ANNIVERSARY 25 YEARS EDITION

INTERNATIONAL SPACE SCIENCE INSTITUTE

2019/2020 Annual Report

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Cover Page

The puzzle is composed of six images (from the upper left to the lower right):

1. Image showing a natural-color capture of a plankton bloom in the Barents Sea by the Sentinel-2A satellite (Image Credit: Copernicus Sentinel data (2016), processed by ESA)

2. Image of Jupiter, taken by the NASA/ESA Hubble Space Telescope on 25 August 2020 (Image Credit: NASA, ESA, A. Simon (Goddard Space Flight Center), M.H. Wong (University of California, Berkeley), the OPAL team)

3. Perseverance Rover Decelerating in the Martian Atmosphere (Illustration) (Image Credit: NASA/JPL-Caltech)

4. ESA's Solar Orbiter is revealing the many faces of the Sun (Image Credit: Solar Orbiter/ EUI Team; PHI Team/ ESA & NASA)

5. Artist's impression of a supermassive black hole at the center of a galaxy (Image Credit: ESO/L. Calçada)

6. Simulation of gas cloud after close approach to the black hole at the center of the Milky Way (Image Credit: ESO/MPE/M. Schartmann)

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The International Space Science Institute (ISSI) is an Institute of Advanced Studies where scientists from all over the world meet in a multi- and interdisciplinary setting to reach out for new scientific horizons. The main function is to contribute to the achievement of a deeper understanding of the results from different space missions, ground based observations and laboratory experiments, and adding value to those results through multidisciplinary research. The program of ISSI covers a widespread spectrum of disciplines from the physics of the solar system and planetary sciences to astrophysics and cosmology, and from Earth sciences to astrobiology.

From the Chairman of the Board of Trustees

This Annual Report is related to a period of time which has been unusual in many ways.

Above all, it is with great sadness that the ISSI staff and community learned the passing away, on January 30, 2020, of Johannes Geiss, founding father and first Executive Director of ISSI. We shall always be very grateful to Johannes for his enlightened vision and outstanding leadership: without him, ISSI would not exist. Two contributions to this Annual Report celebrate his memory.

This unusually long business year, the ISSI 25th one, lasted from July 1, 2019 to December 31, 2020. These additional six months are the consequence of a decision taken on June 18, 2020 by the ISSI Board of Trustees, in relation to some budgetary events which offered the opportunity of making, in the future, both business and civil years to coincide at ISSI.

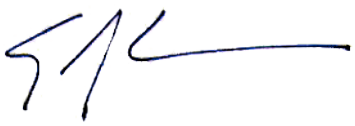
On March 5–6, 2020, the Board of Trustees and the Directorate met for a retreat in order to discuss the adequacy of the current ISSI activities in relation to the present and future needs of the space science community. This brainstorming exercise resulted in a series of recommendations, e.g., moving to open access publications, which were summarized in a plan of action submitted in April, 2020 to ESA and the Swiss Confederation. Since then, both of these funding agencies have renewed their financial commitment to ISSI.

Of course, this 18-month-long period is also unusual because of the Covid-19 pandemic which has severely perturbed all ISSI activities. The "raison d'être" of ISSI – bringing scientists together in Bern in a multi-disciplinary atmosphere with the aim of scientific added values – has been significantly disturbed. ISSI has adapted to these weird times in switching, in a way similar to many other academic institutions, to mostly on-line interactions and in creating the successful ISSI Online Seminar Series.

An important event of this past period was the signature, in August 2020, of a Memorandum of Understanding between ISSI and NASA, through the Universities Space Research Association. The latter will indirectly fund ISSI activities via in-kind participation to US scientists traveling to ISSI Bern.

The Covid-19 has prevented us, so far, from meeting in person the new ISSI-BJ Executive Director, Prof. Wing Ip, who took up his duties in June 2020. We look forward to further developing the already excellent and productive synergy between our two institutes.

We are grateful to all ISSI main actors, namely, its directorate and its staff, its Science Committee, and its Board of Trustees, for their excellent work and continuous dedication. ISSI is extremely grateful to all its funding agencies, national and international, for their essential support.



Georges Meylan
Chairman of the ISSI Board of Trustees
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, January 2021

From the Directors

Back in mid-2019, we were looking forward to a special year celebrating the 25th anniversary of the founding of ISSI. Little did we anticipate how extraordinary the year would become, and in more ways than we could have imagined.

On January 30, 2020, ISSI's founding father and Honorary Director, Johannes Geiss, passed away at the age of 93. This is a momentous loss for the institute, which would literally not exist without his foresight and dedication. Two pieces written by eminent colleagues of Johannes can be found in this annual report, and an obituary is available at the ISSI webpage.

In mid-March, 2020, Switzerland was ordered into a lockdown due to the Covid-19 pandemic, and all activity at ISSI came to a sudden stop. At first, we simply postponed Workshops and International Team meetings by a few months, but then it became clear that the situation would not improve so quickly. As a consequence, we took several initiatives in order to continue serving the space science community. This includes a boost in digitalization, which started in the Spring of 2020 with the relaunch of our website, which is now entirely based on the secure https protocol, and is currently being enlarged for making available a suite of tools for online meetings and collaborations. We also started a new weekly "Game Changers" webinar series on how missions change(d) our view of the solar system, the universe, and the Earth. Further, we are enlarging our seminar room and equip it with the latest hardware for hybrid meetings, anticipating that travel restrictions will remain with us for some time. Nevertheless we hope to return to in-person meetings as soon as possible because these are ISSI's *raison d'être*.

As a consequence of the large number of postponed meetings it was decided to make the 25th business year special in yet another way, namely by adding an extra six months and extend it to the end of 2020. Even though meetings could not be resumed during these extra months this has the advantage that, as of 2021, the ISSI business year will coincide with the calendar year, so the sometimes confusing 6-month shift will be removed.

Only a single Workshop could be held before the lockdown, and another was held in hybrid form between the first and second wave of the pandemic. All the others had to be postponed to 2021 or beyond. None of these Workshops were canceled, though, and they are currently started using a new, alternative scheme involving much online collaboration. In addition, there was one Forum meeting, but a second one had to be postponed and will now be held remotely. Up to the lockdown 45 International Team meetings could be held, but again an even larger number was postponed. All these activities are described in more detail in this annual report. Together they brought 596 visitors to ISSI, 38% of which were coming for the first time. Seven new volumes in the Space Sciences Series of ISSI resulting from earlier Workshops were added to the publication record. We are currently negotiating with the publisher to find ways for making these volumes fully open access, thus responding to an increased demand from scientists who are obliged by their funding agencies to publish open access.

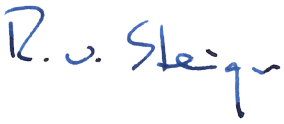
The ISSI Science Committee met for three regular meetings (two of which online), reviewing and discussing all future activities. The Fall 2019 and 2020 meetings were devoted to reviewing Workshop, Working Group, and Forum proposals as well as the Earth Science Work Package and their implementation in the forthcoming year. In the Spring 2020 meeting the Committee primarily reviewed 73 proposals for International Teams and recommended 32 for implementation, five of which are joint with ISSI-BJ. The somewhat lower number of proposals is probably due to the pandemic, but given their high quality the number of accepted ones could be held the same.

On the ISSI staff we had the rare privilege of celebrating a very special event: Silvia Wenger is working at ISSI since its foundation, and we thank her warmly for a quarter century of untiring dedication and service. On the other hand we also had a number of significant changes. After nearly two decades, our computer engineer and system administrator, Saliba F. Saliba, decided to take a challenge and move to a bigger institute at the University of Bern nearby, so he left ISSI at the end of 2020. Thousands of scientists will remember his always quiet and friendly service, getting them started with their work within minutes of their arrival. We thank him for his unusual loyalty to ISSI and wish him all the best in his future capacity. Then, our part-time secretary Jennifer

From the Directors

Fankhauser found a new position closer to her home and family, so she left ISSI in October, 2020. However, after about a year of absence, she will be back, even with an increased part-time tenure. Finally, at the end of 2020, our full-time secretary Alexandra Lehmann left ISSI in order to take a job that would allow her time for further education in parallel. We thank her warmly for nearly five years of service and wish her success and satisfaction with her future projects. The positions were announced immediately, and luckily, they could be filled even with an overlap of one month. We are very happy to warmly welcome Yemisi Momoh as our new secretary and Willi Wäfler as our new computer engineer and system administrator, and look forward to working with them in the future. We acknowledge the future will be challenging due to the backlog of meetings caused by the pandemic, but we are all very determined to continue serving the space science community every way we can.

Tilman Spohn



Rudolf von Steiger

Anny Cazenave

Joachim Wambsganss

The Power to Convene Diverse Teams of Thought and Action

In Memoriam Johannes Geiss

Johannes Geiss talking enthusiastically about the Solar Wind Composition (SWC) experiment on the Apollo 11 mission (Picture taken by Max Füri at ISSI during an interview in May 2001).

Science is a team-sport. Whether it is building space missions, analyzing data or developing theories and models that integrate and relate seemingly unrelated measurements, the best science is done with teams, and often international teams, with the broadest membership possible. This key insight guided Johannes Geiss' life. From his breakthrough solar wind measurements as part of the Apollo program, to his work with NASA and ESA on Ulysses, and ultimately, his initiative that gave rise to International Space Science Institute (ISSI), Johannes knew the power of convening diverse teams to achieve new and crucial science.

This is precisely what Prof. Geiss taught me during the months after his retirement. On the day of his retirement, with Swiss accuracy and without wasting a day, his office moved from the sunny floors of the Physics Institute overlooking the medieval city of Bern, to the grey "dungeons" on the so-called B-level.

I did not know this famed professor very well before that. I had bumped into Prof. Geiss as an undergraduate on the way to my laboratory, where I was testing the properties of the WIND MASS sensor, an instrument pioneering high-resolution solar wind composition measurements of cosmological importance. I had observed that whenever I started talking to Geiss, it took about an hour – giving rise to a new unit of time (1 Geiss = 1 hour of discussion). I loved these discussions because I learned so much from him. On the one hand, he told stories, often nested in each other like a Russian doll. And on the other hand, he never hesitated to summarize and highlight the conclusions from these stories and what they meant for the pursuit of science worldwide.

On the day of his retirement, Prof. Geiss talked to me about the unique position of Switzerland to bring together the international science community. In his marquis Swiss-German accent, he told me about the unique power Switzerland had due to its neutrality, its beauty and its size – it can convene teams of action like no one else can. He wanted to build an institute, funded by several partners, to do science enabled by convening scientists from around the world – the International Space Science Institute. And he wanted them to work, not to just sit around and talk while drinking coffee.

In Memoriam Johannes Geiss

He had a clear vision, but it took many years until that vision turned into reality. I sat in meetings at both local and Swiss national levels that made me convinced of the value of perseverance in the face of jealousy and aversion to change.

Finally, the invitations were sent out for the first workshop focused on the outer heliosphere and the local interstellar medium. This promised to be highly exciting, especially because of recent progress in experimental results from Ulysses and others, three-dimensional MHD modeling of the large-scale heliosphere, and novel and very telling observations of signatures of interactions of stellar spheres with their local galactic environments. The list of attendees was astonishing, encompassing all leaders worldwide who had contributed to this topic. But here was the problem: due to the size and magnitude of this first workshop, students were not allowed. I was devastated. Here was what promised to be one of the most important workshops in my career happening in my backyard, and I was locked out? At this time, I was only months away from graduating with a PhD and getting ready to move to my new boss at the University of Michigan for what I then thought was one year.

I asked Prof. Geiss if I could attend his meeting. He looked at me sheepishly through his thick glasses and responded: "Are you willing to work for it?" That was a no-brainer for me. Growing up, I had spent every vacation earning money doing many jobs, from stacking yoghurts, shoveling manure, and also once as a part-time bartender. The deal was made in two minutes: he would allow me to attend, but I needed to serve food and pour wine for the international guests during the breaks and social events.

Soon enough, the conference started and – even though I was spending most nights finishing my thesis – I was sitting there during the daytime taking notes and listening to my idols from around the world. And even better, I was the guy with the wine-bottle at night, doing my duty and listening to stories just as expected from a bartender, getting to know my heroes of the past who would become future friends. I loved it, and Johannes reminded me several times that it was his idea that got me there.

I sometimes chuckle about the broad impact this event had on my life and career. I met scientists from around the world that I now consider my friends, and the questions that came up in that meeting, in part, became topics of my research as a post-doc and beyond. Here is a specific anecdote that occurred.

Participants of the 1st ISSI Workshop on "The Heliosphere in the Local Interstellar Medium" held in November 1995. Johannes Geiss is pictured in the front row, and the young eager student Thomas H. Zurbuchen is standing in the last row, fifth person from left.

About a month after the conference, I received a package from Russia from one of my new friends whom I'd met with bottle in hand and who was the former director of the Russian Space Science Institute in Moscow. He sent me a package with books and an accompanying handwritten card: "thanks for doing such a good job pouring wine and your interest about space science. Here are some books I wrote that are no longer in print and I am sure you will find useful".

I will never forget this gesture from this pioneer of space, and I will always see it as Johannes Geiss' vision having immediate impact in my life. Because of Johannes' vision, I learned that there is a transformational power in convening diverse teams of action. I still own the book that resulted from that first ISSI workshop, and its papers still get cited.

I have been observing the progress of ISSI and its lasting impact in the global science community. I did a sabbatical there and spent many weeks with my dear friend and ISSI Director, Dr. Ruedi von Steiger, doing some of the most important research of my career. I have spent many Geiss units of discussion there with Johannes and many other visitors from all over the world. I understand science better as a result of it, but equally importantly, I understand the process of building a science community and working better as a result of the diversity of these interactions.

In fact, convening international science teams is a natural and enabling part of science itself. When unimpeded, the pursuit of science can unite leaders and communities around the world. Oftentimes, we find that nations clump together. For instance, NASA collaborates with over 130 countries, but the majority of its collaboration is currently with ten countries. We know that something profound happens, particularly in science, when these leaders from diverse backgrounds come together in a common scientific pursuit: they learn new approaches and perspectives which can yield new insights that were not possible previously. This world-wide force of science spurred by greater diversity of opinion and background is one of my most important hopes for humanity in these uncertain times. Encouraged by Prof. Geiss, I've witnessed in my own life's experience how the unifying and connective power of science can address threats and provide new and unprecedented opportunities. And, even though I am now working in an arena where science activities are sponsored by national agencies, the pursuit of science is enabled by policies and actions that connect the world-wide community as a whole. Johannes Geiss understood this viscerally and – more importantly – he understood that diversity in teams yields exponentially more results, especially by teams that actively want to share their data and approach research together.

In that sense, ISSI is like a central waystation in the broad network of highways that make up the global Space and Earth Science communities. It is where travelers meet and exchange stories and opinions but it is also where they become friends and learn how to work together.

I will never forget that first discussion on the grey floor of the physics building. The vision I learned there, put to work by the founder Prof. Johannes Geiss, has grown with all its subsequent directors into a force to be reckoned with. And, as I told Dr. Günther Hasinger, my colleague and friend at the European Space Agency, ISSI is something I envy him for and am glad I could be part of it, along with so many other American scientists.

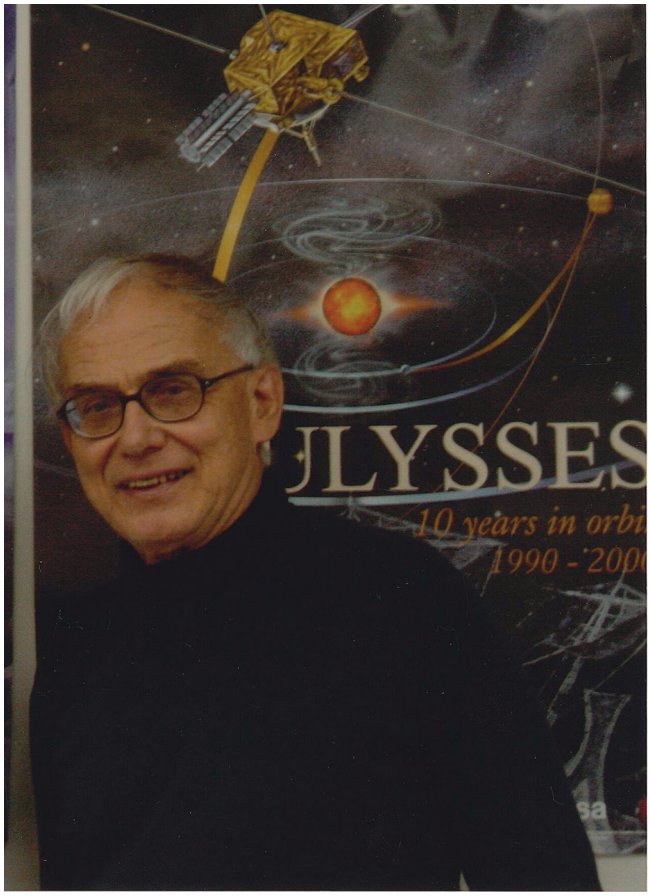
Because, once you experience the excitement of an international team in action, convened at ISSI, you will personally understand what Johannes knew deep within: this IS what science is all about.

Thomas H. Zurbuchen
NASA Associate Administrator for the Science Mission Directorate

Group picture of the joint ACE-ISSI Symposium on the "Composition of Matter" honoring the occasion of Johannes Geiss' 80th birthday in September 2006. The special symposium took place in Grindelwald, Bernese Alps, Switzerland. Johannes Geiss is standing in the front row, Thomas H. Zurbuchen moved forward to the second to last row.

Extraordinary Physicist, Space Science Pioneer, Creator and Promoter of ISSI

In Memoriam Johannes Geiss



Johannes Geiss

Johannes Geiss, the founder of ISSI, died on 30 January 2020, at age 93. He was an extraordinary physicist, widely recognized as a world leader and foremost expert on the composition of a large number of astronomical objects, including meteorites, the Moon, the Sun, comets, planets, the interstellar medium, the proto-solar nebula, and the early universe.

The Physicist

As a student of Max von Laue (Physics Nobel Prize 1914) and Wolfgang Paul (Physics Nobel Prize 1989), Johannes Geiss received an education well-grounded in theoretical and experimental physics. As a co-worker of Fritz Houterman (German atomic and nuclear physicist), Johannes' pioneering work began in the 1950s at the Physikalisches Institut of the University of Bern, which he led through 1990. There, he undertook original theoretical research, and developed ultra-high-vacuum, closed-system mass spectrometry techniques and applied them to isotopic measurements of deep-sea cores to determine the climate history of Earth. He then used the composition of meteorites to determine the history of cosmic rays. With Hubert Reeves he deduced the deuterium abundance in the proto-solar cloud 4.6 billion years ago, with profound implications for the history of the Universe.

The Space Science Pioneer

In the 1960s, he conceived and developed five brilliant collecting foil experiments on the NASA Apollo lunar missions and measured for the first time the composition of the solar wind noble gases and determined the history of the Moon. The success of these original experiments granted him the admiration of NASA, of his American colleagues, and a world-wide reputation. These measurements remain to this day the standard, and the technology that he invented has been used in several foil experiments on the MIR station and the NASA Genesis mission. His mastering of time-of-flight spectrometry composition measurements, led him and his students and colleagues to use this technique in instruments on an impressive number of International space missions. Together with Professor George Gloeckler of the University of Michigan, instruments were flown on the ESA Ulysses mission, the NASA Advanced Composition Explorer (ACE) and WIND Spacecraft, and the ESA Solar and Heliospheric Observatory (SOHO).

The Pioneer of European Space Science

The success of Johannes Geiss' Apollo experiments, and the excellent contacts he established with NASA, offered the Europeans a unique expertise for dealing with the delicate policy problems that arise in international cooperation. It was natural then that Johannes Geiss was invited to help set-up the European space program, first in the framework of the European Space Research Organization, ESRO, in the mid-1970s, and then in 1974 for its successor organization, the European Space Agency, ESA. At the same time, he played a fundamental role in the development of Switzerland's space science program, and its contributions to the success of the current ESA program. Together with his colleagues Martin Huber from the Swiss Institute of Technology in Zurich and Andreas Tamman from Basel, he convinced the Swiss Government to fully engage in the financial battles at the ESA Council. The result was the creation of the Horizon 2000 Program in 1985 and its Cosmic Vision successor, making ESA second after NASA with its many successful paradigm-shifting missions, among which are Rosetta, Planck, SoHO, Cluster, Herschel, XMM, Newton, GAIA, and many others. He was a strong advocate of international cooperation in space research and successfully promoted all these missions and many others to the

world space science community. Under his leadership the Physikalisches Institut in Bern attained worldwide recognition, and many of his graduate students are leaders in space physics today.

Johannes Geiss was a genuine creator of clever ideas. Under his initiative, and for the benefit of the Swiss space science community, he created the so-called PRODEX program, which allowed Switzerland, then ESA Member States Belgium, Norway, Ireland, Austria, Denmark, and Hungary to bring new money to ESA for the development of experiments. The total number of PRODEX members reaches now 16 ESA member states.

The Founder of ISSI

There are some common themes in Johannes Geiss' career: A passion for scientific discovery. The desire and ability to lead, forever seeking a more capable, bolder space science enterprise. And above all, the recognition of the importance of international cooperation, and the singular ability to facilitate it. It is no surprise then that towards the end of his distinguished career, he would draw upon all the threads of his career, science, leadership, international cooperation, and create the International Space Science Institute (ISSI).

ISSI was an outgrowth of the Interagency Consultative Group, a loose federation of four main space science organizations – NASA (USA), ISAS (Japan), IKI (Russia) and ESA (Europe) – which coordinated the exploration of Halley's Comet and thereafter the study of solar terrestrial physics. Space research had by then reached a stage where coordinated efforts using many experiments on many spacecrafts, as well as ground-based observations and theoretical modeling, offer unique physical and observation material for advancing our understanding of the Sun, the Earth, and the Universe beyond.

The question was how best to do this coordination particularly if the goal is to advance science. Agencies are good at planning and executing space missions. Scientists are good at advancing science by coordinating the analysis and interpretation of the data that missions produce, and connecting theorists and their models with data produced by experimentalists. All the scientists need is an opportunity and an organizational structure that enables and facilitates cooperation, and yields demonstrative results from this cooperation.

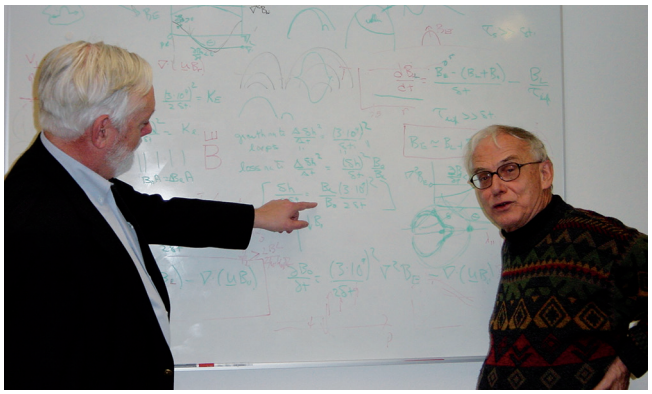
This is the genius of Johannes Geiss' concept for ISSI. An organization that would gather scientists together in Bern, not to plan missions, not to build hardware or fund

Johannes Geiss, few days after the start of ISSI at the Hallerstrasse 6 in Bern in May 1995.

research, but on a volunteer basis, with only in-country costs provided, to hold workshops and team meetings that result in books that summarize the state of a discipline, and scientific papers that advance the field. There is no other institution like ISSI, and scientists over the years have come in droves.

As with many new and original concepts, when ISSI was forming in 1990–1994 the very concept had to be sold, and needed funding obtained. And Johannes Geiss was singularly able to do this. In 1994 he created the Association Pro ISSI, a society, with initial funding from Contraves to promote the idea of ISSI within Switzerland, in view of getting the approval of the ESA council. The long-term friendship between Johannes Geiss and Reimar Lüst, dating back to the creation of ESRO, was also essential, materialized at the time of selecting the first ISSI Executive director. Lüst Insisted that the Director should be a world-class space scientist and he could not propose any one better than Johannes Geiss to take on such a responsibility. Geiss agreed happily and, at the same time, supported Lüst's request that the ISSI Board of Trustees should include a representative of the space agencies involved in Comet Halley's flyby missions: ESA, ISAS, NASA and IKI, already cooperating in the framework of the IACG. This recommendation is still implemented today as can be

In Memoriam Johannes Geiss



Len Fisk and Johannes Geiss discussing science at ISSI.

Roger-Maurice Bonnet and Johannes Geiss after signing the agreement of the ISSI honorary directorship for Johannes Geiss in Alpbach 2003.

Johannes Geiss surrounded by his "small and beautiful" ISSI staff in 2010.

seen in the list of the ISSI Board members. Finally after five years of discussions and votes of the ESA council, the ISSI project was eventually approved in December 1994; Johannes Geiss officially undertook his responsibilities as the first ISSI Executive Director in May 1995: and the International Space Science Institute was born.

The support of the IACG was symptomatic for the future development of ISSI, and only sufficient funding would guarantee success. Hence, in the mind of Johannes, ISSI could only be conceived as a physically and financially small institute. But he added to the constraint that it should also be "beautiful". In other words, it should be truly international, attracting the best brains, offering them an efficient service both financial, administrative, and IT support, and it should be welcoming. In other words, the small and beautiful concept should be administered with a small staff.

