analysing tiniest amounts of noble gases. This type of instrument was in strong demand elsewhere too: one went to Edgar Piciotto's *Laboratory at the Université Libre* in Brussels, another to the *Istituto di Geologia Nucleare* in Pisa, where Peter Eberhardt and Johannes installed them. At Bern, Kurt Marti and Otto Eugster used them to measure the isotopic abundances from helium to xenon in several meteorites for their PhD theses.

It had been known for decades that some meteorites contained large amounts of noble gases. Peter Eberhardt, Norbert Grögler and Johannes showed that these gases are located in thin surface layers of tiny grains inside the meteorite. Their elemental composition and location suggested the solar wind[15] to be their origin. These observations led later to the famous Solar Wind Composition (SWC) experiment on NASA's Apollo missions.

The Teacher and Faculty Member

Johannes began teaching at the University of Bern in 1959 with lectures on nuclear physics including the newly established nuclear shell model. Later, he gave introductory courses in experimental physics for science and medical students, as well as advanced lectures on plasma physics, nucleosynthesis, and experimental cosmology. His publications made in Chicago earned him worldwide acknowledgment, and in 1960 convinced the Executive Council of the Canton of Bern to elect Johannes *Extraordinarius* (Associate Professor) to succeed Charles Peyrou, who became a director at CERN in Geneva. One year later, when Houtermans fell seriously ill, Johannes was installed as *Vizedirektor,* and, when Houtermans died in 1966, the Executive Council elected him Director of the *Physikalisches Institut*.

Fig. 10: Friedrich G. Houtermans and Johannes Geiss, Bern, ca. 1960.

In order to prepare the *Physikalisches Institut* for a grand future, Johannes formed three divisions reflecting the three major research areas pursued at that time. Each of them defined their own research programmes, and each was responsible for securing the necessary research funds. Over the many years since, the divisions have retained their identity, although their research areas have evolved of course. Presently these are:

1. The *Space Research & Planetary Sciences Division* initially led by Johannes, later by Peter Eberhardt, Hans Balsiger, Peter Bochsler, and now by Prof. Nicolas Thomas, Prof. Willy Benz, Prof. Peter Wurz and Prof. Kathrin Altwegg-von Burg.

2. The *Climate and Environmental Physics Division* led by Prof. Hans Oeschger, now by Prof. Thomas Stocker.

3. The *Laboratory for High Energy Physics,* initially led by Prof. Beat Hahn, later by Prof. Klaus Pretzl, and now by Prof. Antonio Ereditato.

14 Hans Oeschger, Ottenbach, Switzerland – 1998, Bern, physics professor at the University of Bern, Swiss climate expert.
15 The solar wind is a stream of charged high-energy particles ejected from the upper atmosphere of the Sun. It mostly consists of electrons and protons.

The Cosmic-Ray Group on the Jungfraujoch High Altitude Research Station was led by Prof. Hermann Debrunner and later by Prof. Erwin Flückiger.

In 1970/71, Johannes served as *Dekan* of the *Philosophisch-Naturwissenschaftliche Fakultät* of the University of Bern, and in 1982 he was elected Rector of the University of Bern for a term of one year, **Fig. 11.** Quite naturally, such executive functions brought him in touch with a broad spectrum of research, education and general policy affairs – as well as others – which he tried to solve on the basis of his wide experience gained in international and interdisciplinary programmes. His liberal heritage from the study years in Göttingen now came to tangible results: for instance, Johannes fostered students' participation in various fields of the university's management.

As a teacher, Johannes advocated the oneness of research and teaching, of which the latter needs permanent updating to reflect progress in disciplinary and interdisciplinary research. Humankind's ever-increasing energy need is another of Johannes' concerns. During the first oil crisis 1973, he organised a multidisciplinary seminar on the energy problem. Regarding the worldwide use of nuclear fission reactors, he remains sceptical as there is no way to globally, simultaneously and safely control the three related fundamental problems, such as their proximity to nuclear weapons, the potential of a *supergau,* or an uncontrolled explosion, and the nuclear waste disposal problem.

Fig. 11: Dies Academicus of the University of Bern, 1982: from left the Rectors of three Universities: Prof. Verena Meyer (University of Zurich), Prof. Eric Jeannet (University of Neuchâtel), and Johannes Geiss, together with Prof. Hubert Herkommer (Dean of *Philosophisch-Historische Fakultät* University of Bern).