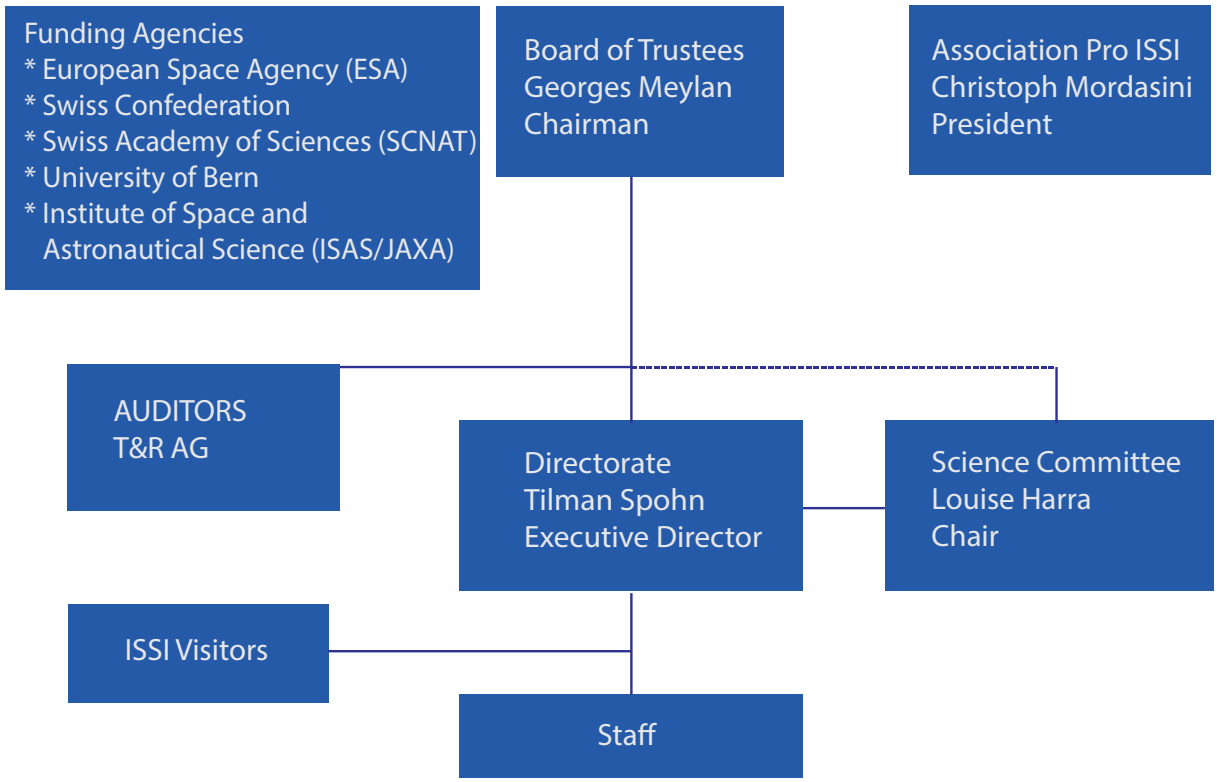
Today, ISSI is flourishing and is the leading place for topical international space science workshops and team meetings, which have resulted in the ISSI series of 79 books and 17 scientific reports. In total, 6310 visitors from 57 countries are testimony to the success of Johannes' concept.

Johannes Geiss – The Person

Johannes Geiss was a modest person, a true mentor to his students, freely sharing his knowledge, skills and ideas with his colleagues. He remained devoted to science, its conduct and promotion, until the end of his life. He was most stimulating to interact with. Many who knew him appreciated his Intelligent eyes and irresistible smiles, his unselfish advice and constructive criticism; he was an admirable human being, socially kind, simple and entertaining, interested in everybody he met, respectful of his "small and beautiful" staff.

Roger-Maurice Bonnet, ISSI Executive Director 2003–2012, and Len Fisk, ISSI Board of Trustees Member

About the International Space Science Institute



The International Space Science Institute (ISSI) is a nonprofit organization set up in Bern in 1995 as a foundation under Swiss law with an endowment by Contraves Space AG, later renamed Oerlikon Space AG and now part of RUAG. Three statutory bodies govern ISSI: the Board of Trustees, the Directorate, and the Science Committee. A fourth important body, the Association Pro ISSI, promotes the idea of ISSI, especially within Switzerland.

The European Space Agency (ESA), the Swiss Confederation, and the Swiss Academy of Sciences (SCNAT) provide the financial resources for ISSI's operation. The University of Bern contributes through a grant to a Director and in-kind facilities. The Institute of Space and Astronautical Science (ISAS/JAXA) is supporting ISSI with an annual financial contribution. ISSI received tax-exempt status from the Canton of Bern in May 1995.

ISSI's **Board of Trustees** oversees the work accomplished at the Institute, exerts financial control, and appoints the Directors and members of the Science Committee. It consists of representatives of the Founder, and of the funding Institutions. Furthermore the Board of Trustees may nominate up to five personalities representing the national and international science community, space industry and space politics for terms of three years. The Board of Trustees is presided over by Georges Meylan.

The **Science Committee**, chaired by Louise Harra, is made up of internationally known scientists active in the fields covered by ISSI. The Science Committee advises and supports the Directorate in the establishment of the scientific agenda providing a proper equilibrium among the activities and reviews and grades the Team proposals in response to the annual call. Science Committee members serve a three year term (with a possible extension of one year).

The **Directorate** is in charge of the scientific, operational, and administrative management of the Institute. It interacts with the Funding Agencies, the Swiss authorities, the Board of Trustees, the Science Committee and the Association Pro ISSI. The Directorate consists of Tilman Spohn (Executive Director), Rudolf von Steiger (University of Bern), Anny Cazenave (CNES, Toulouse, France) and Joachim Wambsganss (Heidelberg University, Germany).

The **Association Pro ISSI** promotes the idea of ISSI by organizing public lectures, where internationally known scientists introduce their results. Summaries of these talks are published in the journal SPATIUM. Member benefits include invitations to lectures and a free subscription to SPATIUM. The Board of the Association Pro ISSI is presided over by Christoph Mordasini.

Financial Overview

The 25th financial year of ISSI had a duration of 18 months for reasons explained in the directors' column (p. 5); consequently, all expenses and revenues were about 50 % higher than in normal years. The result of the year is a surplus of almost 140 kCHF, as opposed to a balanced budget for the entire 18-month period. This positive result was essentially caused by a significant reduction of the operating costs due to Covid-19: Several meetings, notably those of the Board of Trustees and the Science Committee, were held online, and travel costs of ISSI scientists were also strongly reduced. The costs for Workshops, WGs, Teams, and visitors, however, were nominal or as budgeted even though more than half of the activities had to be postponed. This is because the budgeted costs were accrued for future use whenever it will become possible again for these groups to meet at ISSI. In order to facilitate future meetings the seminar room is currently being enlarged and equipped with a state-of-the-art conferencing system, which will consume the better part of the surplus mentioned above.

On the revenue side the contributions from ESA (Directorates of Science and of Earth Observation) and from the Swiss Confederation (State Secretariat for Education, Research and Innovation SERI and Swiss Academy of Natural Sciences SCNAT) were received as budgeted and are gratefully acknowledged, as is the contribution from our Japanese partner, JAXA/ISAS.

In addition to the direct contributions listed here it is important to note that ISSI also receives indirect contributions that do not appear in the table below: One of the directors is employed directly by the University of Bern, and ISSI also benefits from the University through in-kind contributions such as internet connectivity etc.

Rudolf von Steiger

Statement of Operations (in CHF) for the 25th Financial Year (1.7.2019-31.12.2020)

	Expenses	Revenues
ESA Science Directorate		2'055'918.85
ESA Earth Observation Programme		491'833.00
Swiss Confederation		1'480'000.00
Swiss Academy of Sciences (SCNAT)		312'500.00
ISSI Partners: ISAS/JAXA		54'885.00
Salaries and related costs [1]	1'790'625.20	
Fixed costs	427'336.25	
Operating costs [2]	239'703.83	
Investment (depreciated)	42'529.45	
Workshops, Working Groups, Teams, Visitors [3]	1'770'354.12	
Other income or cost [4]		15'158.86
Result of the year	139'746.86	
Total	**4'410'295.71**	**4'410'295.71**

Remarks:

[1] **Salaries:** It should be noted that the majority of the ISSI staff members (including directors) are scientists actively conducting research as well as taking care of organizational, editorial, and administrative tasks.

[2] **Operating costs** include repair and maintenance, insurance, supplies, administration, and public relations.

[3] **Workshops, etc.** also include the balance from income and expenses of guest apartments.

[4] **Other income or cost** includes extraordinary income, interest income, and due to variations in monetary exchange rates.

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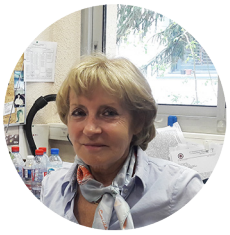

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Scientific Activities: The 25th Year

The Program and the Tools

ISSI's mode of operation is generally fivefold: multi- and interdisciplinary Workshops, Working Groups, International Teams, Forum, and Visiting Scientists. In the 25th business year a total of 943 international scientists participated in the scientific activities of ISSI.

Workshops consist of up to 50 invited scientists exchanging their views on a scientific theme, typically during a week's duration. Workshops always lead to a volume of the Space Science Series of ISSI and in parallel as issues of Space Science Reviews or Surveys in Geophysics. In the 25th year, two Workshops were organized, summaries of which can be found on the following pages. The others had to be postponed to 2021 or beyond using a new, alternative scheme.

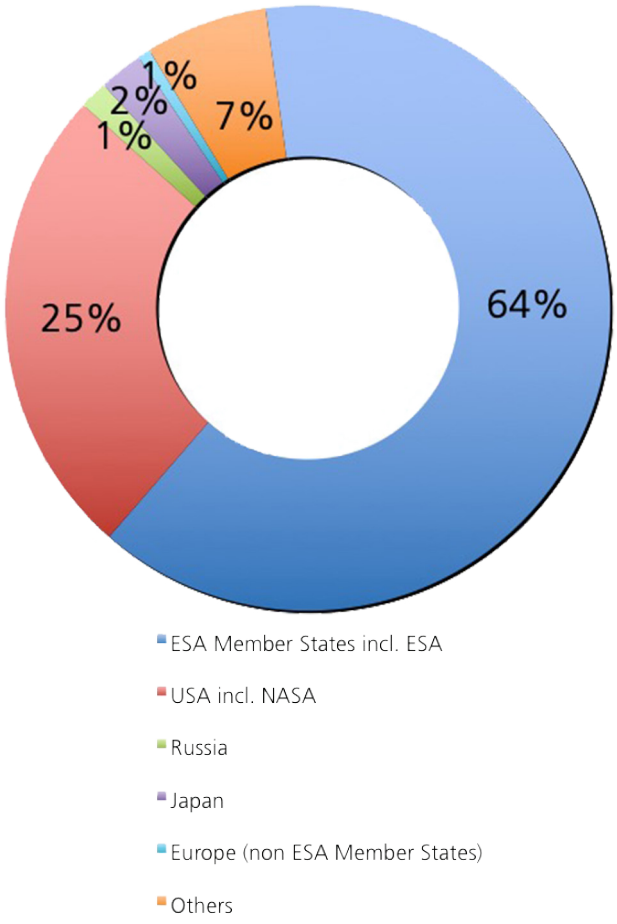
International Teams consist of about 15 external scientists, addressing a specific scientific topic in a self-organized fashion. The results of these activities are customarily reported in scientific journals. In total 45 Team meetings took place in the 25th business year. Details can be found from page 24 on forward. Many face-to-face meetings had to be postponed or were replaced with online meetings.

A Forum is an informal and free-ranging debate consisting of some 25 high-level participants on open questions of a scientific nature or on science policy matters for about two days. A Forum does not necessarily lead to formal recommendations or decisions. In the reported period, one Forum was held, the other Forum had to be postponed to 2021.

Working Groups have a smaller number of members and meet repeatedly as necessary to achieve the assigned objective. The results of the Working Groups are in general published as titles of ISSI Scientific Report Series.

Visiting Scientists spend variable periods of scientific activity at ISSI. 8 individual visitors used the ISSI facilities during the year.

The Young Scientists Program is designed to bring PhD students and young postdocs in contact with the community at work. These young scientists are invited by ISSI to complement the membership of Workshops, Working Groups, International Teams and Forums. 75 young scientists participated in the ISSI activities in the course of the year.



Pie chart showing the ISSI visitors countries of origin. A total of 596 scientists worked at ISSI during the 25th business year, 228 of them were here for the first time.

How to use ISSI tools

As a general rule, participation in ISSI's activities is by invitation only. The financial support for invited scientists covers the local accommodation expenses and a per diem while in Bern.

International Teams: A call for proposals is released every year in January. These proposals are evaluated by the ISSI Science Committee and approved by the Directorate.

Workshops, Working Groups, and Forums: There is no annual call. The scientific community may suggest at any time Workshops, Working Groups, and Forums by submitting an idea on a maximum of one page. The ISSI Science Committee will evaluate these suggestions and the ISSI Directorate will take a final decision.

Game Changers Online Seminars

How Missions Change(d) our View of the Solar System and the Universe

Like many others, ISSI has been driven towards increased digital online communication by the COVID-19 pandemic, if only to keep the communication alive while we all together fight the pandemic.
In the summer of 2020, the ISSI directorate started to prepare a series of online seminar talks scheduled for Thursdays at 5pm CET. The idea was to present missions that have had a great impact on their science field and that could be seen as changing the game, a term that was used as title for the series. The series "Game Changers: How Missions Changed the Game in the Space Sciences" was launched in late July 2020 with a talk on the Hayabusa missions, the second of which is still ongoing. These missions are universally agreed as having been highly innovative sample return missions. Sample return is one of the biggest challenges in Space Exploration and is still quite a new field. The series continued with six more talks in planetary exploration, from the inner to the outer reaches of the Solar system. It then turned to Solar and Magnetosphere Physics before presenting outstanding missions of Astronomy and Astrophysics, from observations of the extremes of the universe to detecting extra-solar planets. The selected missions as listed below were considered as examples, the collection by no means to be complete.
The series is being continued with talks on Earth observation missions in 2021, although it is held that the focus in Earth Observation is more on series of satellites rather than on individual missions. The Game Changer seminar talks were recorded and are part of ISSI's digital online library. They are available at www.issibern.ch/publications/game-changers-seminars/ where upcoming talks are being advertised, too. Between roughly 150 and 280 participants have attended the seminars, many as loyal participants throughout the series.

Tilman Spohn

The following webinars were organized in 2020:

The Hayabusa Missions with Seiji Sugita (University of Tokio, Japan) – 30th July 2020

The New Horizon Missions to Pluto and the Outer Solar System with Alan Stern (SWRI Boulder, USA) – 13th August 2020

Mars Express with Ralf Jaumann (Freie Universität, Berlin, Germany) – 20th August 2020

Venus Express with Prof. Ann C. Vandaele (Institut d'Aeronomie Spatiale de Belgique, Belgium) – 27th August 2020

Juno: Revealing the Mysteries of Jupiter with Ravit Helled (University of Zurich, Switzerland) – 10th September 2020

Cassini-Huygens at Titan with Athena Coustenis (Observatoire de Paris, Meudon, France) – 17th September 2020

Rosetta with Jessica Agarwal (TU Braunschweig, Germany) – 24th September 2020

The Sun from SOHO, and First Glimpses from Parker Solar Probe and Solar Orbiter with Daniel Müller (Solar Orbiter Project Scientist, ESA - ESTEC, The Netherlands) – 1st October 2020

DAWN – Mission to Vesta and Ceres with Carol Raymond (Jet Propulsion Laboratory, Pasadena, USA) – 8th October 2020

Magnetospheric Multiscale (MMS) Mission: How Magnetic Fields around Earth Connect and Disconnect with Rumi Nakamura (IWF Graz, Austria) – 15th October 2020

Ulysses: A New Perspective from High Latitudes with Rudolf von Steiger (ISSI, Switzerland) – 22nd October 2020

INTEGRAL – The Extreme Universe with Enrico Bozzo (Department of Astronomy, University of Geneva, Switzerland) – 5th November 2020

Gaia – The Dynamic Sky in 3D with Anthony G.A. Brown (Leiden Observatory, Leiden, The Netherlands) – 12th November 2020

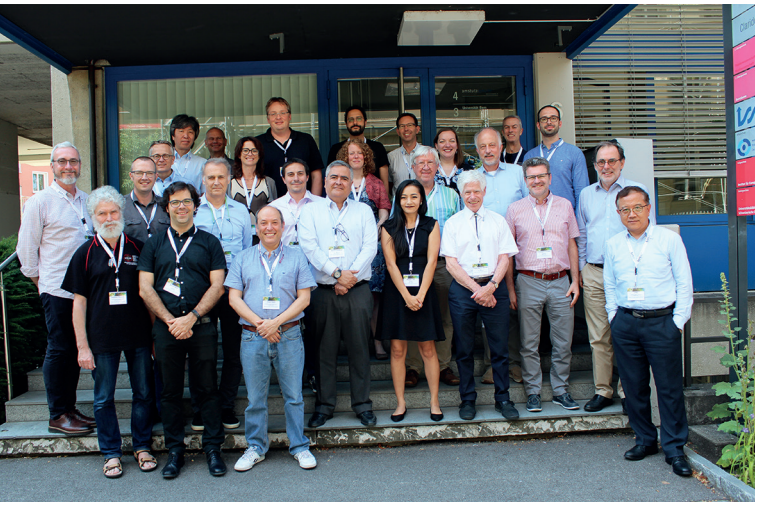
The Hubble Telescope: From Cosmological Conflict to Alien Atmospheres with Tom Brown (Space Telescope Science institute, Baltimore, USA) – 19th November 2020

Planck – From the early Universe to Our Local Environment with Jan Tauber (European Space Agency, Noordwijk, The Netherlands) – 26th November 2020

CoRoT – The First Transiting Exoplanets from Space with Magali Deleuil (Aix-Marseille Université - Institut Universitaire de France, Marseille, France) – 3rd December 2020

XMM-Newton – New Visions of the X-ray Universe with Arvind Parmar (European Space Agency, Noordwijk, The Netherlands) – 10th December 2020

Herschel – A Cool Mission Unveiling the Cold Universe with Göran Pilbratt (European Space Agency, Noordwijk, The Netherlands) – 17th December 2020



Forum Participants (picture taken by S.F. Saliba)

Forums are informal and free-ranging debates among some twenty-five high-level participants on open questions of a scientific nature or on science policy matters. Forums do not necessarily lead to formal recommendations or decisions.

The Impact of Big Data in Astronomy

4–5 July 2019

The rationale behind this topic is the fact that the explosion of astronomical data in volume and complexity is about to change the way we do science. Space-based and ground-based observatories like Gaia, Euclid, LSST or SKA as well as state-of-the-art astrophysical simulations require new tools, means and methodologies for doing research. Among the new techniques range data mining, artificial intelligence, machine learning, pattern recognition and other data-driven methods.

At the Forum, 26 international experts met in order to discuss these new developments. Underlying questions were, e.g.: How do large surveys and big data science change astronomy? What additional training/skills will future astronomers require? What are the challenges for data storage, data curation, data quality, data provenance? Four keynote talks on "Big Data Challenges in Observations" (by Wil O'Mullane), on "Data Challenges in Archiving" (by Françoise Genova and Bruno Merín), on "Big Data Challenges in Simulations" (by Volker Springel) and on "Big Data Challenges – Now and in the Future" (by Alex Szalay) formed the backbone of the Forum. Nine short contributions were presented by participants. The most important and interesting part of the Forum were the very lively and interesting discussions, they gave a very broad and comprehensive view on the benefits and challenges of "Big Data in Astronomy". In addition to the demanding technical aspects, also "social" and "sociological" topics were addressed: How can young as well as experienced scientists be taught about these new techniques? Will the future successful scientists have to be an astrophysicist AND a computer scientist AND a software engineer? Or can future big data science only be done in teams with experts from these fields? How much knowledge in data science is necessary for an astronomer? Can young scientists knowledgeable in data science share this with "classical" older astronomers and teach them the new tools? What are the career perspectives and paths for young scientists who specialize in "data science"?

The following list summarizes the results and recommendations of the Forum:

- The developments and provided services linked to Big Data should be driven by user needs, taking the best advantage of new technological capabilities but not driven by these technological capabilities.
- The usage of AI technologies to automate data curation and preservation should be explored and implemented if relevant.
- Researchers should be provided with data and tools relevant to their science using the new technologies.
- The efforts to release simulation/numerical model data should be pursued, this leads to increased data volumes on top of the instrument generated data.
- Coping with increasing data volume requires investment and improvements in e-infrastructure in particular networks and storage – this will be essential for connecting data silos with volumes in TB and PB scales.
- As, out of necessity, the percentage of budget for software increases we must become more efficient and have less duplicated systems for simulation and processing.
- Long term maintenance of software needs to become a project priority.
- Career paths for astro-cyber-infrastructure need to be laid out properly to show people this is valid and useful career.

A very rewarding Forum was held by ISSI in Bern, there was a high level of engagement and a lively exchange of ideas, the full final report can be downloaded at www.issibern.ch/forum/bigdata/index.php/final_report At the end of the Forum, it was felt that this successful "kick-off" should be followed by suitable further activities, e.g. within IAU or EAS or COSPAR, or maybe with a further event at ISSI.

Joachim Wambsganss and Álvaro Giménez

Workshops

Workshops are selected by the Directorate in consultation with the Science Committee. Proposals or suggestions for Workshops may originate from the external community. The program and speakers are defined by a group of experts serving as conveners. The Workshops can be attended by up to 50 invited scientists. Workshops always lead to a volume of the Space Sciences Series of ISSI (SSSI) published by Springer and in parallel as issues of Space Science Reviews or Surveys in Geophysics.

Surface Bounded Exospheres and Interactions in the Solar System

20–24 January 2020

Studying the evolution of the surfaces and atmospheres of bodies in the solar system is fundamental to our understanding of the present state of the Solar System. This endeavor entails finding how the rates of the ongoing processes vary as a function of the space environment, or, in other words, how the planetary space weather works. Aside from occasional catastrophic events, surface and atmospheric changes are caused predominantly by the continuous bombardment of the bodies by photons, energetic ions and micrometeoroids. In particular, the exospheres are the interfaces between the planetary body and the open space, so that, studying the exospheric refilling and loss processes is the way to expand knowledge of the body's evolution.

The Workshop focused on the large subset of planets, moons and small bodies that are not protected by either strong magnetic fields or thick atmospheres in the inner solar system where the solar influence is stronger. We refer to these cases as surface-bounded exospheres, since the surface release processes are also the exospheric refilling ones and atoms and molecules collide with the surface far more frequently than with each other. The detailed investigation of this subject is a paramount element in exoplanet studies. In fact, the observations with the new generation of high powerful telescopes can provide the exospheric composition and shape of exoplanet exospheres.

In the last decade, diverse space missions provided important new findings for many airless bodies. In fact, SELENE, Chandrayaan-1, LADEE and LRO provided important results about the solar wind and Moon surface interaction, MESSENGER gave many important findings about the neutral and ionized Hermean environment. Also new imaging techniques offered the possibility of improved exospheric observations via Earth-based observation. In the next decade BepiColombo mission to Mercury (arriving at Mercury at the end of 2025) and various orbiters and landers to the Moon are expected to be operated. Therefore, this Workshop was the occasion to collect the present state of knowledge on this subject in preparation for the interpretation of the data to be received from the next generation of missions.

The Workshop was convened by Anna Milillo (INAF/IAPS, Italy), Menelaos Sarantos (NASA-GSFC, USA), Benjamin Teolis (SwRI, USA), Go Murakami (JAXA, ISAS, Japan), Peter Wurz (University of Bern, Switzerland) and Rudolf von Steiger (ISSI, Switzerland). About forty expert scientists from different countries in Europe, from USA and from Japan participated at the Workshop.

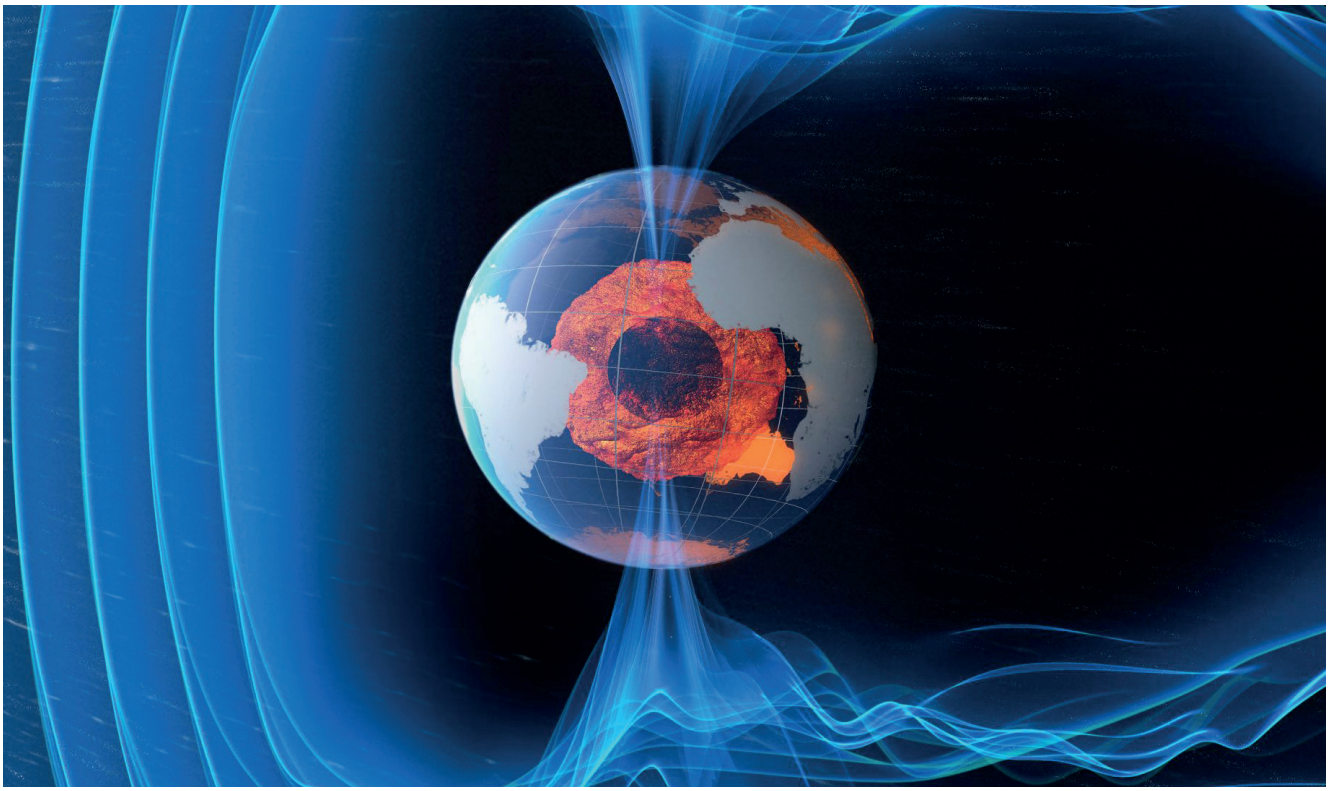
This Workshop started with a review of the different surface processes producing particle release, i.e.: ion sputtering, thermal desorption, space weathering, micrometeoroid impact vaporization, photon- and electron-stimulated desorption, investigated through laboratory experiment, simulation and observations at the Moon, Mercury and asteroids. In the following days, the drivers responsible of particle release, i.e. ions and electrons impacting distributions at Mercury and the Moon, micrometeoroids distribution in the inner solar system, surface temperature and regolithic properties, have been illustrated. Finally, focusing on different group species, like refractories, volatiles and water groups, the processes responsible of circulation, chemical modification and loss in the exosphere have been described through ground or space observations and modeling. The exospheric loss and implication for Mercury and Moon evolution have been discussed. The Workshop closed with the discussion on expected results from the next future space missions and recommended direction for answering the open questions.

Following the Workshop, the outputs in a comparative planetology perspective will be published in a volume of the Space Science Series of ISSI and as a Topical Collection in Space Science Reviews by Springer, organized in 9 chapters.

Anna Milillo

Probing the Earth's Deep Interior Using in Synergy Observations of the Earth's Gravity and Magnetic Fields, and of the Earth's Rotation

1–4 September 2020



The magnetic field and electric currents near Earth generate complex forces that have immeasurable impact on our everyday lives. (Image Credit: ESA/ATG Medialab).

During the past two decades, the GRACE and SWARM space missions have provided a wealth of groundbreaking results about the permanent and time-variable gravity and geomagnetic fields of the Earth. However, more can be learned about the Earth's structure by combining data of the Earth's gravity and magnetic fields, together with Earth's rotation data routinely measured using space geodesy techniques. The use in synergy of these three observables represents a unique way to further investigate the physics of the deep Earth's interior. In addition to the well-known correlation between Earth rotation and magnetic field observed at decadal time scale, recent studies have reported unexpected correlation between spatio-temporal changes of the gravity field and of the magnetic field, also at decadal time scale, that may result from processes occurring in the liquid core and at the core-mantle boundary. The Workshop "Probing the Deep Earth Interior by using in synergy observations of the Earth's gravity and magnetic fields, and of the Earth's rotation" held at ISSI, Bern on 1–4 September 2020, gathered more than 45 scientists (30% face-to-face, 70% remotely) from different horizons and expertise to discuss this new research topic. The four different sessions successively addressed the capability of the gravity and magnetic fields, and Earth rotation observations to detect deep Earth signals on interannual time scales, the current knowledge of processes occurring in the fluid outer core, at the core-mantle boundary and within the lower mantle, as well as the present-day status of theoretical models describing the deep Earth structure. Additionally, a fifth session tackled the deep interior of planets, in which they were presented different methods and their synergies to contribute to a better understanding of the interior of the planets and their differences and similarities to the interior of the Earth.
Numerous discussions on a broad range of transdisciplinary key scientific issues followed the formal presentations.

Anny Cazenave

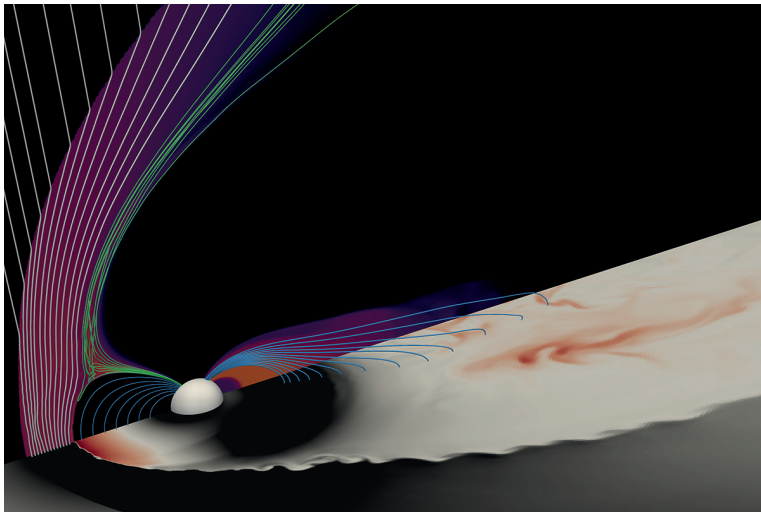
Mesoscale Dynamics in Observations and Simulations: Preparing for Magnetospheric Constellations

Working Groups are set up by the ISSI Directorate for specific tasks, often also of a technical nature. The results of the Working Groups activities are published as volumes of ISSI Scientific Report Series (SR) or in the scientific literature.

There exists a large number of fundamental magnetospheric dynamics questions that are currently unanswerable with the existing suite of observational and numerical tools. A major obstacle is the difficulty of probing observationally and adequately simulating the mesoscale regime that lies between the kinetic and global scales. Mesoscales in Earth's magnetosphere are ~1-2 RE, which makes observations difficult without large constellations of in situ spacecraft. Numerically, global MHD simulations are just now getting to the scale necessary to resolve these scales and are finding mesoscale dynamics that are unconfirmed by our limited observations.

The purpose of this Working Group is to summarize the state-of-the-art of mesoscale dynamics in Earth's magnetosphere, with a primary focus on the nightside, and clearly identify future science, mission, and toolset needs. The outcome will be published as volume 18 in the ISSI Scientific Reports Series. This volume will clearly identify the science questions that need answered, in preparation for large constellations of magnetospheric spacecraft that are appearing soon on the horizon.

Although the global pandemic scuttled our in-person meeting plans, this Working Group has met biweekly via videoconferencing since early January 2020, and is defining a first outline of the chapters, which are focused on the oft-neglected mesoscale regime. In particular, the fundamental open questions are on the solar wind input at the dayside and flank magnetopause and how energy is partitioned in the magnetotail is released and imparted into Earth's inner magnetosphere. The limited understanding arises from the limited in situ measurements of mesoscales, and is the motivations for constellations of spacecraft. The drafts of the chapters are supposed to be delivered by the end of this year. However, the Working Group will meet at ISSI next year to more thoroughly explore the science questions and to have an editorial meeting to finalize the chapters of the ISSI Scientific Report. This volume would provide excellent reference material for students and postdocs, and provide background and motivation to funding space agencies for science-enabling missions and simulation programs.



This image from the high-resolution GAMERA global MHD simulation shows in the equatorial plane mesoscale plasma flows moving towards Earth, while Kelvin-Helmholtz waves propagate and grow downtail along Earth's magnetopause, created by the solar wind – magnetosphere interaction. These global models show far more detail in the mesoscale regime than can be confirmed with our limited in situ suite, and highlight the need for large constellations of in situ spacecraft. Image Credit: figure courtesy S. Merkin (JHU/APL)

The Working Group is composed of the following members: Larry Kepko (NASA GSFC, USA), Minna Palmroth (Univ. Helsinki, Finland), Rumi Nakamura (IWF, Austria), Christine Gabrielse (Aerospace Corp., USA), Tuija Pulkkinen (Univ. Michigan, USA), Jonny Rae (MSSL, UK), Slava Merkin (APL, USA), Daniel Baker (CU/LASP, USA), and Xuzhi Zhou (Peking University, China).

Larry Kepko

International Teams

International Teams consist of about 4-15 external scientists, addressing a specific scientific topic in a self-organized fashion, under the responsibility of a leader in a series of two to three one week meetings over a period of 18 to 24 months. The results of these activities are customarily reported in scientific journals. The selection of International Teams results from an annual call issued in January and from the subsequent review and prioritization done by the Science Committee.

Listed are Teams that had a meeting at ISSI in the period of the 25th business year. A rationale is given only for the selected teams in 2019; for the others see the previous Annual Reports.

Teams selected in 2017

Soft Protons in the Magnetosphere focused by X-ray Telescopes

Team leader: Fabio Gastaldello, INAF-IASF Milan, Italy
Session: 14-18 October 2019

Constraining the Dynamical Timescale and Internal Processes of the Saturn and Jupiter Systems from Astrometry (ENCELADE Team)

Team leader: Valery Lainey, Jet Propulsion Laboratory, USA, and IMCCE, Paris Observatory, France
Session: 9–11 July 2019

Recalibration of the Sunspot Number Series

Team leaders: Mathew Owens, University of Reading, United Kingdom, and Frédéric Clette, Royal Observatory of Belgium, Brussels, Belgium
Session: 19–23 August 2019

Studying Magnetic-Field-Regulated Heating in the Solar Chromosphere

Team leaders: Jaime de la Cruz Rodríguez, and Jorrit Leenaarts, Stockholm University, Sweden
Session: 18–21 November 2019

Observed Multi-Scale Variability of Coronal Loops as a Probe of Coronal Heating

Team leaders: Clara Froment, University of Oslo, Norway, and Patrick Antolin, University of St. Andrews, United Kingdom
Session: 29–31 October 2019

Teams selected in 2018

An Intercomparison of 1D Chemical Kinetics Codes for Exoplanet Atmospheres

Team leader: Benjamin Drummond, University of Exeter, United Kingdom
Session: 2–5 September 2019

Witnessing the Culmination of Structure Formation in the Universe

Team leader: Stefano Ettori, INAF-Osservatorio Astronomico di Bologna, Italy
Session: 23–27 September 2019

Pristine

Team leader: Pascale Jablonka, École Polytechnique de Lausanne, Sauverny, Switzerland
Session: 10–14 February 2020

International Combination Service for Time-variable Gravity Field Solutions

Adrian Jäggi, University of Bern, Switzerland
Session: 13–17 January 2020

Solar Flare Acceleration Signatures and their Connection to Solar Energetic Particles

Team leaders: Natasha Jeffrey, University of Glasgow, United Kingdom, and Frederic Effenberger, GFZ German Research Centre for Geosciences, Potsdam, Germany
Session: 11–15 November 2019

First Contact: Making Sense of 1I/'Oumuamua and Its Implications

Team leaders: Matthew Knight, University of Maryland, College Park, USA, and Alan Fitzsimmons, Queen's University Belfast, United Kingdom
Session: 23–27 September 2019

Novel Approaches to Multiscale Geospace Particle Transfer: Improved Understanding and Prediction through Uncertainty Quantification and Machine Learning

Team leaders: Ryan McGranaghan, University of Colorado, Boulder, USA, and Enrico Camporeale, Centrum Wiskunde & Informatica (CWI), Amsterdam, The Netherlands
Session: 4–8 November 2019

Relativistic Electron Precipitation and its Atmospheric Effect (ISSI – ISSI Beijing Team)

Team leader: Irina Mironova, St. Petersburg State University, Russia
Session: 14–18 October 2019

Study of the Physical Processes in Magnetopause and Magnetosheath Current Sheets Using a Large MMS Database
Team leaders: Götz Paschmann, Max-Planck-Institut für extraterrestrische Physik, Garching, Germany, and Tai Phan, University of California, Berkeley, USA
Session: 16–20 September 2019

Gaia-BGM Exploiting Gaia data with the Besançon Population Synthesis Model for Understanding our Galaxy Evolution
Team leader: Annie Robin, Université Bourgogne-Franche-Comté, Besançon, France
Session: 9–13 December 2019

COSWEB: The Cosmic Web and Galaxy Evolution
Team leader: Gregory Rudnick, University of Kansas, Lawrence, USA
Session: 21–25 October 2019

The Nature and Physics of Vortex Flows in Solar Plasmas
Team leaders: Kostas Tziotziou, National Observatory of Athens, Greece, and Eamon Scullion, Northumbria University, Newcastle upon Tyne, United Kingdom
Session: 3–7 February 2020

Magnetic Helicity in Astrophysical Plasmas
Team leaders: Gherardo Valori, University College London, United Kingdom, and Etienne Pariat, Observatoire de Paris-Meudon, France
Session: 19–23 August 2019

Ice Giants: Formation, Internal Structure, and the Link to Exoplanets
Team leaders: Julia Venturini, International Space Science Institute, Bern, Switzerland, and Ravit Helled, University of Zurich, Switzerland
Session: 2–6 March 2020

Outcome of Collisions in the Early Outer Solar System
Team leader: Jean-Baptiste Vincent, DLR German Aerospace Center, Berlin, Germany
Session: 19–21 February 2020

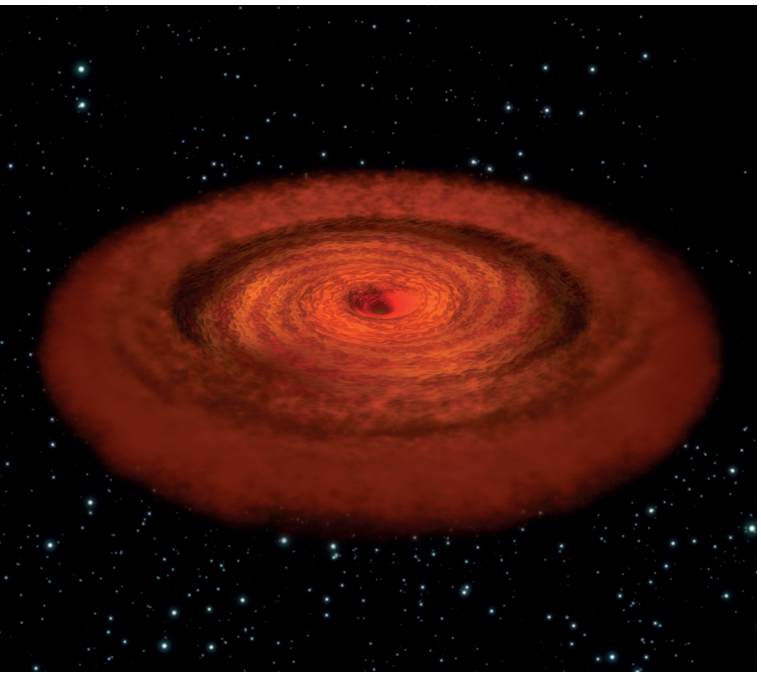
Towards Earth-like Alien Worlds: "Know thy Star, Know thy Planet"
Team leader: Christopher Watson, Queen's University Belfast, United Kingdom
Session: 9–13 September 2019

Swarm is ESA's first Earth observation constellation of satellites. The three identical satellites are launched together on one rocket. The different orbits along with satellites' various instruments optimize the sampling in space and time, distinguishing between the effects of different sources and strengths of magnetism. (Image Credit: ESA/ AOES Medialab)

Teams selected in 2019

Complex Systems Perspectives Pertaining to the Research of the Near-Earth Electromagnetic Environment
Team leader: Georgios Balasis, University of Athens, Greece
Session: 11–15 November 2019
Scientific Rationale: The Team attempts to combine advanced mathematical tools and identify key directions for future methodological progress relevant to space weather forecasting using Swarm, SuperMAG, and other space/ground datasets. By utilizing a variety of complementary modern complex systems based approaches, an entirely novel view on nonlinear magnetospheric variability is obtained. Taken together, the multiplicity of recently developed approaches in the field of nonlinear time series analysis offers great potentials for uncovering relevant yet complex processes interlinking different geospace subsystems, variables and spatio-temporal scales. The Team provides a first-time systematic assessment of these techniques and their applicability in the context of geomagnetic variability.

International Teams



Artist's impression of a supermassive black hole accreting matter. Energetic X-rays can penetrate the accretion disk surrounding a supermassive black hole at the center of an Active Galactic Nucleus. Studying the signature of these X-rays can reveal much about the physics and geometry of the extreme conditions close to the center of the galaxy. (Image Credit: ESA)

Towards a Universal Framework for Merging Atmospheric Observations from the Ground and Space

Team leaders: William Ball, Delft University of Technology, The Netherlands, and Daan Hubert, Royal Belgian Institute for Space Aeronomy, Brussels, Belgium
Session: 10–14 February 2020
Scientific Rationale: Satellite and ground-based ozone observing campaigns have both been operating for the last 40 years and there is now a vast amount of data, with which to diagnose variability and trends in stratospheric ozone. Despite this wealth of information, we cannot currently determine the status of long-term trends in ozone with confidence, and the way in which data from disparate sources are merged is a leading reason why uncertainties remain high. To build confidence, progress must be made in data merging to build robust long-term records. This project aims to build a rigorous state-of-the-art statistical framework to overcome limitations currently associated with merging multiple instrument data sets with different observing characteristics and, ultimately, pave the way to a unified ozone data set for stratospheric and tropospheric ozone, with realistic uncertainty estimates, which can then be used to make robust conclusions about the state of atmospheric ozone.

The Role of Partial Ionization in the Formation, Dynamics and Stability of Solar Prominences

Team leaders: José Luis Ballester and Manuel Luna, Universitat de les Illes Balears, Palma de Mallorca, Spain
Session: *Meeting at ISSI postponed*
Scientific Rationale: Partially ionized plasmas are found across the universe in many different astrophysical environments. During recent years, the study of partially ionized plasmas has become a hot topic within the solar physics community because layers of the solar atmosphere (photosphere and chromosphere) as well as solar structures such as spicules, prominences, are made of partially ionized plasmas. Solar prominences are fascinating structures embedded in the solar corona whose peculiar properties and behavior, not yet well understood, cause them to be the subject of intense research. Furthermore, they are an integral part of major solar eruptions, therefore, greater understanding of their formation and evolution will contribute significantly to our understanding of the origin of space weather, a serious threat to our technology-dependent world. Due to their relatively low temperature prominence plasma is partially ionized, but the exact ionization degree is unknown and the reported ratio of electron density to neutral hydrogen density covers about two orders of magnitude (0.1-10). Partial ionization brings the presence of neutrals and electrons in addition to ions, thus collisions between the different species are possible and the effects on the prominence equilibrium and dynamics must be considered. The Team goal is to expand the understanding of the role of partial ionization in the formation, dynamics, and stability of solar prominences. Each member is an expert in different aspects of prominences; collectively, the research interests offer a combination of expertise in observations, prominence formation and dynamics, waves and instabilities, and numerical simulations. The primary goals are to exchange ideas, establish collaborative links, and develop joint strategies for tackling current problems related to partially ionized prominence plasmas. The expected outcome of the research will be a better understanding of the impact of partial ionization on the physical properties and evolution of solar prominences.

Can We Use X-Ray Reflection Spectroscopy for Precision Measurements of Accreting Black Holes?

Team leader: Cosimo Bambi, Fudan University, Shanghai, China
Session: 9–13 December 2019
Scientific Rationale: Relativistic reflection features are commonly observed in the X-ray spectra of accreting black holes. In the presence of high quality data and with the correct astrophysical model, X-ray reflection spectroscopy can potentially be quite a powerful tool to

probe the strong gravity region, study the morphology of the accreting matter, measure black hole spin, and even test Einstein's theory of general relativity in the strong field regime. The aim of this Team is to improve X-ray reflection spectroscopy to make it a mature technique for precision measurements of the properties of accreting black holes. In particular, the Team will: 1. Identify the differences among REFLKERR, RELXILL, and the relativistic version of REFLIONX, quantify their impact on the parameter estimate of black hole systems by analyzing available X-ray data of XMM-Newton and NuSTAR, and eventually try to arrive at a common model for the whole X-ray astronomy community; 2. Understand instrumental limitations (calibration and energy resolution) and their impact on the possibility of performing precision measurements of accreting black holes; 3. Investigate with simulations and real data biases introduced into the analysis of current data by shortcomings of the available reflection models; 4. Improve the current reflection models to make X-ray reflection spectroscopy capable of precision measurements of accreting black holes.

Models of VHE Emission In Pulsars: Evaluation of the Current State-Of-The-Art and Future Prospects

Team leaders: Ionnis Contopoulos, Academy of Athens, Greece, and Demosthenes Kazanas, NASA Goddard Space Flight Center, Greenbelt MD, USA
Session: 9–12 December 2019
Scientific Rationale: The study of very-high-energy (VHE) emission from rotation-powered pulsars entered a new era ten years ago with the detection of pulsed emission from Crab at energies in the range 25-400 GeV by MAGIC. This was quickly followed by pulsed detections above 100 GeV by VERITAS, and up to 1.5 TeV with MAGIC. Most recently, HESS has announced detection of pulsed emission from Vela from 20 GeV to above 3 TeV. MAGIC has, also, announced detection of pulsed emission from Geminga. Emission up to 1 TeV appears to connect smoothly to the GeV spectra measured by Fermi, except for the emission above 3 TeV from Vela, which may be a separate component. In the near future, CTA will provide improved sensitivity in two energy domains very much relevant for pulsar physics, namely 30-100 GeV and the multi-TeV range. The Team assembles experts on pulsar γ-ray observations and pulsar magnetosphere modeling. The Team members present, compare, and evaluate various theoretical and numerical models based on their ability to reproduce best the VHE pulsed spectra of Crab, Vela and Geminga. It will quantify their limitations, will propose avenues beyond the current state-of-the-art (e.g., hybrid modeling, new numerical methods, new emission sites), and will make predictions that will be tested with CTA. The Team project aims to achieve a deeper understanding of combined space and ground GeV–TeV observations through joint multidisciplinary research, and to pave the way for future international collaborations, and improved high-energy pulsar modeling.

Tropical Width Impacts on the Stratosphere (TWIST)

Team leader: Sean Davis, NOAA, Boulder CO, USA
Session: *Meeting at ISSI postponed*
Scientific Rationale: Over the past ~5 years, the confusion regarding conflicting estimates of recent tropical widening based on different observational datasets (e.g., satellites, meteorological reanalyzes) and climate model simulations has largely been resolved. Despite this recent progress, many new questions have emerged. One question in particular relates to the finding that there are two broad categories of tropical width metrics, referred to as "lower" and "upper" atmospheric metrics. While the "lower" atmospheric metrics co-vary with the Hadley cell edge, the "upper" metrics based on the subtropical jet and tropopause do not. The reason for the disconnect between "lower" and "upper" tropical edge metrics is currently unknown and is surprising given the expected connection between the tropospheric overturning circulation and subtropical jet. The "upper" atmospheric category of metrics has been inadequately studied despite it being important for climate, since variability in the subtropical jet and tropopause characteristics affects transport and mixing of climatically important trace gases in the upper troposphere and lower stratosphere (UTLS), including water vapor and ozone. Indeed, satellite measurements indicate recent unexplained trends in lower stratospheric ozone and other trace gases, and changes in the regions of turbulent mixing near the subtropical jet have been implicated as a possible cause. The causes of such shifts in mixing zones are largely unexplained, and a major deficiency remains in our knowledge of the interrelationships between stratospheric transport and mixing, jet/tropopause properties, UTLS trace gas variability, and their relation to the tropospheric Hadley cells. The need to advance the fundamental understanding of these interrelationships motivated this Team project. The Team project called TWIST (Tropical Width Impacts on the Stratosphere) tackles key research questions regarding the tropical width in the UTLS region. Specifically, the goals of TWIST are to: 1) identify robust satellite-observed metrics of tropical width in the UTLS region based on temperature structure and atmospheric composition, 2) characterize relationships between UTLS tropical width and tropospheric circulation, and 3) identify how these tropical width variations in the UTLS relate to variability and trends in trace gas concentrations and their impact on climate.