During the years from 1966 to 1989, when Johannes was its Director, the *Physikalisches Institut* experienced a significant growth from two to seven professors with a similar increase in the number of scientists, as well as technical and administrative personnel. In cooperation with the two related institutes for theoretical physics, Prof. Heinrich Leutwyler, and applied physics, Prof. Klaus Peter Meyer, research in physics at the University of Bern reached an internationally acknowledged standard. Equally important were the relationships with decision-makers, notably Urs Hochstrasser, Director, Federal Department of Home Affairs, Olivier Reverdin, President, Peter Fricker, Secretary General of the National Science Foundation, and Max Keller, First Secretary of the Department for Education, cantonal administration. Yet, in spite of an enormous managerial load, he knew how to remain a scientist in his heart, and abided by his paradigm **Science First!**

Cooperating with NASA

The launch of Sputnik I on 4 October 1957 provoked a kind of a tsunami all over the world. It prompted US President John F. Kennedy to make the famous statement on 25 May 1961: *"I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth."*

On the other side of the Atlantic, the International Council of Scientific Unions (ICSU) established its Committee on Space Research (COSPAR), which held its first symposium in Nice in January 1960. Johannes was invited to lecture on the constancy of galactic cosmic rays. At the conference, he met Bob Jastrow[16], the official representative of NASA. Following Jastrow's invitation, Johannes went several times to the Goddard Space Flight Center (GSFC) near Washington as a visiting scientist, and to the Goddard Institute of Space Studies (GISS) in New York City. While at these NASA institutes, Johannes began to realise how thoroughly space flight was going to revolutionise many branches of solar system science and astronomy.

Fig. 12: Johannes Geiss (1) participating at the Goddard Institute for Space Studies, New York, 1965. Further personalities are Wilmot (Bill) Hess[17] (2), Hubert Reeves[18] (3), and Fred Hoyle (4).

As mentioned above, research activities at the *Physikalisches Institut* and at the University of Mainz had revealed high concentrations of noble gases on the surface of grains in some meteorites. The favoured explanation was that these elements had come in from the solar wind during an unknown past epoch. In order to corroborate their hypothesis, and to analyse the detailed properties of the solar wind, Johannes joined forces with Peter Eberhardt and Peter Signer, professor at the Earth Science Department of the Federal Institute of Technology (ETH) in Zurich. Their idea was to envisage a space-borne experiment that would collect particles of the solar wind during a certain exposure time. Upon return to Earth, the particles would be analysed in the laboratory by means of mass spectrometers. Such an experiment, however, had to be carried out beyond the Earth's magnetosphere in the undisturbed solar wind. Unfortunately, though, there was no such mission in sight – except NASA's Apollo mission. Was there any chance of convincing NASA to fly a Swiss gadget for sampling solar wind particles to the Moon, use valuable astronaut time to expose it to the solar wind, and bring it back? They decided to try the idea, and submitted an unsolicited proposal to NASA under the heading: "Experimental Determination of the Solar Wind Composition by Measurement of the Elemental and Isotopic Abundances of the Noble Gases". To secure US support, Johannes went to the GISS in New York again in summer 1965, **Fig. 12.** NASA became interested

16 Robert Jastrow, 1925–2008, American astronomer, physicist and cosmologist.
17 Wilmot (Bill) Hess, 1926–2004, director of science and applications at the Manned Space Center in Houston for Apollo 11.
18 Hubert Reeves, 1932, Canadian physicist and astrophysicist, who solved problems of the origin of light elements in the universe.

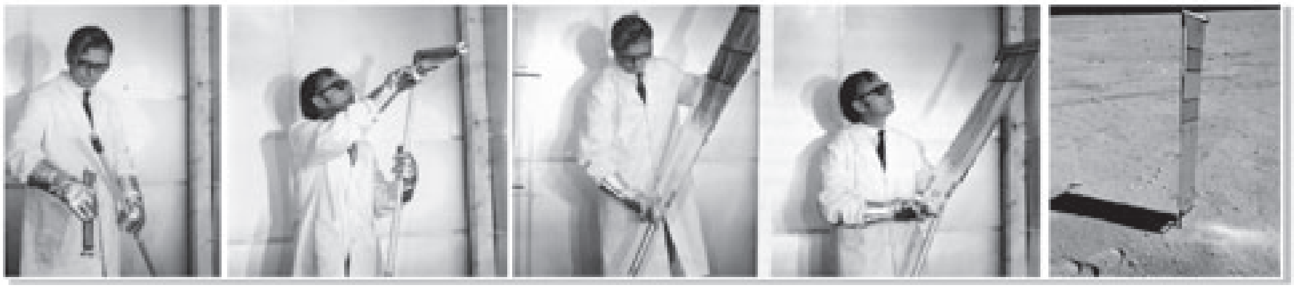

Fig. 13: The sequence of images show Johannes Geiss testing deployment and retrieval of the SWC foil in the thermal chamber at 80°C of Contraves Ltd. in Zurich, while the right image shows the SWC deployed on the lunar surface.

indeed, and as a first action sent a headquarters delegation to the *Physikalisches Institut* to inquire about the capabilities there.

Seemingly, their impression was good: 1967 saw Johannes at NASA's Summer Study "Lunar Science and Exploration" in Santa Cruz, California, where the technical and scientific activities of the astronauts on the lunar surface were planned. One day, he received an urgent call from NASA's Manned Spacecraft Center

Fig. 14: With Charles Duke in Zurich, 1972. The US astronaut successfully deployed and retrieved the SWC on the lunar surface on the Apollo 16 mission.