International Teams

This montage of images taken by the Voyager spacecraft of the planets and four of Jupiter's moons is set against a false-color Rosette Nebula with Earth's moon in the foreground. (Image Credit: NASA)

Provenances of our Solar System's Relics

Team leaders: Maria Drozdovskaya, University of Bern, Switzerland, and Cyrienne Opitom, ESO, Santiago, Chile
Session: 17–21 February 2020
Scientific Rationale: Our Solar System is filled with relics from its past such as comets, asteroids, chondrules. In its earliest phases, the Solar Nebula was a gas-rich protoplanetary disk harboring prebiotic planetary building blocks in various volatile and refractory forms. Going back even further along the evolutionary sequence, the innate Solar disk was formed from a prestellar core. The Team aims to trace the volatiles observed in comets today to their roots in the Solar Nebula and the core that collapsed to form our Solar System. The Team members aim to inventory the molecules dominating Solar System's ices, including species of astrobiological significance and consider the historical information hidden in various isotopic ratios, D/H, 15N/14N, 13C/12C, as well as in the multiple oxygen and sulfur isotopes. The Team work focuses on uniting researchers across the fields of star formation, astrochemistry, disks (protoplanetary, transition and debris) and cometary science with their common use of ground-based facilities such as ALMA and the VLT. The following questions are addressed: How to target common tracers? Are there any specific molecules or isotopic ratios that we should focus on? How do the positions of snowlines in disks affect planet-building materials? The scientists also intend to understand how to exploit the unprecedented capabilities of the JWST and how they can be coupled with ground-based observations. These efforts will culminate in the design of a large observational campaign to obtain consistent datasets that can be used to trace the provenances of our Solar System's relics from core to disk stages.

A Reference Quality Model for Ocean Surface Emissivity and Backscatter from the Microwave to the Infrared

Team leaders: Stephen English, ECMWF, Reading, United Kingdom, and Catherine Prigent, CNRS LERMA, Paris, France
Session: 20–22 November 2019
Scientific Rationale: Satellite observations are vital for the initialization of Numerical Weather Prediction models, that are in turn essential for protection of life and property and minimizing impact of dangerous weather events. They are also very important for climate monitoring and prediction, as well as other application areas such as hydrology and flood awareness prediction. It is not possible to sound the lower troposphere from space without accurate knowledge of the radiative contribution from the Earth's surface.
The European Commission Horizon2020 project, GAIA-CLIM, identified in Deliverable D6.11 that the lack of a reference quality ocean emission and backscatter model was a major gap in our ability to provide absolute calibration of the satellite based observing system.
The gap was also identified by the ECMWF-JCSDA radiance assimilation workshop in December 2015 and the 21st meeting of the International TOVS Working Group in December 2017.
This Team aims to address this gap collaboratively. The priorities for the reference model are that it should be:
Maintained and supported; Have traceable uncertainty estimation at each step; Be documented code freely available to research community; Have new science for IR to MW with BRDF capability; Support passive and active applications.

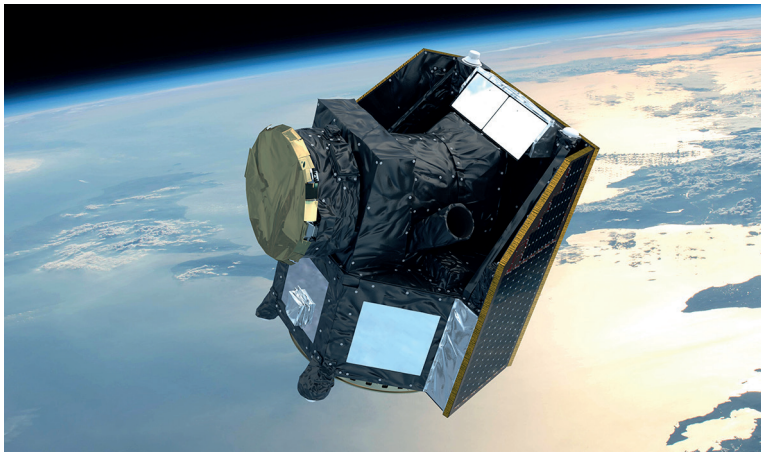
Exploring the Solar Wind in Regions Closer than ever Observed before

Team leader: Louise Harra, World Radiation Center, Davos Dorf, Switzerland
Session: 13–17 January 2020
Scientific Rationale: The Team addresses the overarching science question: What are the sources of the solar wind and what processes lead to its generation and acceleration?
The recent launch of Parker Solar Probe has initiated a new era of observing the heliosphere very close to the Sun. During PSP's first perihelion, the solar disk was observed extensively by space-based missions such as Hinode as well as by ground-based telescopes, such as those operated by the NSO. Similar observations are planned for subsequent PSP encounters and are also planned for the Solar Orbiter mission. Weaving remote sensing observations of source regions and in situ plasma measurements together into a coherent picture of the

solar wind will require intensive collaboration between the fields of space plasma physics, solar physics, and the various modeling communities. This Team brings experts in these areas together for the collaboration needed to make progress on exploiting this collaboration to tackle the overarching science question of this project.

The Role of Solar and Stellar Energetic Particles on (Exo)Planetary Habitability (ETERNAL)

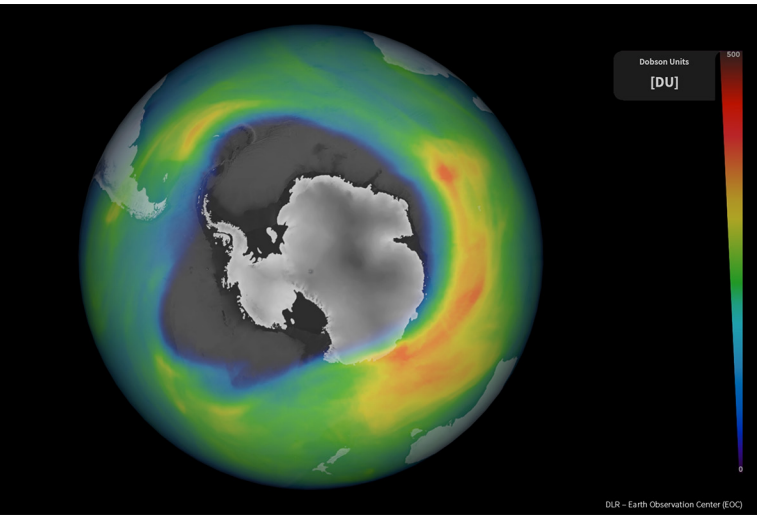
Team leaders: Konstantin Herbst, University of Kiel, Germany, and John Lee Grenfell, DLR, Berlin, Germany
Session: 7–11 October 2019
Scientific Rationale: The question of whether or not we are alone in the universe has fascinated humanity for many centuries. Upcoming missions such as the James Webb Space Telescope (JWST), the Atmospheric Remote-sensing Infrared Exoplanet Large-survey (ARIEL) or the European Extremely Large Telescope (E-ELT), will deliver data addressing this crucial question within the next few decades. Since the dawn of the exoplanet era, some twenty-five years ago, surveys based on the transit – and radial – velocity methods have confirmed the existence of several thousand exoplanets, of which currently 49 (according to Planetary Habitability Laboratory) lie within the habitable zone (HZ). Of particular interest are exoplanets with known masses and radii consistent with rocky interiors. Small orbital separations for habitable planets orbiting K- and M-dwarf stars increase detection probability due to, e.g., favorable (planet/star) flux ratios. Detections of numerous rocky exoplanets in the HZ of G, K, and M-dwarf stars are expected in the near future by both ground-based detection surveys (e.g., MEarth) and the space missions CHEOPS (ESA) and PLATO2.0. However, recent estimations, show that the exoplanetary radiation environment around certain K- and M-dwarf stars may be much harsher compared to what we experience from the Sun. Additionally, due to small planet-star separations an Earth-like exoplanet could be exposed to an enhanced stellar radiation environment, which – in turn – would affect its habitability, e.g., due to a hazardous flux of stellar energetic particles (SEPs) which influence its atmospheric evolution, climate, photochemistry as well as the altitude-dependent atmospheric radiation dose. The influence of higher energy particles upon non-Earth-like atmospheres dominated by CO_2, H_2 and H_2O and the influence on biosignatures and climate is a newly emerging topic in exoplanet science. Thereby, detailed knowledge of the impact of the stellar radiation and particle environment on the (exo)planetary atmospheric chemistry, climate and induced atmospheric particle radiation field is crucial to assess its habitability and, in particular, potential atmospheric bio signatures.



Artist's impression of CHEOPS (Characterising ExOPlanet Satellite) is ESA's first mission dedicated to investigating planets outside our solar system, launched in French Guiana on 17 December 2019. CHEOPS will study known exoplanets that are orbiting bright stars. The aim is to obtain detailed information about these planets to find out more about their composition and internal structure. In this view the satellite's telescope cover is closed. (Image Credit: ESA/ATG medialab)

Foreshocks across the Heliosphere: System Specific or Universal Physical Processes?

Team leaders: Heli Hietala, Imperial College London, United Kingdom, and Ferdinand Plaschke, Austrian Academy of Sciences, Graz, Austria
Session: 2–6 March 2020
Scientific Rationale: The foreshock is a disturbed region upstream of supercritical shocks, formed by the interaction of reflected particles and the incident plasma. Foreshocks can strongly affect particle acceleration, and modify the solar wind before its interaction with magnetospheres or ionospheres downstream of the shock. The research activities focusing on shocks near the Sun, Earth, and other planets have been the efforts of rather unconnected groups. Consequently, a systematic organization of the data obtained so far is lacking, which is why the following science question is still unsolved: How do foreshock processes change with system properties and upstream plasma parameters, across the solar system? In order to answer this question, a Team of researchers was collected within the field of shock and foreshock physics, active within different solar system environments. Together, the Team has the required comprehensive and complementary resources, including both readily available event lists and simulations. A systematic reorganization using the terrestrial foreshock as a benchmark will enable the Team members to disentangle interlinked dependencies between the system properties



Measurements from the Copernicus Sentinel-5P satellite show that the ozone hole over the Antarctic in the year 2020 is one of the largest in recent years. A detailed analyses from the German Aerospace Center indicates that the hole has now reached its maximum size. (Image Credit: DLR/ ESA)

and upstream parameters, revealing their relative importance and universal trends. A comprehensive investigation of foreshock processes provides a strong test of our current understanding, as well as predictions for shocks at objects currently beyond reach (such as exoplanets and astrophysical shocks). The timeliness is underpinned by new data from the Jovian bow shock by Juno; the Parker Solar Probe observations of coronal shocks and interplanetary shocks close to the Sun; and the preparations for Solar Orbiter and BebiColombo.

A New View of Ring-Planet Interactions from Cassini's Grand Finale

Team leaders: Hsiang-Wen Hsu, LASP, Boulder CO, USA, and Ali Sulaiman, University of Iowa, USA
Session: 23–27 September 2019
Scientific Rationale: In situ measurements carried out during the Cassini Grand Finale orbits provided the first direct evidence about the long-speculated ring-planet interactions at Saturn. In addition to the infall of ring material towards Saturn, i.e., the so-called "ring rain" phenomenon, large-scale electromagnetic connections between Saturn's rings and its ionosphere have also been suggested with the initial analysis of the Cassini Grand Finale measurements. The Team focuses on the major open issues about the ring-planet interactions at Saturn and other planetary systems: (1) conduct multi-instrument data analyses for the Cassini Grand Finale dataset to provide a comprehensive view of the global connection between Saturn and its rings; (2) address the implications on the origin and evolution of Saturn's main rings; and (3) generalize the understanding about ring-planet interactions to other giant planet systems. The outcome will significantly advance our understanding of the formation, evolution and dynamics of Saturn's rings and to inform future planetary exploration.

Space Weather Induced Direct Ionisation Effects on the Ozone Layer

Team leader: Antti Kero, University of Oulu, Sodynkylä, Finland
Session: 3–7 February 2020
Scientific Rationale: The Team investigates possible direct stratospheric ozone variability caused by space weather events, i.s., solar proton events and the modulated cosmic ray fluxes. Recently, Denton et al. (2018) have discovered a statistically detectable direct ozone reduction during the solar proton events by using the balloon-sounding datasets, i.e., at the altitudes of the ozone layer. This effect is highly unexpected by the current models, as the ionization rates induced by most of the solar protons events are expected to be significant in the upper stratosphere and mesosphere, but insignificant at the altitudes of the ozone balloon soundings. The influence of Galactic Cosmic Rays on the stratospheric ozone was studied by using SOCOL model in Calisto et al., (2011). A strong loss in the Antarctic polar lower stratosphere with annual mean mixing ratios decreasing by 3 % was reported. However, this effect has not been confirmed by observations to date. The Team makes an assessment on these effects based on satellite (MLS, GOMOS) and ground based datasets (ozonesonde) and atmospheric models (SIC, WACCM-D, SOCOL), including the crucial role of the polar vortex. The primary research objective is to find a mechanism by which the ozone layer is reduced by solar proton events. Moreover, the scientists assess experimentally the importance of the galactic cosmic ray fluxes variations to the stratospheric ozone.

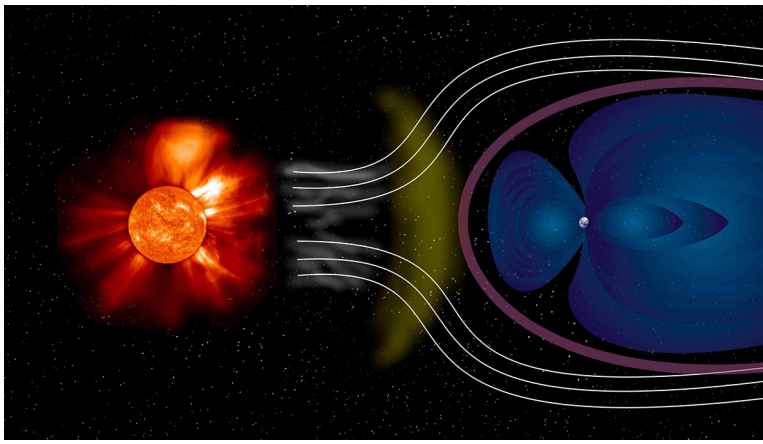
Interrogating Field-Aligned Solar Flare Models: Comparing, Contrasting and Improving

Team leaders: Graham Kerr, NASA Goddard Space Flight Center, Greenbelt MD, USA, and Vanessa Polito, Bay Area Environmental Research Institute, Moffett Field CA, USA
Session: 27–31 January 2020
Scientific Rationale: Understanding the physical mechanisms responsible for, and at play during, solar flares still remains one of the most important open issues in astrophysics. The Team aims to bring together the three most widely used field-aligned loop models that simulate the atmospheric response to flare energy injection: RADYN, HYDRAD & FLARIX. The scientists assess how differ-

ences in numerical techniques and code features (single fluid vs multi fluid, boundary conditions, treatment of energy transport and deposition, numerical grid size and resolution, treatment of radiative processes, treatment of thermal conduction etc.,) affect model-model and model-data comparison. They also compare the results of several post-processing codes, which are often used in conjunction with the (radiation-) hydrodynamic models to obtain the accurate synthesis of spectral lines not included in the original codes: RH, MALI & MULTI. The approach is to select a set of well-observed flares with multi-wavelength coverage. From this canonical dataset, the Team members agree upon a set of observables, use the forward modeling to predict those observables, and also use these as a basis for comparing, contrasting and calibrating the relative performance of the models. As the quality of solar flare observations continues to increase (e.g., the Daniel K. Inouye Solar Telescope (DKIST) and Solar Orbiter), and as the community is reliant on flare loop models to aid in the analysis and interpretation of these observations, it is crucial to have validated models, a solid understanding of the advantages and disadvantages of each code, and to lay the foundations for moving towards model improvements.

Using Energetic Electron and Ion Observations to Investigate Solar Wind Structures and Infer Solar Wind Magnetic Field Configurations (ISSI – ISSI-Beijing Team)

Team leaders: Gang Li, University of Alabama, Huntsville AL, USA, and Linghua Wang, Peking University, China
Session: *Meeting at ISSI postponed*
Scientific Rationale: Solar electron events are common phenomenon observed in interplanetary space. Electrons from < 1 keV to > 300 keV are often observed in these events with an occurrence rate near the Earth of ~190 events per year during solar maximum and ~10 per year during solar minimum. In many of these events ^{3}He ions are also observed at a significantly enhanced level. A majority of these events is related to small flares and they have no fast coronal mass ejections (CMEs) associated with them. Thus the underlying acceleration process is confined both spatially and temporally. Once they are accelerated and escape from the Sun, high energy electrons and ions propagate along the interplanetary magnetic field and scatter of various plasma waves. Observational characteristics (time intensity profiles and spectra) of these electrons and ions provide a probe of the configuration and turbulence level of the interplanetary magnetic field. Recent observations from multiple spacecraft (e.g., STEREO-A/B, Wind, and ACE) showed that electrons and ions in many of these events can be observed over a longitudinal separation of > 90 degrees

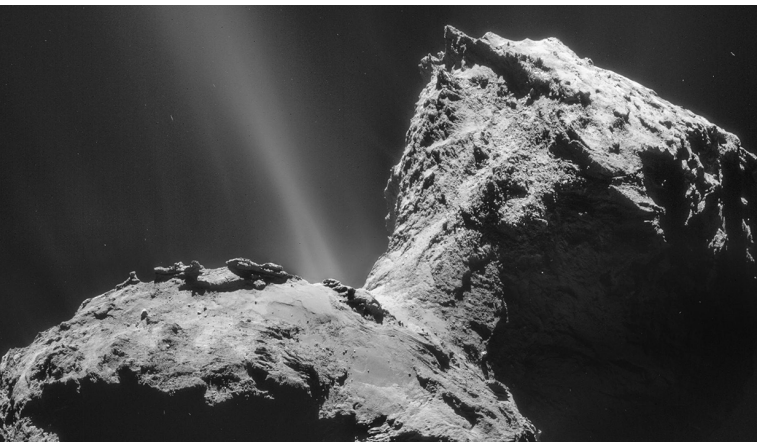


A wind of particles from the Sun called the solar wind buffets the blue funnel-shaped magnetosphere around the Earth. (Image Credit: ESA)

or larger. What causes these large separations? Could it be due to large cross field diffusion or due to significant field line meandering, or perhaps the magnetic field near the Sun experiences a significant divergence within a few solar radii? To answer these questions, the Team makes a comprehensive investigation which includes both observations and simulations, to be carried out by a group of experts in solar and heliospheric theory, modeling, and observations. With these combined studies, the scientists aim to reveal the interplanetary magnetic field configuration in solar electron events. They also quantify the solar wind turbulence level in these events through numerical simulation, obtain particle mean free paths; and using the resulting mean free path parameter to classify events into scatter-free and scatter-dominated cases. The Team member construct an event database which can be used by the heliospheric community.

Characterization of Cometary Activity of 67P/ Churyumov-Gerasimenko Comet

Team leader: Andrea Longobardo, INAF, Rome, Italy
Session: 12–14 February 2020
Scientific Rationale: After 3.5 years from the end of the mission, the data provided by the ESA/Rosetta mission still leads to important results about 67P/Churyumov-Gerasimenko (hereafter 67P), belonging to the Jupiter Family Comets. Since comets are among the most primitive bodies of the Solar System, the understanding of their formation and evolution gives important clues about the early stages of our planetary system, including the scenarios of water delivery to Earth. At the present state of knowledge, 67P's activity has been characterized by measuring the physical properties of the gas and dust coma, by detecting water ice patches on the nucleus surface and by analyzing some peculiar events, such



Gas and dust streams from the 'neck' of Comet 67P/ Churyumov-Gerasimenko. (Image Credit: ESA/Rosetta/ NAVCAM)

as outbursts. The Team aims to build a more complete scenario of the 67P activity during different stages of its orbit. The retrieved results in terms of dust emission, morphology and composition will be linked together in order to offer new insights about 67P formation and evolution. In particular, the main goals of the project are: 1. Retrieval of the activity degree of different 67P geomorphological nucleus regions in different time periods, by reconstructing the motion of the dust particles revealed in the coma; 2. Identification of the main drivers of cometary activity, by studying the link between cometary activity and illumination/local time, dust morphology, surface geomorphology, dust composition. The project will shed light on how (and if) cometary activity is related to surface geology and/or composition or is just driven by local illumination. The physical and compositional properties of the emitted dust give information about the state and the exposition time (i.e., on the evolution) of the surface and sub-surface layers where it is originated, and how they change during the comet orbit. The Team members exploit the great amount of data provided by the ESA/Rosetta orbiter, in particular the GIADA dust detector, the VIRTIS imaging spectrometer, the OSIRIS camera, the MIDAS atomic force microscope and the COSIMA and ROSINA dust and gas mass spectrometers, respectively. Cross-correlation among these data will allow combining different pieces of information (dust composition and morphology, nucleus composition, emission rate, geology), which, thanks to the support of dust models and laboratory measurements of cometary analogs, will lead to the goals.

Understanding the Properties of the Terrestrial Gamma-Ray Flash Population

Team leader: Martino Marisaldi, University of Bergen, Norway

Session: 12–16 August 2019

Scientific Rationale: Thunderstorms are the birth places of the most energetic natural particle acceleration processes on Earth, and Terrestrial Gamma-ray Flashes (TGFs) are the most explosive manifestation of such processes, capable to deliver 10^{18} high-energy photons from thunderclouds to outer space in a few tens of microseconds. Together, active and past TGF-observing missions catalog many thousands of events; however, each mission provides only a partial view of the same phenomenon biased by different energy ranges, orbits, selection criteria and instrumental effects. Up to now, no effort has been undertaken to provide a unifying view of the TGF phenomenon by harmonizing the currently available observations in a single, comprehensive population study. This Team has the specific goal of providing a quantitative description of the population of TGFs in terms of duration, energy spectrum, fluence distribution and occurrence frequency, based on all current observations. This project shall also identify TGF science requirements not accessible by current or near future missions, as the basis for possible future mission proposals.

Closing the Gap Between Ground Based and In-Situ Observations Of Cometary Dust Activity: Investigating Comet 67P to Gain a Deeper Understanding of other Comets

Team leaders: Raphael Marschall, Southwest Research Institute, Boulder CO, USA, and Oleksandra Ivanova, Main Astronomical Observatory of NASU, Kyiv, Ukraine

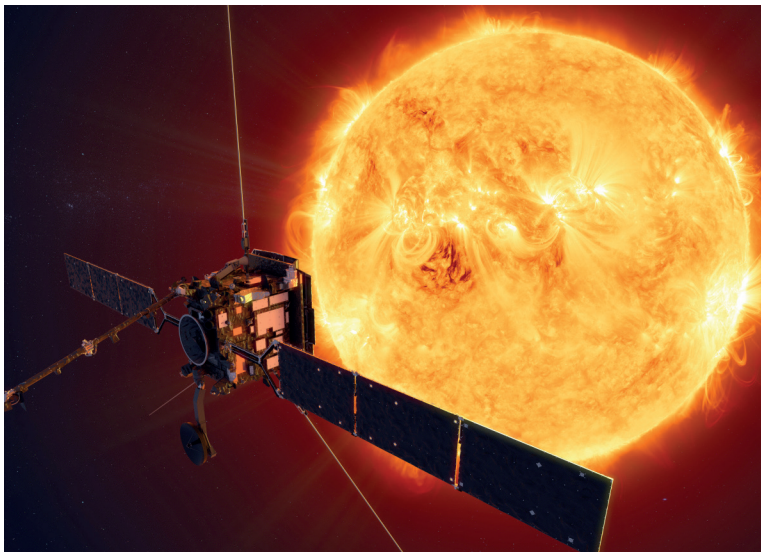
Session: 24–28 February 2020

Scientific Rationale: When cometary dust particles are ejected from the surface they are accelerated because of the surrounding gas flow from sublimating ices. As these particles travel millions of kilometers from their origin into the solar system they produce the magnificent tails commonly associated with comets. During their long journey the dust particles transition through different regimes of changing dominant forces such as gas drag, cometary gravity, solar radiation pressure, and solar gravity. The transition and link between the different regimes is to this day poorly understood. There are two main reasons for this. Firstly, the problem covers a vast range in spatial and temporal scales that need to be matched taking into account multiple transitions of the force regime. Furthermore, observational data covering these large spatial and temporal scales for at least one comet and thus characterizing it in great detail has been lacking until recently. For comet 67P/Churyumov-Gera-

simenko (hereafter 67P) a small number of large scale structures in the outer dust coma and tail have been found from ground based observations. Conversely ESA's Rosetta mission has shown many small scale structures defining the innermost coma close to the nucleus surface. This disconnect between the observations on these different scales has yet to be understood and explained. Solving this problem thus requires an interdisciplinary approach. This Team brings together experts of the recent observational data from ground and in-situ of comet 67P as well as theorists that are able to model the dynamical processes over these different scales. By doing so the Team members intend to answer some of the open questions that came out of the Rosetta mission and the accompanying ground based observations. The understanding gained about 67P will also be put in context by evaluating how it can be applied to furthering our knowledge of other comets.

Searching for Subglacial Water on Mars with Orbiting Ground Penetrating Radars (ISSI – ISSI-Beijing Team)

Team leader: Roberto Orosei, INAF, Bologna, Italy
Session: *Meeting at ISSI postponed*
Scientific Rationale: Mars is today a cold, dry and sterile world, but in the past it had a thicker atmosphere and liquid water flowing on its surface. MARSIS is a synthetic-aperture, orbital sounding radar carried by the European Space Agency spacecraft Mars Express searching for subsurface water and ice. MARSIS found anomalously bright subsurface reflections within a well-defined, 20 km wide zone in the Southern polar cap. Quantitative analysis of the radar signals produced estimates of relative dielectric permittivity matching that of water-bearing materials.
The goal is the search of subglacial water in the Martian polar caps using radar sounding data with several coordinated activities:
– Analysis of all data acquired by the MARSIS and SHARAD radar sounders over the Martian polar caps;
acquisition of raw data mode MARSIS observations over selected locations;
– Electromagnetic modeling of the radar response of the Martian polar caps;
– Electromagnetic simulations of radar propagation in the Martian polar deposits at the frequencies of MARSIS, SHARAD and Mars Global Remote Sensing Orbiter radar sounder.