(MSC) in Houston: the SWC experiment proposal had been accepted by NASA in principle, though not assigned to any flight yet. The details of implementation needed to be defined urgently. Johannes took the next flight to Houston, and quickly came to an agreement with NASA: the institute would deliver a fully autonomous solar wind capture device, including the necessary deployment mechanisms. Yet, the Swiss delivery would have to fulfil two mandatory requirements:

1. The gadget had to allow for extremely easy handling by the astronaut, and
2. The mass of the entire package had to be less than one pound, that is 453 g.

Johannes rushed back to Bern, set up a team of physicists and technicians at the *Physikalisches Institut* to design, manufacture and test in a very short time what was to become the famous SWC experiment, or in short the "Swiss Solar Sail".

During the winter semester 1968/69, Johannes worked as visiting scientist at the Manned Spacecraft Center in Houston. The SWC instrument was ready at that time, but still no specific flight foreseen, as the first missions to the Moon were already fully booked. For security reasons, NASA decided in October 1968 to limit the astronauts' extravehicular activity to one short excursion to the lunar surface, and not to fly the radioactive power supply on the first mission. Therefore, all scientific experiments depending on this power supply were dropped. Johannes now saw his chance coming up as the SWC did not need any power supply, and with the help of Bill Hess, the Science Director of the Manned Spacecraft Center, the SWC got booked for the first flight. Further turbulences arose when NASA decided to hoist the American flag on the Moon prior to mounting the SWC. Again, Johannes could make sure that the astronauts would deploy the SWC before hoisting the US flag and President Nixon's address: a remarkable compromise in favour of science!

The historic moment came on 20 July 1969, when the Apollo 11 Lunar Module (LM) "Eagle" touched down on the Mare Tranquilitatis. Neil Armstrong set the first human foot on the Moon, soon followed by Edwin "Buzz" Aldrin, who, after some walking experi-

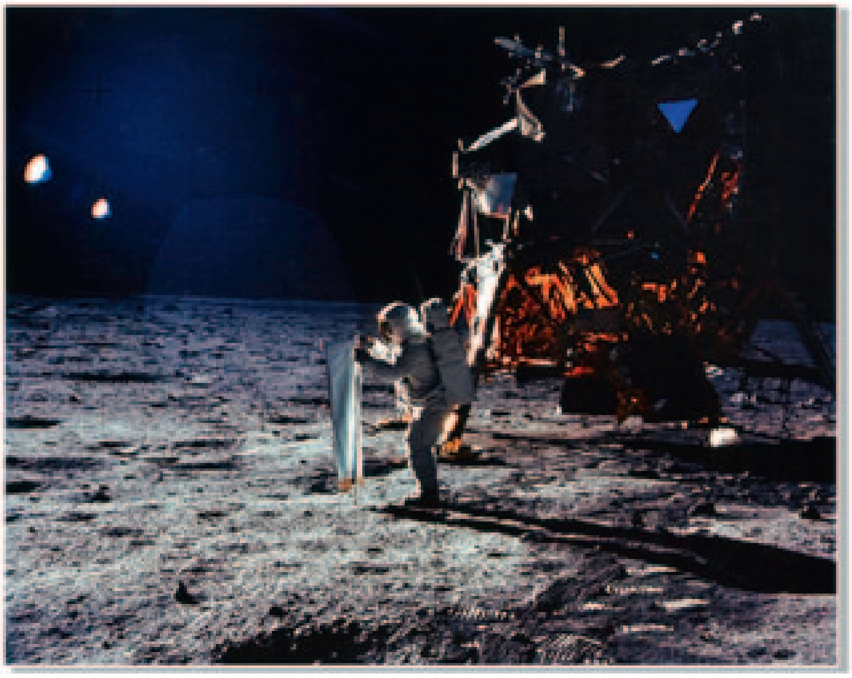

Fig. 15: Astronaut Buzz Aldrin deploying the SWC experiment on the Moon.
(Credit: NASA)

ments, carefully deployed the SWC and two further science instruments **(Fig. 15).** After taking pictures of the landscape, and collecting lunar dust and rocks, Aldrin rolled up the SWC foil, 77 minutes after he had deployed it, and stowed it in the LM. The return flight back to Earth was smooth, and after about two weeks in quarantine in Houston, a courier brought the foil to Switzerland, where the laboratories at Bern and Zürich were ready for the analyses.

Even though the foil's exposure time was much shorter than anticipated, the team was able to determine the abundance of the noble gases helium and neon, as well as the isotope ratios of $^3He/^4He$ and $^{20}Ne/^{22}Ne$.