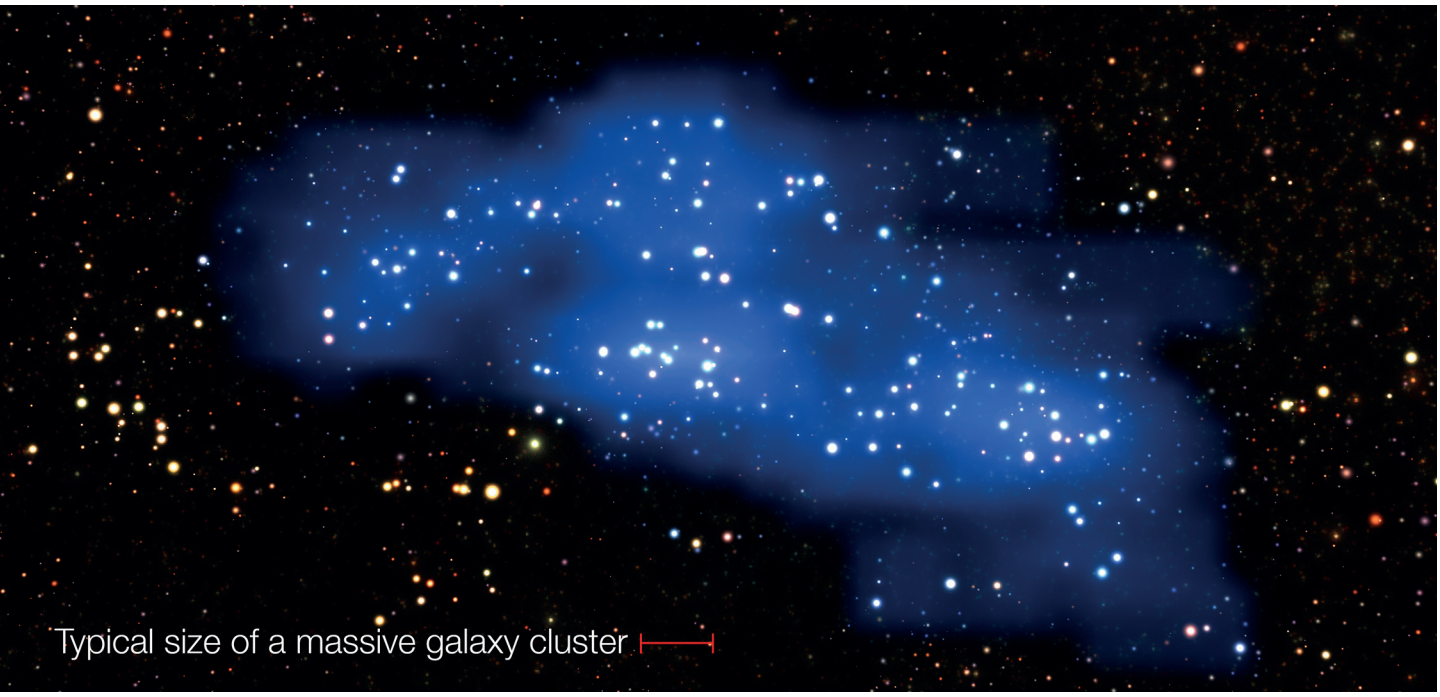


Solar Orbiter, launched in February 2020, will provide the first views of the Sun's unchartered polar regions from high-latitudes, giving unprecedented insight into how our parent star works. This mission also investigates the Sun-Earth connection, helping to better understand and predict periods of stormy space weather. (Image Credit: ESA/ATG medialab)

What Determines the Dynamo Effectivity of Solar Active Regions?

Team leader: Kristof Petrovay, Eötvös Loránd University, Budapest, Hungary
Session: 11–15 November 2019
Scientific Rationale:
Solar active regions (ARs - Sunspot groups and associated phenomena) are formed by the emergence of magnetic flux bundles from the Sun's interior into its atmosphere. The outcome of this emergence process through the turbulent medium of the solar convective zone is subject to very significant random fluctuations, so active regions often strongly deviate for the idealized simple bipolar structure, oriented East-West with a slight latitude dependent tilt. Unusual structure and/or size of an AR may, in turn, result in a large deviation of the amplitude of the global dipole magnetic field built up from the remains of ARs which serves as a seed field for the next 11-year solar magnetic cycle, hence it can give rise to major intercycle variations in the level of solar activity and other cycle properties. The Team members discuss and further study the factors that determine what makes such an exceptional or rogue AR, i.e. what properties of an AR determine its dynamo effectivity. The importance of this issue lies in its key role for our ability to predict an upcoming solar cycle and thereby to provide reliable space climate forecasts on a time scale of years to decades. Developing a capability to forecast space climate variations is important for the planning of future space missions.

International Teams



This visualization shows the extent of Hyperion compared to the size of a typical massive galaxy cluster in the local universe. (Image Credit: ESO/L. Calçada, O. Cucciati et al.)

Modeling Space Weather and Total Solar Irradiance over the Past Century (ISSI – ISSI-Beijing Team)
Team leader: Alexei Pevtsov, National Solar Observatory, Sunspot NM, USA
Session: *Meeting at ISSI postponed*
Scientific Rationale: Observations of magnetic fields on the Sun are ingrained into modern modeling of solar outer atmosphere and solar wind, the conditions throughout the heliosphere, and space weather effects near Earth and around other planets. Unfortunately, the systematic direct magnetographic measurements had only begun around mid-1960th. This lack of magnetograph data for early solar cycles severely restricts developing a comprehensive understanding of solar activity and its space weather effects in the past, and their prediction for the future. The goal is to develop a clear physics-based understanding of long-term changes in heliosphere, solar irradiance, and space weather conditions near Earth. This project employs newly developed maps of magnetic field for modeling the space weather effect on Earth and solar irradiance (TSI) over the last century. The Team uses also community-accepted models such as PFSS, WSA-Enlil etc to model the amount of open flux from the Sun, the location of coronal holes, the electron density, temperature and speed of solar wind in the heliosphere and at 1 AU. The scientists compare and constrain the results of their modeling with historical observations of geomagnetic activity.

Cluster Physics from Space to Reveal Dark Matter: Current and Future Challenges
Team leader: Johan Richard, Université de Lyon, Saint Genis Laval, France
Session: *Meeting at ISSI postponed*
Scientific Rationale: Galaxy clusters are the most massive observable structures in the universe; most of their mass is believed to be made of dark matter. Dark matter has remained 'directly' invisible to us so far, however one way to observe it 'indirectly' is through gravitational lensing, the bending of light rays from background galaxies as they travel through, and in the vicinity of galaxy clusters. The Team combines the best observations ever obtained of massive galaxy clusters from space with state-of-the art methods based on X-ray and lensing analyses, to constrain their physics, map their dark matter content and constrain its particle nature. Until the nature of dark matter gets identified, this combined analysis remains one of the most promising avenues to constrain its spatial distribution and potentially constrain its nature, such as self-interacting dark matter particles. The Team includes world experts in the areas of lensing and X-ray analyses of galaxy clusters. Adding to that, building a complete picture of those massive clusters and using their gravitational lensing power as cosmic telescopes will allow the scientists to probe the high-redshift universe, learn about early galactic assembly and clustering, and prepare targets for follow-up with the upcoming James Webb Space Telescope (JWST).

Radiation Belt Physics from Top to Bottom: Combining Multipoint Satellite Observations and Data Assimilative Models to Determine the Interplay between Sources and Losses

Team leaders: Jean-François Ripoll, CEA/DAM/DIF, Arpajon, France, and Geoffrey Reeves, Los Alamos National Laboratory, USA

Session: 27–31 January 2020

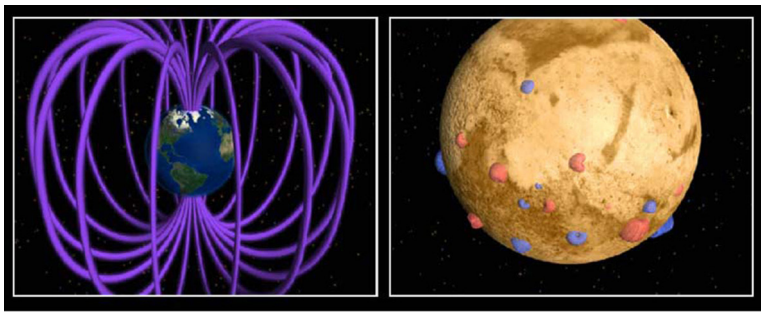
Scientific Rationale: The Team conducts an observationally-oriented study to investigate new discoveries concerning the dynamic processes that govern relativistic electrons and energetic ions in the near-Earth space environment. A fundamental question that remains unanswered is how charged particles are distributed along the magnetic field lines from one hemisphere to the other. In particular, the distribution near the atmospheric "loss cone" is quite different from the distribution of particles that magnetically mirror further up the field. Understanding the relationship between those two parts of the distribution will provide new tools for both, physical understanding and predictive modeling. This broad knowledge has great value for practical space weather applications, with important implications for the man-made technologies that operate in this region. The Team aims to reach a global description of the particle distribution along the entire geomagnetic field line by using and combining datasets from three main missions observing the radiation belts: ESA's Proba V mission (EU), NASA's Van Allen Probes mission (USA), and JAXA's Arase (ERG) mission (Japan). Each mission brings a different latitudinal view of the belts, yet together will deliver a full description along the field line, and result in a new understanding of the dynamics.

A New Non-Equilibrium Model of "Iron Snow" in Planetary Cores

Team leaders: Tina Rückriemen-Bez, DLR, Berlin, Germany, and Chris Davies, University of Leeds, United Kingdom

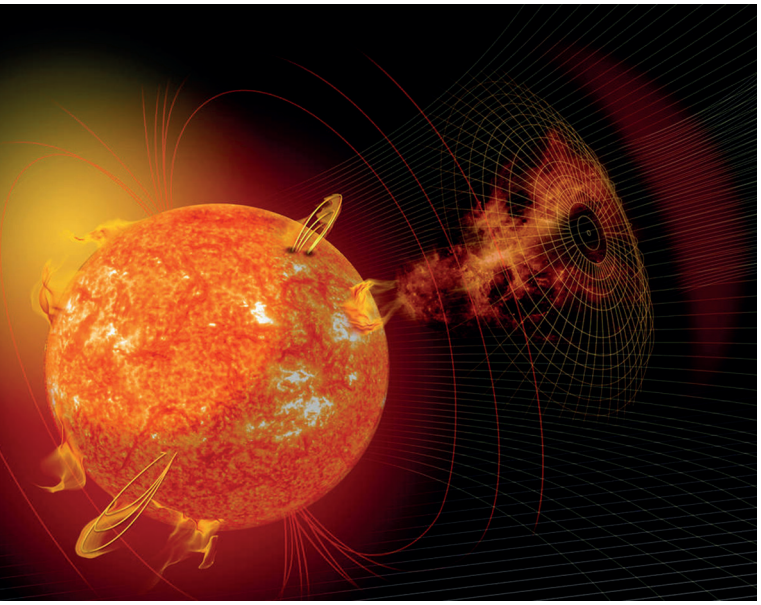
Session: *Meeting at ISSI postponed*

Scientific Rationale: A fundamental question in planetary science is to explain the remarkable variability in the intensity and spatiotemporal properties exhibited by the magnetic fields of terrestrial bodies. These fields are generated in metallic cores, and hence the observed variability is likely tied to differences in the structure, dynamics and evolution of planetary interiors. Earth's liquid core is slowly freezing from the bottom upwards as the planet cools, releasing the heat and light material that power the geomagnetic field. In contrast, recent studies suggest that the cores of the smaller terrestrial bodies including the Moon, Mercury, Mars, Ganymede and planetesimals freeze from the top down with solid iron particles "snowing" into the deeper core. The evolution and dynamics of bodies in this "iron snow" regime is profoundly different to those of Earth as shown by current "first generation" models of iron snow. These models indicate that iron snow plays a vital role in sustaining planetary magnetic fields, but they assume that solid and liquid instantly come into equilibrium, an over-simplification that has recently been shown to significantly affect the model behavior. It is now time to develop the next generation of iron snow models in small terrestrial bodies. The goal is to bring together theoreticians, modelers and experimentalists in order to develop the first non-equilibrium iron snow model of long-term planetary evolution. The basis for the work is a purely mathematical theory of non-equilibrium slurries. Objective 1 of the work is to make this complex theory fit for application to terrestrial bodies in a similar way as has been done for the equilibrium iron snow case. The description of non-equilibrium, however, will require the macroscopic parameterization of microscopic processes. Objective 2 is thus to constrain the model using experimental results. Objective 3 is to compare the new non-equilibrium model to the established equilibrium case and then apply it to Mercury, Mars and Ganymede in order to establish the thermo-chemical and magnetic histories of these bodies. This effort will be a step change in understanding and modeling the evolution of terrestrial planetary cores and will lead to close collaboration between theoreticians, modelers and experimentalists in order to understand complex core freezing processes.



Artist's concept comparing the present day magnetic fields on Earth and Mars. Earth's magnetic field is generated by an active dynamo – a hot core of molten metal. The magnetic field surrounds Earth and is considered global (left image). The various Martian magnetic fields do not encompass the entire planet and are local (right image). The Martian dynamo is extinct, and its magnetic fields are "fossil" remnants of its ancient, global magnetic field. (Image Credit: NASA/GSFC)

International Teams



Artist's depiction of an active sun that has released a coronal mass ejection or CME. CMEs are magnetically generated solar phenomenon that can send billions of tons of solar particles, or plasma, into space that can reach Earth one to three days later and affect electronic systems in satellites and on the ground. (Image Credit: NASA)

Magnetic Open Flux and Solar Wind Structuring of Interplanetary Space

Team leader: Manuela Temmer, University of Graz, Austria
Session: 7–11 October 2019
Scientific Rationale: Correctly deriving magnetic open flux on the Sun and the distance to coronal hole (CH) boundaries is a long-standing open question and crucial for modeling the background solar wind. Knowing the background solar wind in interplanetary (IP) space is fundamentally important for reliable coronal mass ejection (CME) propagation modeling and forecasting. However, estimates of open solar magnetic flux from remote photospheric and in situ spacecraft observations can differ by as much as a factor of two, which is well outside the measurement uncertainties. This suggests a fundamental issue in our understanding about the topology of the coronal magnetic field and the energization of plasma. To tackle that issue, the Team brings together a group of experts with a wide range of expertise to determine the physical source of the (missing) open solar flux using the powerful approach of combining models and observations. Based on the results, the experts develop a methodology for reproducing the interplanetary magnetic field open flux at 1AU distance range with full assessment of uncertainty that can serve as a benchmark for global coronal magnetic field and solar wind models.

Understanding our Capabilities in Observing and Modeling Coronal Mass Ejections

Team leaders: Christine Verbeke, KU Leuven, Belgium, and Marilena Mierla, Royal Observatory of Belgium, Brussels, Belgium
Session: 17–21 February 2020
Scientific Rationale: Coronal Mass Ejections (CMEs) are large-scale eruptions of plasma and magnetic fields from the Sun. They are considered to be the main drivers of strong space weather events at Earth. Multiple models have been developed over the past decades to be able to predict the propagation of CMEs and their arrival time at Earth. Such models require input from observations, which can be used to fit the CME to an appropriate structure. The Team aims to focus on both CME observations as well as modeling and ultimately provide a benchmark of where the community stands on CME arrival time prediction. Such a benchmark is essential for scientists to improve existing models and/or create new models, as well as for tracking improvements arising from new observations. For such a project, it is crucial to bring together expertise from both the observational and the modeling communities. When fitting the CME structure to obtain the parameters needed in simulations, different geometric structures and also different parts of the CME structure can be fitted. These aspects, together with the fact that 3D reconstructions strongly depend on the subjectivity and judgment of the scientist performing them, may lead to uncertainties in the fitted parameters. Up to now, no large study has tried to map these uncertainties and to evaluate how they affect the modeling of CMEs. The Team aims to obtain a better quantification of these errors. This Team will fit a large set of CMEs within a selected period of time so that uncertainties in the CME fittings can be investigated in detail. Each event will be fitted multiple times by different Team members. This opens up the opportunity to discuss what exactly each person is fitting, as well as a possibility for statistics on uncertainties of the fittings. Furthermore, the fittings will be used to run the simulation models. A detailed evaluation of the models will be performed, where an initial validation is performed on the arrival time prediction capabilities of the models. Finally, this will set a benchmark for future models and model updates. The Team will set up a database with the fittings and simulations, open for the community to use. The Team will provide a crucial forum to make substantial progress on quantifying the error in observational inputs as well as on creating a benchmark to evaluate CME arrival time prediction models against by using a well thought-out methodology and involving the international community.

Active Galaxies in Crisis: A Statistical Study of Ultra-Violet Variability (ISSI – ISSI-Beijing Team)

Team leader: Martin Ward, Durham University, United Kingdom

Session: 16–20 December 2019

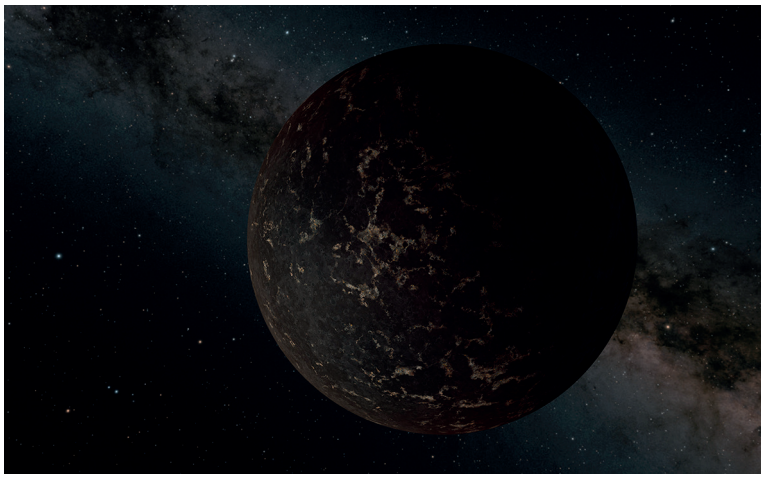
Scientific Rationale: Much progress has been made in our understanding of active galactic nuclei (AGN) in the 85 years, since Karl Seyfert noted their distinctive broad emission lines. Mass accretion via a hot rotating disc onto a super-massive black hole, is now the well accepted picture. However, all is not well with important aspects of our understanding. This has been highlighted by the increasing use of the time domain as a new tool to investigate the inner regions of AGN that we cannot spatially resolve. The Team work focuses on a particular aspect of time domain astrophysics, namely the ultra-violet (henceforth, UV). This wavelength region is not accessible from the ground (except for bluest u-band, which we will make use of) due to atmospheric absorption. For low redshift AGN which often have the best quality data, this is the wavelength region dominated by the accretion disc, a key component in our understanding of the physics of AGN. The timescales of AGNUV variability are inconsistent with basic ideas of the source of the observed variations. In particular, viscosity changes within the disc occur far too slowly compared with observations. This problem has been called "The Quasar Viscosity Crisis". The project aims to address the UV variability as a symptom of this crisis, and proposes explanations based on a large body of unexplored observational data, and modeling. The Team work quantifies the UV variability on timescales from weeks to decades, for a very large sample of AGN. It is the first such study to exploit the huge UV databases that exists for observations from the ESA cornerstone mission XMM-Newton and the Neils Gehrels Swift Observatory. The results will be both statistically significant, as the experts set the UV variability in the context of other basic properties of the AGN, and also the scientists will be certain discover some extreme cases of variability ie., example of a recently identified group of "Changing Look" AGN.

Zooming in on Rocky Planet Formation

Team leaders: Rens Waters, SRON, Utrecht, The Netherlands, and Inga Kamp, University of Groningen, The Netherlands

Session: 27–31 January 2020

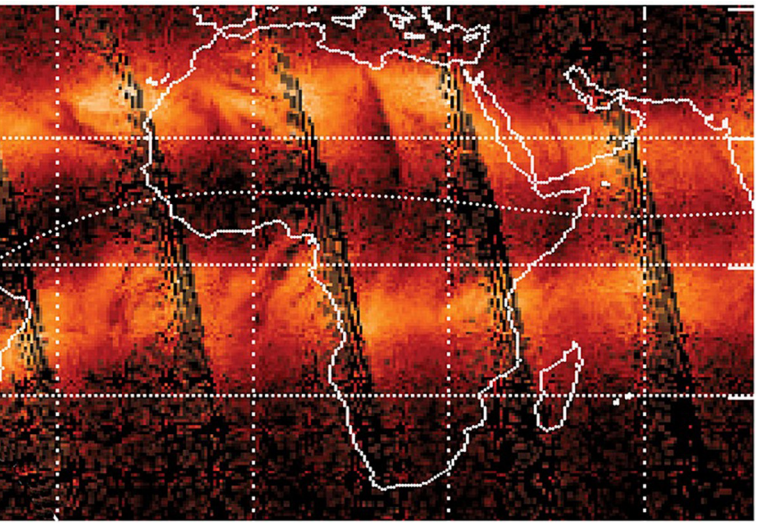
Scientific Rationale: The inner regions of planet forming disks surrounding young stars are key to our understanding of the formation of rocky, Earth-like planets and super-Earths. We know from exoplanet surveys that such



Discovered in 2018 by NASA's Transiting Exoplanet Satellite Survey (TESS) mission, planet LHS 3844b is located 48.6 light-years from Earth and has a radius 1.3 times that of Earth. It orbits a small, cool type of star called an M dwarf – especially noteworthy because, as the most common and long-lived type of star in the Milky Way galaxy, M dwarfs may host a high percentage of the total number of planets in the galaxy. (Image Credit: NASA/JPL Caltech)

planets are abundantly present around low mass stars. Rocky planets are essential ingredients in the quest for life outside the solar system. Understanding their properties and formation history is key to our efforts to put the solar system in perspective. We can now for the first time spatially resolve the inner 10 au of planet forming disks (e.g. ALMA, SPHERE/GPI, VLTI/PIONIER/GRAVITY/MATISSE) and will obtain spectra of the warm gas in the inner disk regions (JWST, CRIRES+) that allows us to characterize their structure, dust and gas content and composition. Recent and ongoing surveys (e.g. Corot, Kepler, TESS) provide data to study many rocky exoplanets and exoplanetary architectures. These two key phases, the initial disk stage and the final planet properties, are only emerging now. The experts use current models and observations to link these two key phases allowing us to confront theories and observations of planet formation with the observed outcome of the planet formation process. Finally, the scientists compare this to the solar system for which increasingly quantitative data from exploration missions, meteorite analysis and remote sensing are becoming available.

International Teams



Images of ionospheric irregularities over Africa as seen in airglow depletions. The dark patches within the brighter equatorial "arcs", either side of the geomagnetic equator (dotted line), are where communication signals would be lost (Image Credit: E. Yizengaw et al., figure courtesy of Larry Paxton, Applied Physics Laboratory).

The Identification and Classification of 3D Alfvén Resonances

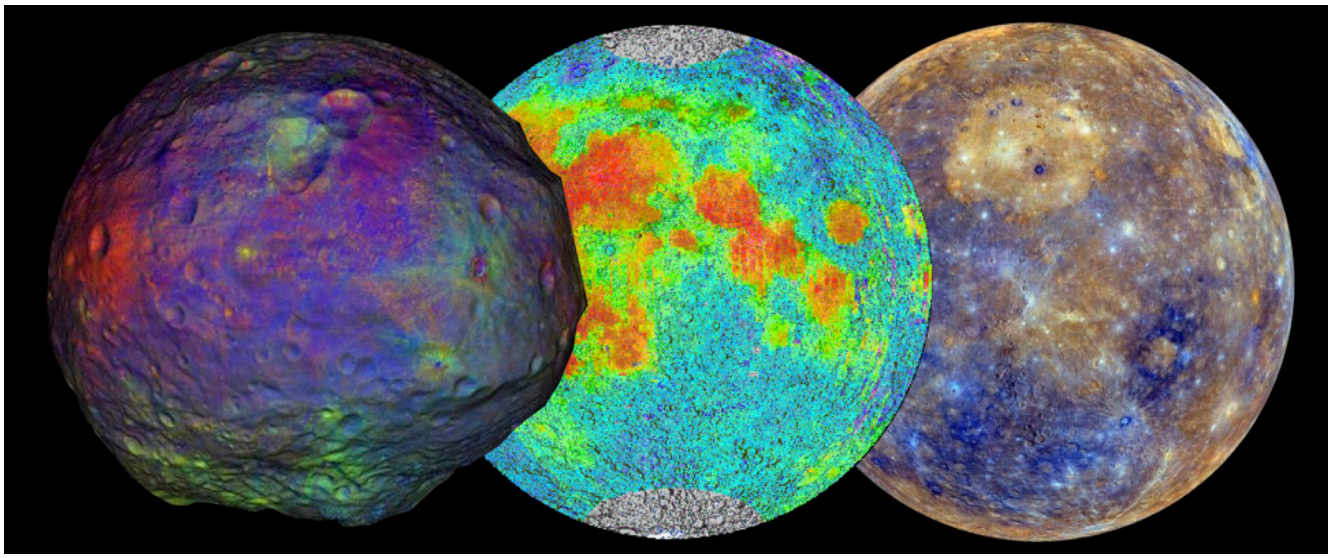
Team leader: Andrew Wright, University of St Andrews, United Kingdom
Session: 12–16 August 2019
Scientific Rationale: The coupling of global fast MHD waves to resonant Alfvén waves in the Earth's magnetosphere has been used to explain observations in solar coronal loops or other planetary magnetospheres (Mars, Jupiter and Saturn). But, Alfvén waves play also key role in magnetosphere-ionosphere coupling and auroral processes, as well as particle acceleration and transport of energy. Until recently the most sophisticated theory was 2D, however, three Team members have performed simulations of Alfvén resonances in 3D. The Team will focus on regions where the magnetosphere is most non-axisymmetric, either due to density plumes (in the afternoon) or field lines being distended due to the global convection cycle. Specifically, the Team focuses on (i) identifying signatures of 3D Alfvén resonances in simulations, (ii) develop software to search for these in data sets, (iii) produce maps of 3D resonance properties to highlight the potential impact in related research areas, (iv) apply this knowledge to improve remote sensing of plasma density using 3D Alfvén waves and to understand the modification of Alfvén resonance signatures in ground magnetometer data by the overlying ionosphere.

Why Ionospheric Dynamics and Structure Behave Differently in the African Sector?

Team leaders: Endawoke Yizengaw, The Aerospace Corporation, El Segundo CA, USA, and Keith Groves, Boston College, Chestnut Hill MA, USA
Session: 4–8 November 2019
Scientific Rationale: The Team fully utilizes data from recently deployed multi-instruments in the African sector to better understand the physical processes that control the unique ionospheric dynamics and structures often observed in the region compared to other longitudes. Much of what is known about equatorial ionospheric physics is based on Jicamarca radar observations. However, satellite observations consistently show significant longitudinal differences in the global distribution of equatorial ionospheric irregularities and its driving electrodynamics. The equatorial ionosphere in the African region often behave differently than other parts of the Earth. In the African region, satellite observations have shown ionospheric bubbles that are uniquely much deeper (in terms of bubble depth) and very active all year round unlike other longitudinal sectors. The international experts are well experienced and carry out a comprehensive study to address the longstanding fundamental problems often observed in the region. These include: (1) Why ionospheric irregularities in general are unique in the African sector? (2) What are the possible driving mechanisms that create unique equatorial structures in Africa? (3) Why do existing models fail to predict such unique structures in the African sector? In order to address these problems, the long-term (about ten years) multi-instrument observations that are archived by individual PIs will be utilized. Since different instruments observe different parameters, coordinating results obtained from different instruments allow us to understand the physical process that control unique ionospheric dynamics and structure in the African sector.

Deciphering Compositional Processes in Inner Airless Bodies of our Solar System

Team leader: Francesca Zambon, INAF, Rome, Italy
Session: *Meeting at ISSI postponed*
Scientific Rationale: The mineralogy and average composition of the surfaces of airless bodies observed today in our Solar System are the result of formation and evolution processes that occurred over geologic timescales. Over the last decade, there has been a dramatic increase in our knowledge of the mineralogical and geochemical context of airless planetary bodies such as Vesta, Mercury, and the Moon, thanks to visible to near-infrared and nuclear remote sensing instrumentation carried onboard several planetary space missions (e.g., Dawn, MESSENGER, Chandrayaan-1). The subsequently large amount of collected data was crucial for identifying the nature and the distri-



The figure shows the three bodies studied by the ISSI Team led by Francesca Zambon. Right image: Vesta RGB-clementine like color composite image obtained by the Dawn Framing Camera. Central image: Moon iron concentration map obtained by the Clementine global color data. Left image: Mercury RGB color composite image, called 'Enhanced', produced using the data acquire by the MESSENGER MDIS-Wide Angle Camera. (Image Credit: NASA, JPL-Caltech, UCLA,MPS, DLR, IDA, PSI, LPI, API)

bution of the main chemical and mineralogical species. Resulting high-level products such as global compositional maps reveal that while each of these bodies is unique in its composition and surface evolution, they share similarities that must be interpreted. The next logical step is to analyze the available data from all these missions combined in order to better understand the general context of the formation and evolution of the inner Solar System that resulted in the surface compositions observed today. To combine space observations from multiple instruments, theory, and ground truth from laboratory investigations, this Team brings together a group with representatives from different branches of planetary sciences. Technically, in order to identify correlations in the datasets, the Team members rely on multivariate statistical methods. The expected outcome, unprecedented, will be to quantify the similarities and differences in the surface compositional properties of Vesta, Mercury and the Moon, substantially enhancing the scientific return of individual instrumental datasets and/or individual space missions. The project is focused on two specific questions: 1. Why do the chemical changes induced by space weathering in surface regoliths appear to be so different on Vesta, Mercury and the Moon and what is the role of primary mineralogy and composition? 2. The question of the presence and abundance of olivine at the surface of Vesta is a case in point that requires not only better identification of that mineral, but also its relationship with associated phases. Given that olivine has also been found on the Moon, but not identified on Mercury, what are the implications for all three of these planetary bodies?

Sombreros and Lampposts: The Geometry of Accretion onto Black Holes

Team leaders: Andrzej Zdziarski, Polish Academy of Sciences, Warszawa, Poland, and Tomaso Belloni, INAF, Merate, Italy

Session: 13–17 January 2020

Scientific Rationale: The standard model of accretion onto black holes (BHs) predicts formation of an optically-thick accretion disc extending down to the innermost stable circular orbit (ISCO), which explains well the soft state of BH binaries. However, this model cannot explain states in which BH binaries and AGNs predominantly emit hard X-rays. It has to be instead emitted by some hot plasma. The location of this plasma has been the subject of an intense controversy. According to one view, the disc evaporates and changes to a hot flow relatively far from the BH. According to the other, the disc still extends down to the ISCO, and the hot plasma is located very close to both its inner edge and the horizon. The former scenario explains a large number of observations. Arguments for the latter are given mainly by observations of broad Fe K emission lines due to reflection on the disc, lines whose broadening is explained by extreme relativistic effects and therefore must originate very close to the BH. The Team discusses the arguments of both sides, summarizes the current status of this issue, and devises projects that could lead to a definitive resolution of this controversy.

International Teams approved in 2020

The following listed teams have been selected for implementation from the proposals received in response to the 2020 Call for International Teams:

Effects of Solar Wind High-Speed Streams on the Ionosphere-Thermosphere System
Team Leaders: Anita Aikio, University of Oulu, Finland, and Aurélie Marchaudon, Université de Paul Sabatier, France

Langmuir Probes, a 100 Year Workhorse: Easy to Fly but Difficult to Interpret
Team Leader: Laila Andersson, University of Colorado, USA

Use of Geostationary Satellites to Improve Air Quality Characterization and Forecasts (ISSI – ISSI Beijing Team)
Team Leaders: Guy Brasseur, Max Planck Institute for Meteorology, Hamburg, Germany, and Claire Granier, NOAA, Toulouse, France

SHoT: The Stellar Path to the Ho Tension in the Gaia, TESS, LSST and JWST Era
Team Leader: Gisella Clementini, INAF, Bologna, Italy

Data-driven 3D Modeling of Evolving and Eruptive Solar Active Region Coronae
Team Leaders: Georgios Chintzoglou, Lockheed Martin Solar and Astronphysics Lab, Palo Alto, USA, and Michael Wheatland, The University of Sydney, Australia

The Earth's Exosphere and its Response to Space Weather
Team Leaders: Hyunju Kim Connor, University of Alaska, Fairbanks, USA, and Jochen Zoennchen, University of Bonn, Germany

Getting Ultra-Precise Planetary Radii with PLATO: The Impact of Limb Darkening and Stellar Activity on Transit Light Curves
Team Leader: Szilard Csizmadia, University of Bonn, Germany

The Fireworks Finale in High-Redshift Distant Galaxy Proto-Clusters
Team Leaders: Hervé Dole, Université Paris-Saclay, Orsay, France, and Brenda Frye, The University of Arizona, Tucson, USA

Feeding the Spinning Top – Spin Evolution of Accretion-Powered Pulsars in High-Mass X-Ray Binaries
Team Leader: Ilek El Mellah, KU Leuven, Belgium

Time-Variable Gravity Field Modeling and Simulation from Present and Future Gravity Satellite Missions (ISSI – ISSI Beijing Team)
Team Leader: Wei Feng, Chinese Academy of Sciences, Hubei, China

Advanced Three-Dimensional Modeling of the Magnetic Field in Active Regions on the Sun
Team Leader: Gregory D. Fleishman, New Jersey Institute of Technology, Newark, USA

Stratospheric Age-of-Air: Reconciling Observations and Models
Team Leader: Hella Garny, DLR, Wessling, Germany

Similarities and Differences in the Plasma at Comets and Mars
Team Leader: Charlotte Goetz, ESTEC, Noordwijk, The Netherlands

Towards Determining the Earth Energy Imbalance from Space
Team Leader: Margrit Haberreiter, World Radiation Center, Davos, Switzerland

Multi-Sensor Observations of Antarctic Sea Ice and its Snow Cover
Team Leaders: Petra Heil, University of Tasmania, Hobart, Australia and Rachel Tilling, NASA Goddard Space Flight Center, Greenbelt, USA

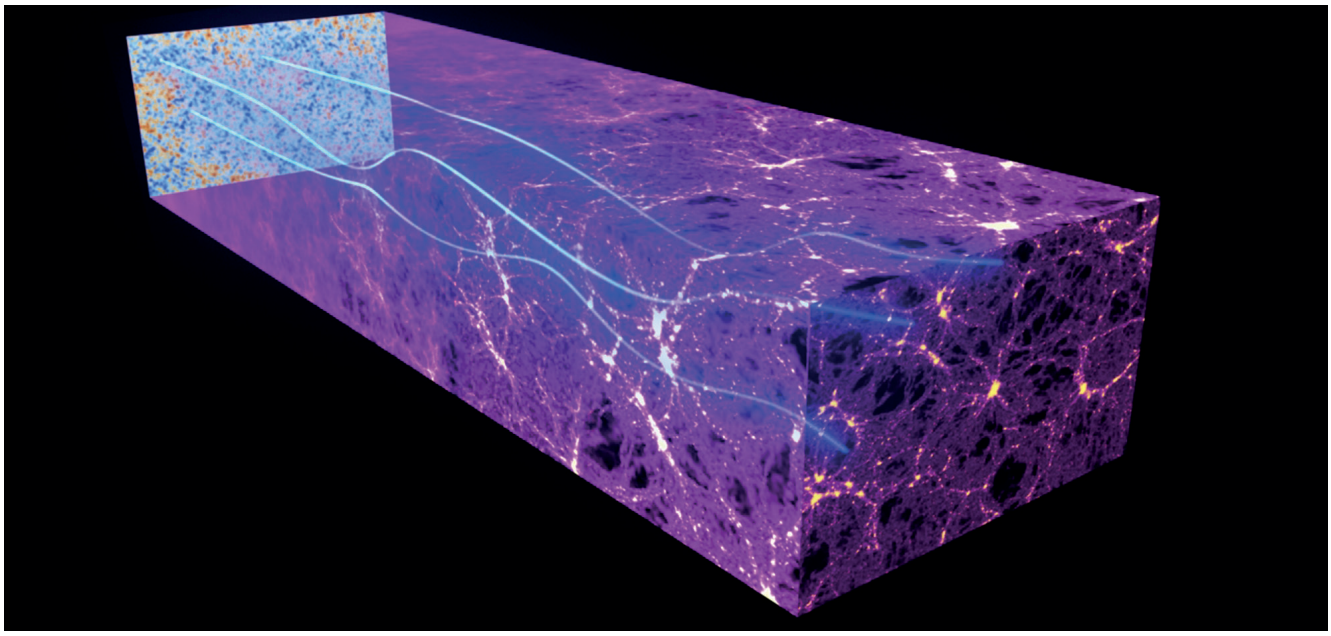
WaLSA: Waves in the Lower Solar Atmosphere at High Resolution
Team Leader: Peter Keys, Queen's University Belfast, United Kingdom

Resolving the Generation Mechanisms and Electrodynamical Effects of Medium Scale Traveling Ionospheric Disturbances (MSTIDs)
Team Leaders: Jeffrey Klenzing, NASA Goddard Space Flight Center, Greenbelt, and Katherine Zawdie, US Naval Research Laboratory, Washington, USA

The Life Cycle of Comets
Team Leader: Rosita Kokotanekova, European Southern Observatory (ESO), Garching, Germany

The Metal-THINGS Survey of Nearby Galaxies
Team Leader: Maritza Lara-Lopez, University of Copenhagen, Denmark

Understanding Mesoscale Ionospheric Electrodynamics Using Regional Data Assimilation
Team Leader: Karl Magnus Laundal, University of Bergen, Norway



Artist's impression showing how photons from the early universe are deflected by the gravitational lensing effect of massive cosmic structures as they travel across the universe. (Image Credit: ESA)

Population-Dynamical Archeology of Galaxies (ISSI – ISSI Beijing Team)

Team Leaders: Ryan Leaman, Max Planck Institute for Astronomy, Heidelberg, Germany, and Ling Zhu, Chinese Academy of Sciences, Shanghai, China

Strong Gravitational Lensing Studies with CSS-OS and EUCLID (ISSI – ISSI Beijing Team)

Team Leader: Ran Li, National Astronomical Obsevatories of China, Chinese Academy of Science, Beijing, China

Understanding Satellite, Aircraft, Balloon, and Ground-Based Composition Trends: Using Dynamical Coordinates for Consistent Analysis of UTLS Composition

Team Leader: Luis Millan, NASA Jet Propulsion Laboratory, Pasadena, USA

Solar Extreme Events: Setting Up a Paradigm

Team Leaders: Fusa Miyake, Nagoya University, Japan and Ilya Usoskin, University of Oulu, Finland

Multi-Scale Magnetosphere-Ionosphere-Thermosphere Interaction (ISSI – ISSI Beijing Team)

Team Leader: Toshi Nishimura, Boston University, USA

Multiwavelength View on Massive Stars in the Era of Multimessanger Astronomy

Team Leader: Lida Oskinova, University of Potsdam, Germany

Unravelling Solar Wind Microphysics in the Inner Heliosphere

Team Leaders: Denise Perrone, Italian Space Agency, Rome, Italy, and Sergio Toledo-Redondo, Universidad de Murcia, Spain

Warm Coronae in AGN: Observational Evidence and Physical Understanding

Team Leaders: Pierre-Olivier Petrucci, Université Grenoble Alpes, Saint-Martin-d'Hères, France, and Giorgio Matt, Universita' degli Studi Roma Tre, Italy

Mass Loss from Io's Unique Atmosphere: Do Volcanoes Really Control Jupiter's Magnetosphere?

Team Leader: Lorenz Roth, KTH Royal Institute of Technology, Stockholm, Sweden

Coronal Dimmings and Their Relevance to the Physics of Solar and Stellar Coronal Mass Ejections

Team Leaders: Astrid Veronig, University of Graz, Austria and Karin Dissauer, NorthWest Research Associates, Boulder, USA

Towards a Unifying Model for Magnetic Depressions in Space Plasmas

Team Leader: Martin Volwerk, SRI, Austrian Academy of Sciences, Graz, Austria

Molecular and Metallic Ions in the Magnetosphere

Team Leader: Masatoshi Yamauchi, Swedish Institute of Space Physics, Kiruna, Sweden

Johannes Geiss Fellow 2019

The Johannes Geiss Fellowship (JGF) is established to attract to ISSI – for limited duration visits – international scientists of stature, who can make demonstrable contributions to the ISSI mission and increase ISSI's stature by their presence and by doing so will honor Johannes Geiss for his founding of ISSI and his contributions to ISSI, and for his many contributions to a broad range of space science disciplines.

Interview with Johannes Geiss Fellow Bruno Leibundgut

Bruno Leibundgut (European Southern Observatory (ESO), Garching, Germany) was elected as the Johannes Geiss Fellow 2019. In the following paragraphs he answers a few questions asked by Lorena Moreira, ISSI postdoc, about his scientific work (in pandemic times).

Lorena Moreira: How has the Johannes Geiss Fellowship contributed to your career? And why did you apply to the Fellowship?

Bruno Leibundgut: The Johannes Geiss Fellowship was a great opportunity for me to refocus some of my research and reconnect to Swiss astronomy. Most of my professional career was spent at an international organization and an observatory. This means that I had to deal with many science administration aspects and for a while, during my time as ESO Director for Science, was contributing to the scientific direction of the organization and managing the scientific environment. There was not much time left for research. The Johannes Geiss Fellowship allowed me to catch up with recent developments in my fields of supernova physics and cosmology. Being able to devote all of my time to research was a very welcome change to my current work. This was also the reason to apply for the Johannes Geiss Fellowship. It seemed to be an ideal opportunity to combine the research time it promised at a scientific institute in Switzerland. I used the time to meet several astronomers in Bern and Geneva to discuss various projects and the interaction of Swiss astronomers with ESO.

Lorena Moreira: On which projects did you work during your stay at ISSI?

Bruno Leibundgut: The original plan was to write up a paper from a Masters thesis of one of my students on SN1987A. He analyzed the evolution of this nearest supernova in several centuries from a decade of HST observations and his results should be cast into a publication. My first weeks at ISSI were used to clear my ESO work backlog. I also had a couple of trips to conferences and for talks during my Johannes Geiss Fellowship. My research at ISSI focused is on some cosmology aspects, which I wanted to explore more deeply. This also involved learning new software tools. The time at ISSI enabled me to enlarge my knowledge and read up on topics, which in my normal work life always seemed to fall to the wayside. The main research work in the end was on the adH0cc (accurate distances for H0 through core collapse supernovae) project. I am leading a large program with the ESO Very Large Telescope (VLT) to carefully observe about 2 dozen individual Type II supernovae to determine their distances and then derive the local cosmic expansion rate, the Hubble constant. We acquire detailed spectroscopy and photometry of a supernova over several weeks to follow its brightness evolution and the speed with which it expands to connect these parameters into a distance measurement. Much of the data reduction processes were worked out during my time in Bern.

Lorena Moreira: What are according to you the next breakthroughs in cosmology? What do you think the future hold for your scientific career?

Bruno Leibundgut: There is a discrepancy of the value of the Hubble constant from measurements in the local and the distant universe. This 'Hubble tension' could, if confirmed, point to deficiencies in the currently favored cosmological model, the Lambda Cold Dark Matter (Lambda CDM) universe. This model contains several components that at the moment lack a physical understanding, namely 'dark energy' in the form of Einstein's cosmological constant Lambda and 'dark matter', which is inferred indirectly, but has so far not been detected as a particle. These particles would have to be fairly massive so that they can clump under gravity to form galaxies. We call this type of matter 'cold'. The difference of the Hubble constant as calculated from the information in the distant universe, the measurements from the cosmic microwave background as determined by the ESA Planck satellite, and the direct measurement in the local universe shows that the Lambda CDM model may not be complete. Right now it is unclear, whether this is a real physical effect or just systematic problems of the Hubble constant determinations. It is important to explore as many independent methods as possible to check that we are not fooled by unknown problems in the measurements.
Our adH0cc project contributes a new method of the local Hubble constant that is completely independent of any of the other determinations. It will take a couple of years until we have collected the necessary data and can

analyze them. In the end, we should be able to check for any systematic effects we use to measure the Hubble constant. In some sense, this work arches back to the start of my scientific career, where I also tried to determine the Hubble constant - with an uncertainty that was a factor 10 higher than today's measurements!
I was always interested in the physics of stellar explosions and how this connects to their use as cosmological distance indicators. My research of this connection continues and I hope that I can learn about the explosion physics as much as about cosmology. There are plenty of unsolved problems in both areas. The current cosmological picture has firmed up significantly over the past two decades, but with dark energy and dark matter contains at least two parameters, which lack a physical understanding.

Lorena Moreira: As you have recently experienced staying away from your permanent office during your visits at ISSI and during the current pandemic situation, what do you think that we can learn from these experiences to thrive scientifically?

Bruno Leibundgut: ISSI was a great place for me to focus on my research. The quiet environment allowed me to concentrate on the adH0cc project and make the necessary preparations to fully explore the data. Such quiet periods, when the hectic of the outside world is shielded, are important in a research career. I believe, they are needed to focus one's mind. Small 'sabbatical' stays, like my Johannes Geiss Fellowship at ISSI, are important to reflect on the research direction. The ISSI setting was especially joyful for me; I could quietly sit in my office and work for myself but was connected to the scientific environment of the institute and the University of Bern. I participated in the CSH Science and Religion Forum: "Limits of Science – Opportunities for Religion?", which I would not have been able to do in my regular work environment, simply because there would not have been the time. The combination of 'quiet time' in a lively environment seems to me conducive - maybe even central - to research work. The exchange beyond the limited scientific topics to enlarge the intellectual horizons is key for good science.
With the pandemic and increased home office the nature of meetings has changed. The many online meetings and conferences offer new opportunities, e.g. participation from different time zones and recording of presentations for asynchronous viewing. We experience an increased participation through the online format, which means that more people can attend online meetings and at a decreased cost. My experience, though, is that discussions are stifled through the online format and are much reduced.

Bruno Leibundgut, Johannes Geiss Fellow 2019, and Lorena Moreira, ISSI postdoc in Earth Sciences. This picture was taken at ISSI in January 2020.

The future will see a combination of the different formats. Small focused meetings to discuss specifics and with free-format discussion rounds profit from direct and extended interaction, while the general information exchange meetings should become hybrids with some physical participation and streaming/recording for a wider audience.

Previous Johannes Geiss Fellows

The Johannes Geiss Fellowship (JGF) started in 2015. George Gloeckler from the University of Michigan, USA has been elected as the first JGF recipient. Followed up by Kurt Lambeck from the Australian National University, Australia in 2016. In 2017, Gary Zank from the University of Alabama, USA, was elected as third JG Fellow. Karel Schrijver (Lockhead Martin, Palo Alto, USA9 was elected as the Johannes Geiss Fellow 2018.

Johannes Geiss Fellows 2020 and Visiting Scientists

Interview with Johannes Geiss Fellows 2020 Weiqing Han and Sabine Schindler

The elected Johnannes Geiss Fellows 2020 Weiqing Han (left picture) and Sabine Schindler (pictured on the right). Due to the strict travel restrictions, both weren't able to visit ISSI in the reported period but they will catch up their research fellowships. (Image Credit: W. Han, S. Schindler)

Weiqing Han, University of Colorado at Boulder, USA, and Sabine Schindler, University of Innsbruck, Austria have been elected as the 2020 Johannes Geiss Fellows. Weiqing Han is a world-renowned oceanographer who specializes in Global Sea Level Change, in particular, in coastal regions. Sabine Schindler is a highly recognized astrophysicist who specializes in the observation and modeling of galaxies and galaxy clusters. Unfortunately, both weren't able to travel to Switzerland due to the strict travel restrictions because of the pandemic in 2020. We have tele-interviewed both in Spring 2020, asking a few questions about their upcoming fellowships at ISSI.

Prof. Han, Prof. Schindler, what was your motivation to apply for the Johannes Geiss Fellowship at the International Space Science Institute? And have you already made plans when you will visit ISSI?

Weiqing Han: The ISSI has been doing and leading active research in global and regional sea level variability and change, which fits my research interest and has been one of my major research focuses in the past decade. The motivation of my application is to establish collaboration with ISSI, and hope that by combining our effort and working in a simulating environment we can more effectively achieve our research goal.

Sabine Schindler: The International Space Science Institute is well known in the community – and well known to me – as an excellent place for networking and communication in space science. To spend my sabbatical there with a Johannes Geiss Fellowship seemed ideal to me to expand the connections to the space science community and to the Swiss universities. I am very happy, that this Fellowship was awarded to me and I am looking forward to my stay in Bern. I plan to start my visit in November.

Could you describe your scientific project(s) on which you plan to work during your visit to ISSI?

Weiqing Han: Rapid sea level rise is one of the most consequential impacts of the warming climate, exerting threats to human society in low-lying coastal areas and island nations. The observed rates of sea level change in the past few decades and century, however, have large spatial differences due to a complex mix of natural and anthropogenic factors. During my proposed visits to ISSI, I plan to investigate the effects of continental shelf and slope on coastal sea level signals that originate from open ocean. This area of research is important, because coastal bathymetry plays a crucial role in accurately depicting open-ocean impact on coastal sea level during historic periods and for future projections. Yet, this information is extremely limited due to the lack of high-resolution, basin-scale datasets and model experiments that can adequately resolve continental shelf and slope.

Firstly, we will analyze tide gauge observations, gridded satellite altimetry data, coastal altimetry data, together with reconstructed and reanalysis sea level products, to understand in which coastal areas a large amount of interior ocean signals can arrive at and be trapped to the coasts. While tide gauges are right on the coasts, altimeter data are contaminated by lands near the coasts. Therefore, the location of altimeter data may be a few tends of kilometers offshore from the tide gauge location. Secondly, we will analyze large ensemble (LE) and CMIP6 climate model historic simulations, comparing the

relatively coarse resolution model results with those of finer resolution ones, which can better represent continental shelf and slope.

Sabine Schindler: I plan to work on extragalactic astrophysics. I have a special interest in galaxies and galaxy clusters for two reasons: Firstly, for the physical processes and interactions that determine their evolution and secondly, for their cosmological applications. I plan to do observations as well as numerical simulations to do study these topics. I furthermore intend to do some interdisciplinary research, if something interesting is coming up in my discussions with the colleagues. I will keep my eyes open in this respect.

Prof. Schindler, is there a particular galaxy (or galaxies) you plan to focus on? And if so, why this particular one?

Sabine Schindler: I usually focus on processes, like e.g. ram-pressure stripping in galaxies or metal enrichment in galaxy clusters. I then select my targets according to the best suitability for a particular question.