The Deuterium Puzzle

That was an exciting new frontier as it allowed to estimate the mean baryonic[19] matter density in the universe. Up to 1964, when Arno A. Penzias[20] and Robert W. Wilson[21] discovered the cosmic microwave background radiation, two theories on the evolution of the universe were in fierce competition. Alexander Friedmann[22] on the one hand stipulated an expanding universe (1922) that had commenced with a "Big Bang". On the other hand, the Steady-State theory by Fred Hoyle[23], Thomas Gold[24], and Hermann Bondi[25] (1948) stipulated an ever-expanding universe without a beginning. Mathematically, both theories were valid solutions of Einstein's equations of general relativity, and both were compatible with the observations by Edwin Hubble[26] of the expanding universe (1926). Then, the cosmic background radiation findings gave the Steady State theory the deathblow[27]. Yet, the origin of some isotopes of the light elements could not be explained satisfactorily. In particular, the deuterium and ^3He abundances remained a mystery. The Solar Wind Composition experiment resolved this puzzle. It showed that deuterium was 5 to 10 times less abundant in the protosolar cloud[28] than on Earth or in meteorites, confirming the hypothesis that deuterium was produced in the Big Bang exclusively. ("Deu-

19 i. e. ordinary matter
20 Arnold Allan Penzias, 1933, Munich, Germany, American physicist and astronomer, Nobel Prize laureate in Physics 1978.
21 Robert Woodrow Wilson, 1936, Houston, Texas, American physicist, Nobel Prize laureate in Physics, 1978.
22 Alexander Alexandrowitsch Friedmann, 1888, St. Petersburg, Russia – 1925, Leningrad, Russian physicist and mathematician.
23 Sir Fred Hoyle, 1915–2001, British astronomer and mathematician.
24 Thomas Gold, 1920, Vienna – 2004, Ithaca, New York, Austrian/American astrophysicist and radio-astronomer.
25 Sir Hermann Bondi, 1919, Vienna – 2005, Cambridge, Great Britain, Austrian/British mathematician and cosmologist.
26 Edwin Powell Hubble, 1889, Marshfield, Missouri, USA – 1953, San Marino, California, American astronomer.
27 See *Spatium* no. 24: Cosmic Vision, by Hansjörg Schlaepfer, February 2010.
28 The solar system is thought to have evolved from a large cloud of dust and gas, the proto-solar cloud.

terium in our bodies is authentic Big Bang stuff" [3]). This in turn allowed an estimate to be made of the average density of baryonic matter in the universe amounting to some five atoms per cubic metre[29]. Furthermore, it corroborated the hypothesis that those five atoms give rise to only 5% of the observed gravity while the remaining 95% come from exotic, still unknown forms of matter[30].

The SWC experiment was an outstanding success. NASA decided to include the Swiss Solar Sail in four subsequent Apollo missions, where the exposure time was greatly increased allowing the scientists in Bern to extract more particles out of the foil, and hence to get more precise data.

Cooperating with Heinrich Leutwyler, Alfred Bürgi and Rudolf von Steiger, Johannes developed the theory of the acceleration and motion of heavy ion species in the corona and chromosphere. Such a theory did not exist at the time of the Apollo flights, and it was needed to correctly interpret the results of the SWC and the later solar wind composition experiments.

Thanks to their growing recognition at NASA, the team around Johannes with most notably Peter Eberhardt and Norbert Grögler also participated in the investigation of

Fig. 16: Analysing lunar rock samples. From right to left: Malcolm Brown[32], University of Durham, Norbert Grögler, University of Bern, S. Guggisberg, PhD candidate, University of Bern.

the lunar rock samples returned by the astronauts, **Fig. 16.** They investigated the products of cosmic ray induced spallation. Shortly before the lunar landings, a new radioactive age determination technique, the $^{40}Ar/^{39}Ar$ method had been invented at the University of California in Berkeley. It was successfully applied by Anton Stettler of the Bern group, and later by other PhD candidates. They were able to estimate the ages of mare basalts, as well as the time in the Moon's early history when giant impacts produced the large lunar basins. This in turn gave new insights into the formation and evolution of the Moon[31].

Establishing Cooperation with ESRO and ESA

The launch of Sputnik I had further impacts in Europe. It prompted ten European countries including Switzerland to found the European Space Research Organization (ESRO) in 1962 to jointly exploit the emerging space capabilities for peaceful scientific purposes. Quite naturally, over the years Johannes served this organisation in a variety of roles and leading activities, which in turn helped the *Physikalisches Institut* to participate prominently in a variety of space programmes.

One of his commitments was the membership, later the chair of ESRO's Launching Programme Advisory Committee (LPAC) that directly reported to the ESRO Director General, Sir Herman Bondi. A few years after its coming into being, ESRO's programme turned out to be technically too ambitious, and beyond budgetary constraints. Bondi charged the LPAC with the drafting of an appropriate revised programme. After a series of meetings, Johannes and Prof. Johannes Ortner, who served as the committee's secretary, finalised the report during their winter holidays in Silvaplana, Switzerland. This revised programme was endorsed, and remained the guideline for ESRO's science programme until it was superseded much later by ESA's Horizon 2000 programme.