Have you been to Switzerland and what – in addition to ISSI – makes Bern appealing to you for a visit?

Weiqing Han: In 2015 and 2018, I was invited to attend the sea level workshops organized and hosted by ISSI, Dr. Anny Cazenave from ISSI and Dr. Detlef Stammer from the U. of Hamburg, which aimed to tackle important but challenging issues toward understanding and projecting global (2015 meeting) and coastal (2018 meeting) sea level changes. On my side, the outcomes of the two meetings are that I led two review articles that were published in Surveys in Geophysics, one for climate modes' impacts on spatially uneven sea level changes in the world's oceans (published in 2017) and the other, focuses on impacts on coastal ocean (published in 2019).

Sabine Schindler: I have been to Switzerland before, both for work and for pleasure. I have enjoyed both. There is a very interesting astrophysical community in Switzerland, that I plan to visit. I have also been to Bern before, which I liked very much as a city.

Individual Scientists are invited for extended periods to work on scientific subjects at the forefront in areas of interest to ISSI. The results of this research are to be published as books or in major scientific journals, with appropriate acknowledgment to ISSI.

Furthermore, the following Visiting Scientists have worked at ISSI in the course of the twenty-fifth year:

Octavio Miguel Guilera, Universidad Nacional de La Plata, La Plata, Argentina, working period: 12.2.-8.3.2020.

Bill Hartmann, Planetary Science Institute, Tucson, USA, working period: 23.8.-13.9.2019.

Bruno Leibundgut, Johannes Geiss Fellow 2019, European Southern Observatory, Garching, Germany, working period: 30.10.2019-8.2.2020.

Zhaosheng Li, Xiangtan University, Xiangtan, China, working period: 8.1.-7.2.2020.

Ken McCracken, IPST, University of Maryland, College Park, USA, working period: 4.3.-15.3.2020.

Herbert Palme, University of Cologne, Germany, working period: 31.8.-4.10.2020.

Karel Schrijver, Johannes Geiss Fellow 2018, Lockheed Martin, Palo Alto, USA (retired), working period: 16.9.-5.10.2019.

Yuri Skorov, Institute for Geophysics and Extraterrestrial Physics, University of Braunschweig, Germany, working periods: 31.7.-6.8.2019, 17.-30.11.2019 and 15-29.2.2020.

Geophysics from Space Using Micro- or Nano-Satellite Constellations – Alpbach Summer School 2019

The Alpbach Summer school (Austria) is a major European educational yearly event in space sciences. Following a scenario followed over more than 40 years, 60 European students selected by the ESA Member states respective space organizations, randomly selected by the School's head tutor are distributed in four teams. Over a period of 11 days, starting with a series of scientific and technical lectures adapted to the main topic of the School, under the supervision and assistance from groups of tutors, they are asked to developing a space mission responding to the main topic of the school, starting from the elaboration of a related science objective leading to a Phase A of four different mission concepts through to mission-launch and post-launch activities. On the last day of the school the four teams do present a 60 min. PPT description of their proposals to the Jury, which assess the respective Scientific and Technical value, the competitiveness and the quality of the mission's presentation, and eventually grant to each of them an "Oscar" corresponding to one or several of these criteria.

The organizations involved in the school are the Österreichische Forschungsförderungsgesellschaft (FFG), represented by the Director of the Summer School, Mrs Michaela Gitsch with support from ESA, the University of Graz, and ISSI, which pursuing its effort to involve the future generation of space leaders in its activities, offers administrative support to the School Roger-M. Bonnet is chairing the Jury. The School is also supported by Austrospace, the association of Austrian space industries and research institutions and by the EuroPlanet EU Infrastructure.

The four 2019 team proposals received the following Oscars:

• ORPHEUS: an innovative series of small satellite constellations that provide insights into the geo-dynamo within the Earth`s outer core. Continuing on the dataset produced by the ESA SWARM mission, it represents a most advanced new concept combining long-term measurements, lasting for more than two solar cycles, with a new curlometer configuration, allowing the estimation of the ionospheric current flows, significantly improving the characterization of the structure and dynamics of the core magnetic field. It was exceptionally awarded two oscars: The best science and the best presentation.

• RUBIKS (Reconstruction of Under-crust Behavior with Interconnected (K) cube Satellites: a nanosatellite mission dedicated to analyzing the Earth's mantle using eight CubeSats on two Cartwheel-helix orbits. It would proceed with magnetic and gravity measurements of the Earth's interior, in order to gain information on the electrical conductivity and density of the mantle.
It was awarded the Oscar for: The most innovative mission.

• MAGMA-C: a proposed eight-satellite constellation in a Low-Earth Orbit (LEO) to measure and provide an unprecedented 3D conductivity-profile of the induced magnetic field in the Earth's mantle. The team had to overcome a significant crisis, a situation that all space missions have been confronted to. Due to a very late, but important feedback of a science tutor, the team had to focus on reworking the science case formulation, and eventually succeeded with a sustained effort (at very late / early hours) to conclude also the engineering part. For that reason, It was awarded an additional Oscar especially created by the jury at the end of its deliberations for Crisis Management.

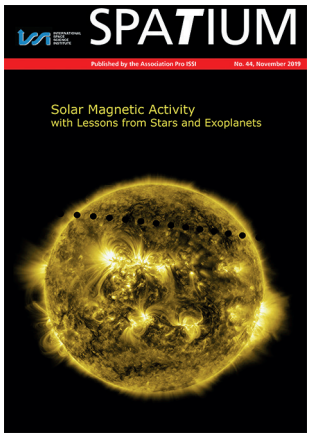
• GRAVL (GRAvity Observations by Vertical Laser Ranging): a mission to study mass redistribution in the upper mantle before, during, and after earthquakes by measuring the vertical component of the gravity vector of low-orbiting satellites from a high orbit laser ranging platform. It was awarded the Oscar for the best technical design. In addition, GRAVL was chosen to be studied further at the Post-Alpbach event hosted by ESA in November 2019. Twenty four of the 58 attendees were invited to apply for this opportunity.

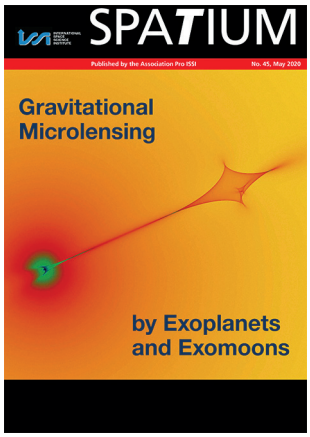
Alpbach Summer School 2020

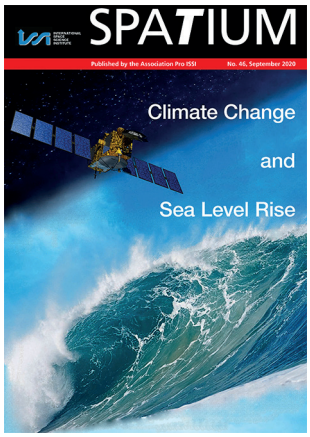
Carefully considering potential travel and other restrictions for health and safety reasons in the various member states and the difficulty in guaranteeing social distancing measures during the school, FFG in accordance with ESA, ISSI, and Austrospace, the Summer School Alpbach 2020 has been postponed to July 2022 to limit potential exposure of participants or employees to the virus. The subject "Comparative Plasma Physics in the Universe" will be maintained. From 12 to 16 July 2021, there will be an online lecture course on the topic Earth Magnetosphere, multisatellite missions in the field of plasmaphysics for students who already applied for 2020.

Roger-Maurice Bonnet

The Association Pro ISSI







In the reported period, the SPATIUM No. 44, 45 and 46 have been published by the Association Pro ISSI.

The Pro ISSI Association was founded in 1994 under Swiss law with the goals to create a Space Science Institute in Switzerland, and to communicate the fascinating results of space sciences to the Swiss public. With the creation of the Foundation International Space Science Institute (ISSI) in 1995 the first objective had been reached. Pro ISSI focuses now on providing a bridge between leading space scientists and its members, representing universities, industry, politics and public administration. The Association offers public lectures on new insights in space science, and publishes 2–3 SPATIUM issues per year. The Pro ISSI Association, which consists presently of 117 members, meets once per year for its general assembly. The Board of Pro ISSI consists of Adrian Jäggi (President), Christoph Mordasini (Vice President), Anuschka Pauluhn (Editor Spatium), Andreas Verdun (Editor Spatium), Annette Jäckel (Treasurer) and Yasmine Calisesi (Secretary).

Public Lectures

Pro ISSI exceptionally organized, as a consequence of the Covid-19 pandemic situation, only two public lectures in the period of this report:

The General Assembly was held on 30th October 2019 followed by a lecture given by the ISSI Director for Earth Science, Dr. Anny Cazenave. In her talk "Climate Change, Ocean Warming, Land Ice Melt and Sea Level Rise" Dr. Cazenave spoke about various reasons that sea .level is presently rising at a rate of more than 3 mm/year.

Due to the Covid-19 situation the first lecture scheduled in spring 2020 had to be postponed and was eventually scheduled for the General Assembly in fall 2020.

The General Assembly was held on 14th October 2020 followed by a virtual lecture given by Dr. Bruno Leibundgut, Johannes Geiss Fellow 2019 and former ESO Director for Science, who spoke about "Cosmology Today". His lecture provided an overview of the current understanding of cosmology and the observations on which it is based.

SPATIUM

The Association's magazine SPATIUM elaborates on selected lectures offered by Pro ISSI. It appears twice to three times per year. During the reporting period, issue no. 44 was published in November 2019, reporting on Solar Magnetic Activity. Dr. Karel Schrijver, Johannes Geiss Fellow 2018, elaborated what we have learned about the dynamo that drives solar activity, how magnetism heats the solar atmosphere and drives the solar wind. In contrast, issue no. 45, published in December 2019, reports on Gravitational Microlensing by Exoplanets and Exomoons. The author, Prof. Joachim Wambsganss, ISSI Director for Astrophysics and Cosmology, portrayed one of the fastest growing branches in Astrophysics and explained the various search techniques for exoplanet detections. And eventually, issue no. 46, published in September 2020, reports on Climate Change and Sea Level Rise. The author, Dr. Anny Cazenave, ISSI Director for Earth Science, elaborated that sea level rise is one the best indicators of climate change, integrating changes in ocean warming, land ice melt, and changes in water storage in continental river basins.

These publications together with all previous issues of SPATIUM can be found on Pro ISSI's homepage www.issibern.ch/association-pro-issi/spatium/

Adrian Jäggi

International Space Science Institute Beijing

The International Space Science Institute-Beijing (ISSI-BJ) was jointly established by the International Space Science Institute (ISSI) and the National Space Science Center (NSSC) with the support of the International Cooperation Bureau and the Space Science Strategic Project of the Chinese Academy of Science (CAS). ISSI-BJ is a close cooperation partner of ISSI. Both institutes share the same Scientific Committee, the same study tools, and other information of mutual relevance and interest. However, both use independent operational methods and different funding sources. More information can be found on its website: www.issibj.ac.cn. Subscribe to the Newsletter to be up to date on the events organized by ISSI-BJ: https://bit.ly/37OPtRW.

Forums

Between July 2019 and December 2020, ISSI-BJ organized and hosted numerous activities, including forums, workshops, scientific lectures, as well as International Team meetings.
In the given period, five Forums were hosted at ISSI-BJ:
• 24–26 July 2019 – Exploring Greenhouse Gases, Water and Climate Changes by LEO-LEO Occultation
• 4–5 September 2019 – NSSC/ISSI-BJ 2nd Strategic Forum on Space Science
• 5–6 September 2019 – Cross-scale Measurements of Space Plasmas to Explore Magnetic Reconnection
• 23–25 September 2019 – Science Objectives and Observation System for the International Meridian Circle
• 7–8 November 2019 – Exploration of Outer Heliosphere and Nearby Interstellar Medium
To make the forum discussions, conclusions, and results accessible to the international scientific community and to the public, the insights gained from these forums were and will be published in the ISSI-BJ "TAIKONG" magazine series (see: Publications).

Workshops

Between July 2019 and December 2020, the following workshop was held at ISSI-BJ:
• 14–18 October 2019: Oscillatory Processes in Solar and Stellar Coronae
The outcomes of the workshop will be published as Volume No. 76 of the Space Science Series of ISSI (SSSI).

International Teams

In the given period, five International Team meetings were held at ISSI-BJ:
• 21–25 October 2019: "The electromagnetic data validation and scientific application research based on CSES satellite" – Prof. Shen Xuhui (China), Prof. Gauthier Hulot (France), Prof. Zhang Xuemin (China)
• 29 October – 1 November 2019 "The eruption of solar filaments and the associated mass and energy transport" – Prof. Jean-Claude Vial (France), Prof. Chen Pengfei (China)
• 4–8 November 2019 "Weak gravitational lensing studies from space missions" – Prof. Fan Zuhui (China)
• 4–8 November 2019 "Radioactive nuclei in the cosmos and in the solar system" – Prof. Alexander Heger (Australia), Prof. Maria Lugaro (Hungary)
• 11–15 November 2019: "Chemical abundances in the ISM: the litmus test of stellar IMF variations in galaxies across cosmic time" – Dr. Donatella Romano (Italy), Prof. Zhang Zhiyu (China)
At the beginning of 2020, ISSI-BJ and ISSI released a joint Call for Proposals for International Teams in Space and Earth Sciences, and as a result, seven new International Teams were selected, including five ISSI/ISSI-BJ joint teams. Thus, by the end of December 2020, ISSI-BJ had 16 active International Teams.

Outreach Activities

ISSI-BJ continuously promotes outreach and educational activities for the general public as well as young scientists as a co-organizer of the "Understanding Science" seminars. In the reported period, ISSI-BJ held two scientific seminars:
• "Life in the Universe" with Prof. Alvaro Giménez (CSIC Foundation, Spain) on Thursday, December 5, 2019
• "Listening to the Universe" with Prof. Richard de Grijs (Macquarie University, Sydney) on Thursday, May 14, 2020 [online lecture]
Furthermore, in response to the difficult times the whole world is navigating through, ISSI-BJ has started a new series of online seminars named "On Things to Come" that kicked off in September 2020. This webinar series aims to introduce to the international scientific community some new and ongoing key space missions. In the given period, seven lectures were organized:
• 23 September 2020: Prof. Geraint Jones – ESA Comet Interceptor Mission
• 21 October 2020: Ralph Lorenz – NASA Dragonfly Mission
• 4 November 2020: Wang Chi – ESA/CAS SMILE Mission
• 25 November 2020: Heike Rauer – ESA PLATO Mission

Workshop Participants of the ISSI-BJ Workshop on "Oscillatory Processes in Solar and Stellar Coronae" which was held from 14 to 18 October 2019. The resulting papers are published as a Topical Collection in Space Science Reviews and will appear as Volume 76 in the Space Science Series of ISSI (SSSI). (Image Credit: ISSI-BJ)

• 9 December 2020: Takehiko Satoh – JAXA Akatsuki Mission
• 18 December 2020: Olivier Witasse – ESA JUICE Mission
• 21 December 2020: Dr. Tomohiro Usui – JAXA Phobos Mission

The recordings of all online seminars are available on the ISSI-BJ YouTube Channel "ISSI-BJ".

Publications

In the given period, ISSI-BJ published seven issues in the "TAIKONG" magazine series. The series reports the contents of the ISSI-BJ forums and reflects in a neutral way the discussions and advices from all the participants:

• Chen, X. L., et al. (July 2019). Discover the Sky by Longest Wavelength. ISSI-BJ TAIKONG No. 14
• Liu, C. L., et al. (Dec. 2019). Exploring Greenhouse Gases, Water, and Climate Changes by LEO-LEO Occultation. ISSI-BJ TAIKONG No. 15
• Giménez, A., Wu, J. (Feb. 2020). Frontiers and Opportunities of Space Science: NSSC/ISSI-BJ 2nd Strategic Forum on Space Science. ISSI-BJ TAIKONG No. 16
• Wang, C., Liu, W., Blanc, M., et al. (Feb. 2020). Cross-scale Measurements of Space Plasmas to explore Magnetic Reconnection. ISSI-BJ TAIKONG No. 17
• Seyedabadi, E. M., Falanga, M., et al. (Apr. 2020). Science Missions using CubeSats. ISSI-BJ TAIKONG No. 18
• Blanc, M., Liu, W. et al. (May 2020). Science Objectives and Observation System for the International Meridian Circle. ISSI-BJ TAIKONG No. 19
• Wang, C., McNutt, R. et al. (August 2020). Exploration of Outer Heliosphere and Nearby Interstellar Medium. ISSI-BJ TAIKONG No. 20

The electronic version of all magazine issues is available at: http://www.issibj.ac.cn/Publications/

Finally, as the outcome of two ISSI-BJ forums held in 2019, two scientific articles were published on the Chinese Journal of Space Science, i.e.:

• Liu, C., Kirchengast, G., Sun, Y., Wang, X., Lü, D., Bai, W., Du, Q., Loescher, A., Syndergaard, S., Tian, L., Zhang, Z. (2020). Exploring Greenhouse Gases Water and Climate Changes: Scientific Opportunities for the Climate and Atmospheric Composition Exploring Satellites Mission. Chinese Journal of Space Science, 40(2): 151-168.
• Seyedabadi, M. E., Falanga, M., Azam, M., Baresi, N., Fléron, R., Jantarachote, V., Juarez Ortiz, V. A., Julca Yaya, J.J., Langer, M., Manuthasna, S., Martinod, N., Mughal, M. R., Noman, M., Park, J., Pimnoo, A., Praks, J., Reyneri, L., Sanna, A., Sisman, T. Ç., Some, J., Ulambayar, T., Yu, Xiaozhou, Dong, Xiaolong, Baldis, L. (2020). Science Missions Using CubeSats. Chinese Journal of Space Science, 40(4): 443-461.

Laura Baldis

Staff Activities

Listed are activities in which ISSI staff scientists participated between 1 July 2019 and 31 December 2020. This includes presentations given, meetings attended, outreach, honors received, and chairmanships held.

Presentations

6-7 July 2019 – M. Falanga: Forum on "Space Missions using CubeSats", Thailand

11 July 2019 – J. Wambsganss: "Auf der Suche nach der zweiten Erde", Hector Fellow Symposium, Heidelberg, Germany

18 July 2019 – J. Wambsganss: "Auf der Suche nach der zweiten Erde", Industrie-Gesprächskreis Rhein-Neckar, Heidelberg, Germany

15–20 September 2019 – T. Spohn: Talk on "HP3", EPSC-DPS Meeting, Geneva, Switzerland

20 September 2019 – J. Venturini: "Jupiter's formation: heavy element enrichment and link to giant exoplants", invited talk, EPSC-DPS joint Meeting, Geneva, Switzerland

4 October 2019 – J. Wambsganss: "Germany joining the IAU: A complicated Story", IAU@100 Day, Paris, France

17 October 2019 – T. Spohn: Lecture on "Mars Research", DLR Institute of Atmospheric Physics, Oberpfaffenhofen, Germany

22 October 2019 – J. Wambsganss: "Einstein für alle: Lichtabklenkung am Sonnenrand vor 100 Jahren", Akademie für Ältere, Edingen-Neckarhausen, Germany

25 October 2019 – J. Wambsganss: "Einstein für alle: Gravitationslinsen heute", Deutsch-Amerikanisches Institut DAI, Heidelberg, Germany

4–8 November 2019 – R. von Steiger: "COSPAR Roadmap on Small Satellites for Space Science (4S)", Invited talk at the 4th COSPAR Symposium, Herzliya, Israel

5 November 2019 – J. Wambsganss: "Extrasolare Planeten", Naturwissenschaftliche Gesellschaft Thun, Switzerland

19 November 2019 – J. Wambsganss: "Auf der Suche nach der zweiten Erde", Hochschule für Wirtschaft und Gesellschaft, Ludwigshafen, Germany

23 November 2019 – R. von Steiger: "50 Jahre Mondlandung – Die Schweiz im Weltraum", talk at Gesellschaft zum Distelzwang, Bern, Switzerland

9–12 December 2019 – T. Spohn: Talk on "HP3", AGU Fall Meeting, San Francisco, USA

15 January 2020 – J. Wambsganss: "Nobelpreis für Physik 2019: Kosmologie und Exoplaneten", 48. Bad Honnefer Industriegespräch, Bad Honnef, Germany

5 February 2020 – T. Spohn: Seminar talk, DLR, Berlin, Germany

3 March 2020 – J. Venturini: "Formation of ice giants and link to sub-Neptunes", ISSI Team on "Ice-giants: formation, structure and link to exoplanets", 2nd meeting, Bern, Switzerland

5 March 2020 – J. Wambsganss: "Astronomy and Photography: How Black Drops lead to Innovations", Biennale Fotografie und Wissenschaft im Dialog, Heidelberg, Germany

11 March 2020 – A. Cazenave: "Climate change and sea level rise", Plenary Lecture, Dutch Earth Sciences Congress, Utrecht, The Netherlands

4–8 May 2020 – T. Spohn: EGU online conference, Vienna, Austria

6 May 2020 – L. Moreira: "An 8-year cycle in the rate of the global mean sea level", EGU General Assembly (online)

15 May 2020 – J. Venturini: "The formation of super-Earths", Talk in the Group Meeting of the Theoretical Astrophysics and Planetary Sciences department, University of Bern, Switzerland (online)

29 May 2020 – J. Wambsganss: "Searching for Extrasolar Planets with Gravitational Microlensing", Excellence Cluster Structure Jour Fixe, Heidelberg, Germany (online)

23 July 2020 – J. Wambsganss: "Licht auf krummen Wegen – Gravitationslinsen im All", Haus der Astronomie, Heidelberg, Germany (online)

26 August, 2020 – J. Venturini: "The nature of the Radius Valley: insights from formation and evolution", seminar at the Observatory of Cordoba, Argentina (online)

14 September 2020 – J. Venturini: "The nature of the Radius Valley: insights from formation models", Poster presentation at the Royal Astronomical Society (online), https://ras.ac.uk/ras-2020-posters

29 September–2 October 2020 – R.-M. Bonnet: "Progress in Solar Physics", Conference on Space Plasma Science – Perspectives for Coming Decades, associated with IKI 55th anniversary and 80 years of Albert Galeev (online)

22 October 2020 – R. v. Steiger: "Ulysses: A New Perspective from High Latitudes", talk in the ISSI Game Changers Seminar series (online)

23 October 2020 – A. Cazenave: "Sea level change from global to local, role of observations", invited talk OSTST (online)

25 October 2020 – R.-M. Bonnet: Live Celebration 30th anniversary of Hubble Space Telescope, C. Nicollier et al., Cité des Sciences, Paris, France

10 November 2020 – A. Cazenave: "Coastal see level rise from satellite altimetry", invited lecture, Bern University, Switzerland (online)

13 November 2020 – A. Cazenave: "The Earth, a planet like no other", ISSI lecture (online), https://youtu.be/jUW-zIIR-O60

20 November 2020 – A. Cazenave: "Sea level rise observed from space at global, regional and local scales", CSIR-NGRI Diamond Jubilee 1st lecture (online)

10 December 2020 – A. Cazenave: "Sentinel-6 and sea level rise", invited talk, European Space Week, European Commission, Czechia (online)

11 December 2020 – L. Moreira: "Influence of interannual variability in estimating the rate and acceleration of present-day global mean sea level", Poster AGU Fall Meeting (online)

Meetings

6–7 July 2019 – M. Falanga: Forum on Space Missions using CubeSats, Thailand

15–17 July 2019 – T. Spohn: Alpbach Summer School, Introduction, Alpbach, Austria

23–26 July 2019 – R.-M. Bonnet: Alpbach Summer School, Alpbach Austria

26 July 2019 – T. Spohn: Meeting EuroPlanet Board (online)

3–4 September 2019 – T. Spohn: NSSDC Forum Beijing, China

4–5 September 2019 – R.-M. Bonnet: Second Strategic Forum on Space Science, Huairou-Beijing, China

11–13 September 2019, 18 May 2020, and 9–11 September 2020 – R. v. Steiger: Evaluation Commission of SNSF Eccellenza Grants and Fellowships

16–20 September 2019 – J. Wambsganss: Annual Meeting of Astronomische Gesellschaft, Stuttgart, Germany

25–27 September 2019 – R.-M. Bonnet: ISSI-BJ Board of Trustees meeting, Beijing, China

9 October 2019 – R. v. Steiger: Swiss National Committee of SCOSTEP Board Meeting, FHNW Brugg-Windisch, Switzerland

11 November 2019 – T. Spohn: Meeting with State Secretary, Mrs. M. Hirayama, Bern, Switzerland

14–15 November 2019 – J. Wambsganss: 16th Meeting of Rat für Informationsstrukturen (RfII), Karlsruhe, Germany

18 November 2019 – T. Spohn: Workshop on Manufacturing in Space, Braunschweig, Germany

7 December 2019 – R. v. Steiger: Dies Academicus, Stiftungsfeier der Universität Bern, Switzerland

9–13 December 2019 – R. v. Steiger: AGU Fall Meeting, San Francisco, USA

14 December 2019, and online, May 8, 2020 – R. v. Steiger: Space Science Reviews Editorial Committee Meeting, San Francisco, USA

16 December 2019 – T. Spohn: Visit from Embassy of Colombia, ISSI, Bern, Switzerland

Staff Activities

27–29 January 2020 – J. Venturini: NCCR PlanetS General Assembly, Montreux, Switzerland