When the Bernese Apollo team was preparing the first lunar experiments, ESRO commissioned the Zurich-based Contraves AG with

29 See *Spatium* no. 1: Entstehung des Universums, by Johannes Geiss, April 1998.
30 See *Spatium* no. 18: Einstein in Bern: The Great Legacy, by Rudolf von Steiger, February 2007.
31 See *Spatium* no. 4: Earth, Moon and Mars, by Johannes Geiss, June 2000.
32 George Malcolm Brown, 1925, Redcar, England – 1997, Headington, England, British geologist, Professor of Geology at Durham University, Nasa Principal Investigator of the Apollo Moon expeditions.

converting their anti-aircraft missile into the Zenit sounding rocket **(Fig. 17)**. The *Physikalisches Institut* contributed Penning manometers that measured the pressure and temperature profiles on the test launch from the Italian site Salto di Quirra, Sardinia, in October 1967. At the same time, the Bernese physicists began to develop mass spectrometers for atmospheric research and, a few years later, participated in the sounding rocket programme of ESRO, measuring the molecular and ionic compositions in various layers of the upper atmosphere. When ESRO terminated its sounding rocket programme, the *Physikalisches Institut* continued their programme in cooperation with other space agencies.

GEOS

As a follow-up to the Apollo SWC experiment, Johannes intended to study the time variation in the solar wind composition with a spaceborne mass spectrometer. As no mission into the undisturbed solar wind was in sight, he joined forces with Prof. Reimar Lüst[33], Director of the Max Planck *Institut für Extraterrestrische Physik* (MPE) in Garching, and submitted an instrument proposal for the forthcoming geostationary satellite GEOS, the first scientific spacecraft of the newly founded European Space Agency

Fig.: 17: Launch of the Zenit sounding rocket from Salto di Quirra, Sardinia, 1967 (upper panel). Below: after-launch conference, from left to right: Nik Schliep (Contraves), Johannes Geiss, Mr. Lehman (University Geneva), Ernest Kopp *(Physikalisches Institut),* Karl Kotacka (Contraves).

33 Reimar Lüst, 1923, Barmen, Germany, German astrophysicist, President of the Max Planck Society 1972–84, Director General of ESA 1984–90.

(ESA)[34]. After some queries, the proposal was accepted. Peter Eberhardt and Johannes acted as Group Leaders for the *Physikalisches Institut* responsible for the mass spectrometer on the one hand, and Reimar Lüst at MPE for the electronics on the other hand. The GEOS instrument was designed specifically for ion composition measurements in the magnetosphere; it initiated a stunning series of world-standard spaceborne mass spectrometers by the *Physikalisches Institut*.

Johannes subcontracted manufacturing and testing of two flight models to Contraves. Yet it turned out that the Swiss National Science Foundation providing the funding for the Swiss part, was very reluctant to accept industrial partners in such programmes. As we will see later, this experience prompted Johannes to initiate a new institutional arrangement providing scientists as well as industrial partners with a sound basis for participating in the Agency's scientific programmes.

GEOS was launched in 1977 from Cape Canaveral, and the mass spectrometer became a resounding success. The second flight model was launched on GEOS-2 one year later. They allowed scientists to identify for the first time unambiguously the origin of the ions in the Earth's magnetosphere **(Fig. 18)**.

Fig. 18: Receiving data from the GEOS satellite, from left to right: in front Johannes Geiss, behind Karl Knott (ESA), Hans Balsiger, Peter Eberhardt, H. Rosenbauer (MPE), D. Young.

Giotto

At that time, there were plans for a joint ESA-NASA International Comet Mission (ICM), whereby NASA would implement a rendezvous with comet Temple-2, while ESA would execute a fast fly-by of Halley's comet. As NASA decided to step back a few years later, ESA tackled the mission on its own, calling it Giotto[35]. The payload consisted of a camera and three mass spectrometers to identify the matter in the comet's tail. Of course, the *Physikalisches Institut* contributed mass spectrometers, for which Hans Balsiger served as Principal Investigator (PI), while Kathrin Altwegg-von Burg and Johannes acted as Co-Investigators. Peter Eberhardt was Co-I of the neutral gas mass spectrometer.

Giotto was launched by ESA's Ariane-1 launcher in 1985 on a seven-year interplanetary cruise, and then rushed through the comet's coma with a relative velocity of some 245,000 km/h at a distance of a mere 600 km from the comet's nucleus. This breathtaking mission was an outstanding success: it provided the first close-up images of a comet's nucleus and the first in-situ measurements of its gas and dust, and consolidated ESA's fame as a world leader in complex space science missions.

Rosetta-Rosina

When Prof. Roger-Maurice Bonnet took over the helm of ESA's Science Directorate in 1983, he installed two committees to prepare a new long-term plan for the science programme, called the Horizon-2000 plan. This document had on the one hand to stimulate the European science community, and on the other to secure the timely availability of new enabling technologies. After some preparative work, the Topical Teams came up with a programme characterized by three large "Cornerstone Missions". The proposals were:
- for astronomy: the x-ray multi mirror mission (XMM),
- for astrophysics: the far infrared Herschel Mission, and for

[34] ESA was founded in 1975 as a successor organization embracing both the former European Space Research Organization (ESRO) and the former European Launcher Development Organization (ELDO).
[35] In honour of Giotto di Bondone, 1266, Florence, Italy – 1337, Florence, Italian painter, creator of the famous painting *Adoration of the Magi* in the *Scrovegni Capel* in Padua in 1305 showing the Halley comet, one of its earliest representations in history.

- solar system science: the combined SOHO-Cluster mission.

These proposals were well received by the Survey Committee, but it was up to Johannes to submit a fourth, unsolicited proposal for a mission in the field of planets and comets termed "Planetary Mission to Primordial Bodies/Including Return of Pristine Material". While the sample return part had to be cancelled later due to reasons of cost, the primordial bodies part became the Rosetta mission currently underway to comet Churyumov-Gerasimenko[36]. The *Physikalisches Institut* continued its tradition by contributing another mass spectrometer, this time bearing the affectionate name *Rosina,* with Hans Balsiger and later Kathrin Altwegg-von Burg as PI.

Fig. 19: Scientific talks on the roof of the **Physikalisches Institut,** from left to right Johannes Geiss, Joseph Fischer, and George Gloeckler (University of Maryland).

Ulysses-SWICS

As a result of the formation of the solar system, all planets circle the Sun nearly in the ecliptic plane, and therefore all space probes also move near the ecliptic plane. This was true at least until 1992, when the joint ESA-NASA spacecraft Ulysses swung-by Jupiter, bringing it far out of the ecliptic plane on an orbit towards the Sun's poles. In the frame of an international consortium, the *Physikalisches Institut* contributed to the Solar Wind Ion Composition Experiment (SWICS), a special time-of-flight mass spectrometer designed by Prof. George Gloeckler[37] of the University of Maryland, **Fig. 19.** The ESA built spacecraft Ulysses was launched by the US Space Shuttle in October 1990, and it remained operational for the subsequent 19 years completing three 6-year orbits around the Sun.

The unique orbit of Ulysses allowed for the first ever measurements over the poles of our daytime star. George Gloeckler, Johannes and Rudolf von Steiger evaluated and interpreted the solar wind composition data[38]. The results of the wind speed and temperature measurements are shown in **Fig. 20.** It turns out that the speed of the solar wind (more precisely that of helium) is fast and nearly constant at high latitudes reaching some 800 km/h, whereas it is slower and more variable in lower latitudes. The solar corona temperature on the other hand is lower at high latitudes, while it reaches values of some 2.5 million K near the ecliptic plane. It is obvious how much our portrait of the Sun has gained by including high solar latitudes thanks to Ulysses.

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36 See *Spatium* no. 4: Kometen, by Kathrin Altwegg-von Burg, October 1999.
37 George Gloeckler, 1937, Professor of Physics at the University of Maryland, investigated the heliosphere in three dimensions with experiments on the Voyager and Ulyssses spacecraft.
38 See *Spatium* no. 2: Das neue Bild der Sonne, by Rudolf von Steiger, November 1998.

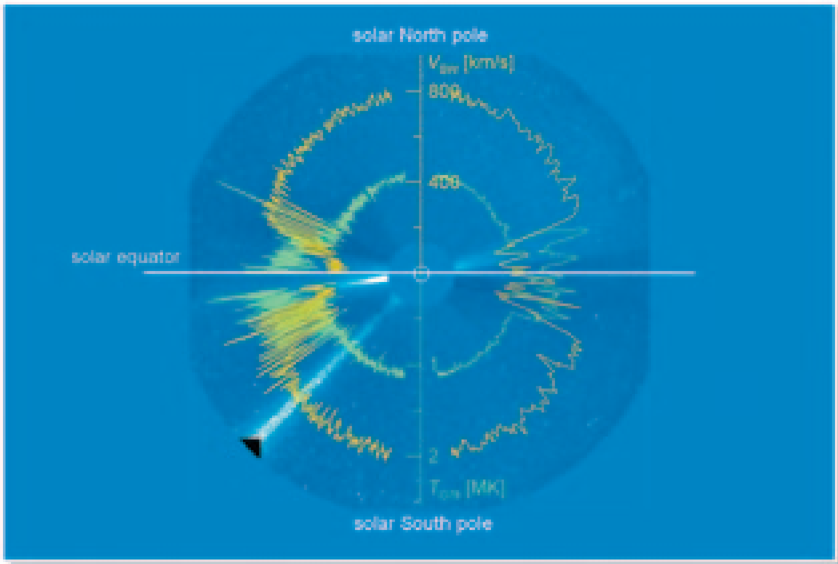

Fig. 20: Probing the solar wind with the Ulysses / SWICS instrument: The yellow line indicates the speed of the solar wind while the green line shows the corona temperature. (Credit: R. von Steiger).

Pioneering the Swiss Space Community

After the foundation of ESRO, the question came up as to whether a Swiss national space science programme or even a dedicated Swiss space institute should be set-up to manage the programmes with ESRO. Sticking to his paradigm of science first, Johannes advocated the direct cooperation of scientific groups with ESRO, as space science is not a scientific discipline per se, but rather a novel method that would become important in many scientific fields. Furthermore and not least, such an institution would absorb significant parts of the limited resources available in Switzerland at the expense of scientific activities.

PRODEX

Yet, Swiss participation in ESRO programmes turned out to be much more difficult than expected because ESRO (as well as the later ESA) did not support scientific groups in its member states. Rather, these had to find their funding sources on national grounds. This in turn severely hampered Swiss participation, because of a specific Swiss problem: whereas membership in international organizations (UNESCO, CERN, ESRO, ESA) was handled by the Federal Department of Foreign Affairs (DFA), support for research and education, including the National Science Foundation (SNSF), is the concern of the Federal Department of the Interior. The difficulties encountered when negotiating the financial support with the SNSF for the GEOS mass spectrometer prompted Johannes to act. To this end, he contacted Dr. Peter Creola, who had just returned from ESA's headquarters, to taking over the helm of the Swiss ESA delegation, and Dr. Jean-Pierre Ruder of the Department of the Interior. The trio designed the Prodex (Programme de dévelopment d'expériences), and got it accepted in Switzerland and by ESA too. In contrast to ESA's science programme, which is mandatory for all member states, Prodex is designed as an optional programme intended to serve the participating states in the development of scientific instruments.

SOHO-CELIAS

The first cornerstone mission of ESA's Horizon 2000 programme was SOHO[39], and CELIAS[40] became part of its payload. This mass spectrometer was proposed by an international consortium with Dieter Hovestadt of the *Max Planck Institut für Extraterrestrische Physik* and Johannes acting as Principal Investigators (PI): After the two retired, Peter Bochsler became the sole PI. When it came to negotiating the industrial contract for CELIAS, Johannes felt the need to secure the PI an equal footing vis-à-vis ESA and industry. The idea gained full acceptance by Roger M. Bon-

[39] Solar and Heliospheric Observatory.
[40] Charge, Element, and Isotope Analysis System.

net, who set-up the Prodex office to address the complex contractual issues. In addition, he appointed Dr. Henk Olthof head of the Prodex office. Not least thanks to Olthof and his group's convincing pragmatism, the programme became an outstanding success. Prodex has attracted various other ESA member states such as Austria, Belgium, Denmark, Ireland, Norway, Hungary and the Czech Republic. It has also begun to serve as a backstair for other nations to gain access to ESA, and eventually become full members of ESA.

Certainly, Prodex was instrumental in securing the *Physikalisches Institut* its role as a major player in the European space science league. Yet, it also stimulated the emergence of a variety of space research activities at different institutions in Switzerland, such as the ETH Zurich, University of Zurich, Geneva Observatory; *Paul Scherrer Institut* at Villigen, and the *Physikalisch-Meteorologisches Observatorium,* Davos, just to name a few. As the Prodex rules require at least 50% of a Prodex grant to go to industry, a small, but recognised Swiss space industrial community could emerge. Thanks to Prodex, Swiss made instruments can be found today on the majority of ESA's science missions.

Creating ISSI[41]

Now that the *Physikalisches Institut* had acquired worldwide fame, and the co-operation between Switzerland and ESA was well underway, one might expect Johannes to look for repose. Nothing could be more wrong! Rather, he saw the need for providing the still fragile Swiss space science community with a focal point to secure worldwide recognition.

An impressive fleet of scientific spacecraft orbits somewhere deep in space, delivering huge amounts of data daily down to Earth. The instruments aboard those spacecraft have become increasingly complex, and so has the task of interpreting the data. From his experience with NASA and ESA, Johannes saw the need for enhancing the science return of these missions by improving the interactive, international and interdisciplinary data evaluation and interpretation process. To this end, he intended to create an institute that could host scientific teams from all over the world.

At an informal meeting in 1989, Prof. Gustav A. Tammann of the University of Basel, and Prof. Martin C. E. Huber of the Swiss Federal Institute of Technology, Zurich, agreed to give his idea a try, which in turn found support also by Reimar Lüst and Roger M. Bonnet of ESA. Lüst proposed that the IACG[42] should take over the patronage even though not all IACG members could be expected to contribute directly to funding the new institute. Rather, it was envisaged that ESA and Switzerland would become its main sponsors, while other IACG members might contribute according to their specific possibilities and rules.

Johannes looked for and got support in the east, from Prof. Roald Sagdeev, Soviet Academy of Sciences, and in the west from Prof. Len Fisk, NASA's Associate Administrator of Science. Upon finding support on international grounds, time had come to address the Swiss authorities. To this end, Johannes motivated a group including Gustav A. Tammann, Prof. André Maeder, University of Geneva, Hans Balsiger, Hanspeter Schneiter, Chairman of the Swiss Space Industry Group, and later Prof. Bernhard Hauck, University of Lausanne, and Prof. Andreas Ludi, Rector of the University of Bern, to pursue the idea in Switzerland.

It was up to Hanspeter Schneiter to draft a letter to the Federal Council in 1991. Their answer was friendly though non-committal. Still, some months later, State Secretary Heinrich Ursprung invited the group to discuss their proposal. It was agreed that the group would search for the required premises,

41 International Space Science Institute.
42 The Inter-Agency Consultative Group (IACG) for Space Sciences is an international forum of the European Space Agency(ESA), the Institute of Space and Astronautical Science (ISAS), Japan, the then Intercosmos Council of the Soviet Academy of Sciences, now the Russian Aviation and Space Agency (RASA), and the National Aeronautics and Space Administration (NASA).

while the State Secretary would look after an eventual federal funding source.

The initial steps were more difficult than the group had assumed, yet luck was on their side: early 1994, Johannes received the surprising news that the Government of the Canton of Bern had agreed to contribute the start-up financing for the first four years of operation. In order to create an official point of contact for the authorities, the group founded Pro ISSI, an association under Swiss law, and elected Johannes as president, Bernhard Hauck as vice-president, and Hanspeter Schneiter as treasurer, with Hans Balsiger, Andreas Ludi, André Maeder, and Gustav A. Tammann as further members of the board. Johannes is credited with having paid the first CHF 100.– into our association's empty account.

The commitment of the Canton of Bern got the ball rolling: the federal authorities followed by granting support for the first two business years.

In order to finally secure ESA's contribution, a document needed to be created that specified the *idée de manœuvre* of the institute. Upon a request by Jean-Marie Luton, Director General of ESA, Johannes drafted the brochure "ISSI – International Space Science Institute" (2). Its opening statement reads as follows:

"It is proposed to create an institute in Switzerland at which scientists from many countries can work together to achieve a deeper understanding of the results from space missions, adding value to those results through multidisciplinary research in an atmosphere of international cooperation."

Who could ever better define Johannes' credo than he does here with his own words? Sure enough, they did not miss those to whom they were addressed: together with further contributions by Andreas Ludi and Hanspeter Schneiter, and upon formal approval by the IACG members, the document served the ESA Council to pass the financial support of the new institute, not least thanks also to a skilful presentation by the Swiss representative, Peter Creola.

Now that the financial aspects were settled at least for the initial phase, the issue of the legal framework came up. Hanspeter Schneiter proposed running the institute under a foundation with Contraves AG, Zurich, as the founder, offering an endowment of CHF 100,000.–. Not surprisingly, the idea found rapid acceptance. The foundation's board of trustees was established which in turn started ISSI on 1 May 1995, appointing Johannes as Executive Director, Rudolf von Steiger as Senior Scientist, and – in September 1995 – Professor Bengt Hultqvist, University of Stockholm, as a further member of the Directorate. The board rented the premises at Hallerstrasse 6 in Bern, Johannes hired the staff, and Rudolf von Steiger ordered the necessary technical infrastructure. When everything was in place, ISSI's thrilling pioneering phase had come silently to an end, and a new brilliant star was borne …

The institute was barely ready, when the first workshop took place at ISSI on "The Heliosphere in the Local Interstellar Medium". The event was a resounding success, and as a tangible result, the first volume in the Space Science Series was published followed by some three to four additional reports per year.

After having fulfilled the Pro ISSI association's first objective of creating a space science institute in Switzerland, its second mandate of conveying the fascination of space science to its members, and to the public at large, was addressed with priority. Together with Dr. Hansjörg Schlaepfer, Contraves AG, Zurich, serving as editor, Johannes created the Spatium series. The first issue on *"Entstehung des Universums"*[43] appeared in April 1998, and was well received by the sponsoring authorities, the Pro ISSI members, and also by the many scientists visiting ISSI. Further issues followed at a rate of one to three volumes per year. *Spatium* endeavours to maintain scientific correctness while using an easily understandable communication style.

[43] Emergence of the Universe.

When Johannes saw that the new star ISSI had reached a safe orbit in the international space science community, time had come for him to retreat. Expressing their gratitude for an outstanding achievement, the ISSI board of trustees nominated Johannes Honorary Director at the end of 2002, thereby adding a humble further line on his long record of honours and awards.

New York, 1955

Seven days after her departure from Rotterdam, the *MS Maasdam* arrives in New York. The New World's famous symbol, the Statue of Liberty gives her its welcome. Disembarking is fast at that time: Carmen and Johannes rush to the nearest taxi that takes them to the Greyhound Station in Manhattan. The long nightly ride brings them to Chicago: a new exciting phase in their young lives begins.

References

The following list provides the reader with a non-exhaustive list of related papers. In addition, the reader might be interested in other articles published in the Spatium series so far, see back cover and ISSI's home page www.issibern.ch.

(1) Cesare Emiliani, Johannes Geiss: On glaciations and their causes, Geologische Rundschau, Volume 46, Number 2, 576-601

(2) Johannes Geiss et al.: ISSI International Space Science Institute, Association Pro ISSI, http://www.issibern.ch/associationproissi/history.html,

(3) J. Geiss and G. Gloeckler: Evolution of Matter in the Universe, in The Solar System and Beyond, ISSI Scientific Report, SR-003, ESA Publications Division, 2005

(4) Stephan Zellmeyer, A Place in Space, The history of Swiss participation in European space programmes 1960–1987, Beauchesne, Paris, 2008

(5) Kathrin Altwegg, Hans Balsiger, Beat Hugi (Eds.): Archäologie im All, Die Suche nach dem Ursprung des Lebens, Paul Haupt Verlag, Bern, 2009

(6) Thomas Myrach et al. (Hrsg.): Science & Fiction, Imagination und Realität des Weltraums, Berner Universitätsschriften, Haupt Verlag, 2009

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