10–13 February 2020 – R. v. Steiger: NASA Heliophysics Theory, Modeling, and Simulations Program Evaluation Panel Meeting, San Antonio, USA

24–28 February 2020 – T. Spohn: InSight Science Team Meeting, Nice, France

25 February 2020 – R.-M. Bonnet: ISSI-BJ Executive Director, Meeting ISSI Bern – ISSI Beijing (online)

26–27 March 2020 – J. Wambsganss: 17th Meeting of Rat für Informationsinfrastrukturen (RfII) (online)

10 June 2020 – J. Wambsganss: 18th Meeting of Rat für Informationsinfrastrukturen (RfII) (online)

15 June 2020 – R. v. Steiger: Living Reviews in Solar Physics Editorial Board meeting (online)

30 June–1 July 2020 – M. Falanga: Astronomy & Astrophysics GA (online)

20–24 July 2020 – T. Spohn: InSight Science Team Meeting (online)

27–31 July 2020 – J. Wambsganss: Exoplants III (online)

2 August 2020 – R. v. Steiger: Swiss National Committee of SCOSTEP Board Meeting, FHNW Brugg-Windisch, Switzerland

21–25 September 2020 – J. Wambsganss: Annual Meeting of Astronomische Gesellschaft (online)

6 October 2020 – R. v. Steiger: Ulysses launch meeting "It was 30 years ago today" (online)

5–6 November 2020 – J. Wambsganss: 19th Meeting of Rat für Informationsinfrastrukturen (RfII) (online)

ISSI Scientists in the Media

12 July 2019 – Alle kennen das Bild von der US-Flagge auf dem Mond. Zuerst aber stand da die «Swiss Flag», Article by A. Feusi, Neue Zürcher Zeitung

15 July 2019 – T. Spohn: Interview on "InSight HP3", Heute Journal, ZDF Television

4 February 2020 – Sein Sonnensegel war mit der Apollo 11 auf dem Mond, SRF Tageschau, Swiss Televison

4 February 2020 – Der Mann mit dem Sonnenwindsegel auf dem Mond: Johannes Geiss, Pionier der Weltraumforschung, ist tot, Article by A. Feusi, Neue Zürcher Zeitung

4 February 2020 – Einer, der nach den Sternen griff, Article by Dölf Barben, der Bund

24 February 2020 – Sehnsucht nach dem großen Marsbeben, Article by Peter Michael Schneider, SPEKTRUM

16 July 2020 – China greift nach dem Mars, Article by Peter Michael Schneider, SPEKTRUM

17 August 2020 – R.-M. Bonnet: Interview on "Kourou et l'épopée Spatiale", TV France Ô

19 October 2020 – J. Venturini: Interview to M. Guisande about the origin of the Radius Valley (for a press release in Spanish in Argentina), https://bit.ly/38SoiX7

28 October 2020 – How water explains missing planets, Article by A. Bastani incl. Interview with J. Venturini, https://bit.ly/3eJsNXI

29 October 2020 – Forscher finden eine Erklärung für "fehlende" Exoplaneten in Erdgröße, Article with J. Venturini, Salzburger Nachrichten

17 November 2020 – "Exoplanets", Interview with J. Venturini (in Spanish), Radio Uruguay, https://spoti.fi/3tvKjmw (Spotify)

16 December 2020 – Der Plan hinter Chinas Mondmission, Article by Peter Michael Schneider, SPEKTRUM

Chairman- and Memberships, Honors

Roger-Maurice Bonnet:
- Member of Institut Français d'Histoire de l'Espace (IFHE), France
- President of IFHE's Aubinière Price Award, France
- President of the Alpbach Summer School Jury 2019, Austria
- Member of ISSI-BJ Board of Trustees
- Board of Advisers, International Space University, Strasbourg, France
- Member Royal Swedish Academy of Sciences
- Member Academia Europaea
- Member Royal Society of Sciences, Liège, Belgium
- Member International Academy of Astronautics (IAA), Van Karman Awardee
- Member Academy of Air and Space
- Included in the "Hall of Fame" National Air and Space Museum, Washington DC, USA
- Asteroid 18627 1998DH33 named ROGERBONNET

Anny Cazenave
- Nomination member of the Earth science panel of the European Space Science Committee of the European Science Foundation (2020-)
- Awarded the Vetlesen prize 2020, Columbia University, USA
- Fellow of the IUGG (International Union of Geodesy and Geophysics)

Maurizio Falanga:
- Member of the Astronomy & Astrophysics Journal Board of Directors, Swiss representative since 2011
- Member of International Astronomical Union (IAU)
- Member of International Academy of Astronautics (IAA)
- Member of European Astronomical Society (EAS)
- Member of Swiss Society for Astrophysics and Astronomy (SSAA)
- Member of the Evaluation Committee NASA NICER payload on the International Space Station (ISS)
- Member of the Einstein Probe mission science team, scheduled for launch in 2022
- Reviewer of the Astronomical projects for the Chinese Space Station and committee member, China Manned Space Program
- Reviewer Rising Star Research proposals, Ministry of Science and Technology, Taiwan
- Reviewer Italian Antarctic Programme astronomy proposals
- Reviewer of the 2020 generic call for proposals, Agence National de La Recherche (ANR, France)

Tilman Spohn:
- Fellow American Geophysical Society
- Full member Academy of Astronautics
- Member Academia Europaea
- European Astrobiology Inst. Management Committee
- Planetarium Berlin Board of Trustees
- Principal Investigator for the Heat Flow and Physical Properties Package HP3 on the NASA InSight mission to Mars
- Asteroid 12062 1998FB10 named TILMANSPOHN

Rudolf von Steiger:
- President of the Henrich Greinacher Foundation
- Board member of the Phil.-nat. Faculty, University of Bern
- Member of the Evaluation Committee for Eccellenza Fellowships and Grants of the Swiss National Science Foundation
- Evaluator and Rapporteur for H2020-MSCA-IF-2019 and H2020-MSCA-IF-2020 Marie Skłodowska-Curie Fellowships of the European Commission
- External Advisory Board member of the SHARP Project in H2020
- Vice-chair of the COSPAR Task Group to Develop an Actionable Plan for an International Constellation of Small Satellites (TGCSS)
- Full member of the International Academy of Astronautics
- Editorial Committee member of Space Science Reviews
- Specialty Chief Editor of Frontiers in Space Science
- Editorial Board member of Living Reviews in Solar Physics

Joachim Wambsganss:
- Member of Astronomische Gesellschaft (German Astronomical Society, AG)
- Member of European Astronomical Society (EAS)
- Member of American Astronomical Society (AAS)
- Member of International Astronomical Union (IAU)
- Member of „Rat für Informationsinfrastrukturen" (German Council for Information Infrastructure)
- President of Astronomische Gesellschaft (until September 2020)
- Chairman of Rat deutscher Sternwarten (Council of German Observatories; until September 2020)

Staff Publications

Listed are all papers written or co-authored by ISSI staff that were submitted or that appeared between 1 July 2019 and 31 December 2020. The papers that are published in the Space Science Series of ISSI (SSSI) can be found from page 73 on.

Attree, N., A. Hagermann, N. Patel et al. (including T. Spohn), Potential effects of Martian atmospheric collapse on heat flow measurements by InSight, EPSC, ESPSC-DPS2019-76, 2019.

Attree, N., M. Siegler, M. Grott, A. Hagermann, T. Spohn et al., Potential Effects of Atmospheric Collapse on Measurements of the Martian Heat Flow by InSight, Planet. Space Sci., 180, 2020.

Attree, N., N. Patel. A. Hagermann et al. (including T. Spohn), Potential effects of atmospheric collapse on Martian heat flow and application to the InSight measurements, Planetary and Space Sci. 180, 104778, 2020.

Bakala, P., V. De Falco, E. Battista, K. Goluchová, D. Lančová, M. Falanga, L. Stella, Three-dimensional general relativistic Poynting-Robertson effect. II. Radiation field from a rigidly rotating spherical source, Phys. Rev. D, 100, 104053, 2019.

Baker, D., A. Chandran, L. Chang, M. Macdonald, M. Meftah, R. Millan, J.U. Park, P. Kumar, C. Price, R. von Steiger, and Ji Wu, An International Constellation of Small Spacecraft, Space Research Today, 208, 23–28, 2020.

Banerdt, W.B., S. Smrekar, D. Antonangeli et al. (including T. Spohn), InSight—Early Results from a Half (Earth)-Year on Mars, LPICo, 2089, 6421, 2019.

Banerdt, W.B., S.E. Smrekar, D. Banfield et al. (including T. Spohn), Initial results from the InSight mission on Mars, Nature Geoscience, 1-7, 2020.

Banerdt, W.B., S.E. Smrekar, P. Lognonné et al. (including T. Spohn), Overview and Status of the InSight Mission, GSA Annual Meeting, USA, 2019.

Banfield, D., A. Spiga, C. Newman et al. (including T. Spohn), First results from InSight's meteorology station on Mars, Nature Geoscience 13, 190-198, 2020.

Banfield, D., A. Spiga, C. Newman et al. (including T. Spohn), The atmosphere of Mars as observed by InSight, Nature Geoscience, 1-9, 2020.

Baroch, D., A. Giménez, I. Ribas et al., Analysis of apsidal motion in eclipsing binaries using TESS data I. A test of gravitational theories, Astrophys. Astronom.,635, A 145, 2020.

Beghein, C., H. Xu, J.C.E. Irving et al. (including T. Spohn), Can Higher Mode Surface-Wave Dispersion Discriminate Between Different Mars Mantle Models?, AGU Fall Meeting, 2019.

Benveniste, J., A. Cazenave et al., Requirements for a Coastal Zone Observing System, Front. Mar. Sci., 6, doi: 10.3389/fmars.2019.00348, 2019.

Blanc, M., O. Prieto-Ballesteros, N. André et al. (including T. Spohn), Joint Europa Mission (JEM): a multi-scale study of Europa to characterize its habitability and search for extant life, Planetary Space Sci. 193, 104960, 2020.

Bonnet R.-M., G. Haerendel, Reimar Lüst Obituary, Space research Today Vol. 208 p. 4-6, 2020.

Bonnet R.-M., Jean-Claude Pecker Astrophysicien du Soleil, L'Astronomie, 137, 36, 2020.

Bonnet R.-M., L. Pierre, Pecker Jean-Claude (1923-2020), Encycélopedia Universalis, in press, 2021.

Bonnet R.-M., Obituary of Johannes Geiss, Space Research Today, Vol. 207 p.5-7, 17 February 2020.

Bonnet R.-M., Préface, Hôtel Lunaire, Prof. Wu Ji, EDP-Sciences, 2020.

Bonnet R.-M., Reimar Lüst Obituary, Le Monde 4 April 2020

Bonnet R.M., Reimar Lust & Jacques Blamont - The birth of two greet actors of European Space research, ESA Publiactions, in press, 2021.

Bozdag, E., A.C. Plesa, S. Padovan et al. (including T. Spohn), Effect of thermal variations in Mars' mantle on 3D seismic wave propagation, AGUFM, DI51A-0009, 2019.

Bozzo, E., L. Ducci, L., M. Falanga, A semi-analytical treatment to wind accretion in neutron star supergiant high mass X-ray binaries: I. eccentric orbits, MNRAS, 501, 2403, 2020.

Brinkman, N., C. Schmelzbach, D. Sollberger et al. (including T. Spohn), The first active seismic experiment on Mars to characterize the shallow subsurface structure at the InSight landing site, SEG Techn. Progr. Exp. Abstracts, 4756-4760, 2019.

Cazenave A. and the Climate Change Initiative Coastal Sea Level Team, Coastal sea level anomalies and associated trends 2 from Jason satellite altimetry over 2002-2018, Nature Scientific Data, 7, 357, 2020.

Cazenave A. et al., Temporal variations of the gravity field, Encyclopedia of Solid Earth Geophysics, 2020.

Cazenave A., Contribution to the WMO (World Meteorological Organization), Report on the state of the global climate: Statement on the State of the Global Climate 2019, WMO-No 1248, 2020.

Cazenave A., Contribution to the WMO (World Meteorological Organization) report on African climate: State of the climate in Africa 2019, WMO-No. 1253, 2020.

Cazenave A., G. Meehl, M. Montoya et al., Climate Change and Impacts on Variability and Interactions, in: Mechoso C.R. (Eds.), Interacting Climates of Ocean Basins; Observations, Mechanisms, Predictability, and Impacts', Cambridge University Press, ISBN 9781108492706, 2020.

Cazenave A., Sea level rise, Global to Local, Editorial, Journal of the Geological Society of India, 2020.

Cazenave, A., B. Hamlington et al., Observational requirements for long-term monitoring of the global mean sea level and its components, Front. Mar. Sci., 6, 582, 2019.

Chen J., B. Tapley, C. Wilson, A. Cazenave et al., Global ocean mass change from GRACE 1 and GRACE Follow-On, and altimeter and Argo measurements, Geophys. Res. Lett., 47, 22, e2020GL090656, 2020.

Chen, X., J. Burns, L. Koopmans, (incl. M. Falanga) et al., Discovering the Sky at the Longest Wavelengths with Small Satellite Constellations, ISSI-BJ Taikong-14, arXiv:1907.10853, 2019.

Coustenis, A., R. Rodrigo, T. Spohn et al., Editorial to the Topical Collection: Ocean Worlds, Space Sci. Rev. 216, 1-4, 2020.

De Falco, V., P. Bakala, M. Falanga, Three-dimensional general relativistic Poynting-Robertson effect. III. Static and nonspherical quadrupolar massive source, Phys. Rev. D, 101, 124031, 2020.

De Martino, F. Bernardini, K. Mukai, M. Falanga, N. Masetti, Hard X-ray cataclysmic variables, Adv. Space Res., 66, 5, 1209-1225, 2020.

Dehant, V., V. Debaille et al. (including T. Spohn), Geoscience for understanding habitability in the solar system and beyond, Space Sci. Rev., 215, 42, 2019.

Falanga M., P. Bakala, R. La Placa, Exploring higher order images with Fe K α-lines from relativistic disks: black hole spin determination and bias, Astron. Astophys., submitted, 2020.

Golombek, M., N.H. Warner, J.A. Grant et al. (including T. Spohn), Geology of the InSight landing site on Mars, Nature Communications 11 (1), 1-11, 2020.

Gouzenes Y., F. Leger, A. Cazenave et al., Coastal sea level change at Senetosa (Corsica) during the Jason altimetry missions, Ocean Sciences, 16, 1–18, 2020.

Grott, M., N.T. Mueller, S. Piqueux et al. (including T. Spohn), Phobos Eclipse Observations with the HP3 Radiometer on Insight, AGU Fall Meeting Abstracts, DI42A-05, 2019.

Grott, M., T. Spohn, J. Knollenberg et al., Calibration of the Heat Flow and Physical Properties Package (HP) for the InSight Mars Mission, Earth and Space Sci. 6 (12), 2556-2574, 2019.

Grott, M., T. Spohn, J. Knollenberg et al., Design, Kalibrierung und Betrieb der HP3 Wärmeflusssonde für die InSight Mars Mission, Temperatur, Berlin, 2020.

Guilera, O.M., S. Zsolt, M.P. Ronco, J. Venturini et al., Giant planet formation at the pressure maxima of protoplanetary disks. II. A hybrid accretion scenario, Astron. Astrophys., 642, A140, 2020.

Höning, D., N. Tosi, H. Hansen-Goos et al. (including T. Spohn), Linking continental growth models to the thermal evolution of Earth, AGUFM, DI33B-0025, 2019.

Höning, D., N. Tosi, T. Spohn, Degassing, weathering, decarbonation: What determines the atmospheric CO2 content on stagnant lid planets?, EPSC, EPSC-DPS2019-1689, 2019.

Höning, D., N. Tosi, T. Spohn, The effect of interior evolution on the long-term carbon cycle and the habitability of terrestrial planets, AGUFM, P21A-01, 2019.

Hudson, T.L., R. Deen, E. Marteau et al. (including T. Spohn), InSight HP3 Mole Near-Surface Motion and Subsurface Implications, LPI, 1217, 2020.

Kedar, S., W.B. Banerdt, N. Brinkman et al. (including T. Spohn), Characterization of the InSight Landing Site Near Surface Properties Using the Heat Flow and Physical Properties Probe (HP3) Mole as a Seismic Source, AGUFM, DI42A-04, 2019.

Kenda, B., M. Drilleau, R.F. Garcia et al. (including T. Spohn), Subsurface structure at the InSight landing site from compliance measurements by seismic and meteorological experiments, J. Geophys. Res.: Planets 125, 6, e2020JE006387, 2020.

Staff Publications

Klüter, J., U. Bastian, J. Wambsganss, Expectations on mass determination using astrometric microlensing by Gaia, Astron. & Astroph., 640, A83, 2020.

Kretschmar, P., F. Fürst, L. Sidoli (incl. M. Falanga) et al., Advances in Understanding High-Mass X-ray Binaries with INTEGRAL and Future Directions, New Astron. Rev., 86, 101546, 2019.

Krone-Martins, A. et al. (incl. J. Wambsganss), Gaia GraL: Gaia DR2 Gravitational Lens Systems. V. Doubly-imaged QSOs discovered from entropy and wavelets, arXiv:1912.08977, submitted, 2019.

Kuiper, L., S.S. Tsygankov, M. Falanga et al., High-energy characteristics of the accretion-powered millisecond pulsar IGR J17591-2342 during its 2018 outburst - XMM-Newton, NICER, NuSTAR, and INTEGRAL view of the 0.3-300 keV X-ray band, Astron. Astrophys., 641, 37, 2020.

La Placa, R., L. Stella, A. Papitto, (incl. M. Falanga) et al., Neutron Star Radius-to-mass Ratio from Partial Accretion Disk Occultation as Measured through Fe K Line Profiles, Astrophys. J., 893, 129, 2020.

La Placa, R., P. Bakala, L. Stella, M. Falanga, A New Approximation of Photon Geodesics in Schwarzschild Spacetime, Res. Notes AAS, 3, 99, 2019.

Lognonné, P., W.B. Banerdt, W.T. Pike et al. (including T. Spohn), SEIS first year: nm/s^ 2 (and less) broadband seismology on Mars and first steps in Mars-Earth-Moon comparative seismology, AGU Fall Meeting, 2019.

Lognonné, P., W.B. Banerdt, W.T. Pike et al. (including T. Spohn), Constraints on the shallow elastic and anelastic structure of Mars from InSight seismic data, Nature Geoscience 13 (3), 213-220, 2020.

Lutovinov, A., V. Suleimanov, L. Manuel et al. (incl. M. Falanga), INTEGRAL View on cataclysmic variables and symbiotic binaries, New Astron. Rev., 91, 101547, 2020.

Meyssignac, B. et al. (including A. Cazenave), Measuring Global Ocean Heat Content to estimate the Earth Energy Imbalance, Front. Mar. Sci., 6, doi: 10.3389/fmars.2019.00432, 2019.

Mischna, M., V. Stamenkovic, N. Lanza et al. (including T. Spohn), The VALKYRIE Payload for Probing the Martian Subsurface, AGUFM, P41C-3466, 2019.

Miyazaki, S. et al. (incl. J. Wambsganss), OGLE-2013-BLG-0911Lb: A Secondary on the Brown-dwarf Planet Boundary around an M Dwarf, Astron. J., 159,76, 2020.

Mueller, M., S. Piqueux, M. Lemmon et al. (including T. Spohn), Mars Soil Properties From Phobos Eclipse Observtions By Insight Hp3 Rad. Nt, Icarus 282, 118-126, 2020.

Mueller, N.T., G. Matthias, S. Piqueux et al. (including T. Spohn), The HP3 radiometer on InSight, LPICo, 2089, 6194, 2019.

Mueller, N.T., J. Knollenberg, M. Grott et al. (including T. Spohn), Calibration of the HP3 Radiometer on InSight, Earth and Space Sci., 7, 5, e2020EA001086, 2020.

Mueller, N.T., M. Grott, S. Piqueux et al. (including T. Spohn), Phobos Eclipse Observations with the HP3 Radiometer on Insight, AGU Fall Meeting, 2019.

Nagakane, M. et al. (incl. J. Wambsganss), OGLE-2015-BLG-1649Lb: A Gas Giant Planet around a Low-mass Dwarf, The Astronomical Journal 158, A212, 2019.

Papitto, A., M. Falanga et al., The INTEGRAL view of the pulsating hard X-ray sky: from accreting and transitional millisecond pulsars to rotation-powered pulsars and magnetars, New Astron. Rev., 91, 101544, 2020.

Pike, W.T., W. Banerdt, S. Smrekar et al. (including T. Spohn), Results From the Insight Mission After a Year and a Half on Mars, EGU General Assembly Conf. Abstracts, 22031, 2020.

Piqueux, S., N. Mueller, M. Grott et al. (including T. Spohn), Regolith Properties Near the InSight Lander Derived from 100 Sols of Radiometer Measurements, LPI, 1309, 2020.

Plesa, A.C., D. Breuer, S. Padovan et al. (including T. Spohn), Using Insight Data To Constrain Thermal Evolution Models, GSA Annual Meeting in Phoenix, Arizona, USA, 2019.

Plesa, A.C., E. Bozdag, A. Rivoldini et al. (including T. Spohn), Seismic Velocities Distribution in a 3D Mantle: Implications for InSight Measurements, Wiley, 2020.

Ponte, R.M. et al. (including A. Cazenave), Towards comprehensive observing and modeling systems for monitoring and predicting regional to coastal sea level, Front. Mar. Sci., doi: 10.3389/fmars.2019.00437, 2019.

Ruckriemen-Bez, T., D. Breuer, T, Spohn, Top-down versus Bottom-up Core Freezing: Modes of Core Crystallization and Implications for Dynamos in Terrestrial Planets and Satellites, AGUFM, GP31A-04, 2019.

Sazonov, S., A. Paizis, A. Bazzano, (incl. M. Falanga) et al., The Galactic LMXB Population and the Galactic Centre Region, New Astron. Rev., 88, 101536, 2020.

Schmelzbach, C., N. Brinkman, D. Sollberger et al. (including T. Spohn), Seismic investigations of the Martian near-surface at the InSight landing site, EGU General Assembly Conf. Abstracts, 20481, 2020.

Soderlund, K.M., K. Kalousová, J.J. Buffo et al. (including T. Spohn), Ice-Ocean Exchange Processes in the Jovian and Saturnian Satellites, Space Sci. Rev. 216 (5), 1-57, 2020.

Sollberger, D., C. Schmelzbach et al. (including T. Spohn), Sparse Reconstruction of Aliased Seismic Signals Recorded During the Insight Mars Mission, IEEE 8th International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP), 2019.

Sollberger, D., C. Schmelzbach, F. Andersson et al. (including T. Spohn), A reconstruction algorithm for temporally aliased seismic signals recorded by the InSight Mars lander, Earth and Space Sci. Open Archive ESSOAr, 2020.

Spohn, T., M. Grott et al., Mars Regolith Properties as Constrained from HP3 Mole Operations and Thermal Measurements, EGU General Assembly Conf. Abstracts, 9163, 2020.

Spohn, T., M. Grott, S.E. Smrekar et al., The Heat Flow and Physical Properties Package on the InSight Mission-Status and First Results, EPSC, EPSC-DPS2019-637, 2019.

Spohn, T., S.E. Smrekar, M. Grott et al., The Heat Flow and Physical Properties Package HP 3 on InSight: Status and First Results, AGU Fall Meeting 2019.

Stamenkovic, M., N. Lanza et al. (including T. Spohn), Probing The Modern-Day Martian Subsurface Habitability With Valkyrie. V., Astronomy 3, 116-120, 2020.

Stern, D. et al. (incl. J. Wambsganss), Gaia GraL: Gaia DR2 Gravitational Lens Systems. VI. Spectroscopic Confirmation and Modeling of Quadruply-Imaged Lensed Quasars, Astron. Astrophys., submitted, 2020.

Trewin, B., A. Cazenave, S. Howell et al., Headline indicators for global climate monitoring, Bull. Amer. Met. Soc., 1–49, 2020.

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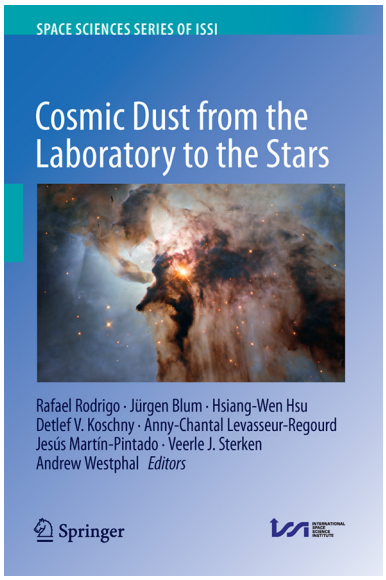

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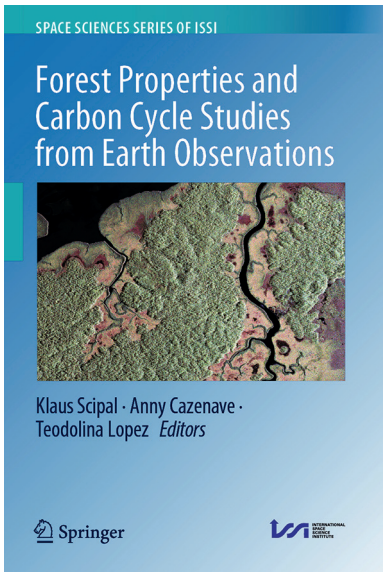

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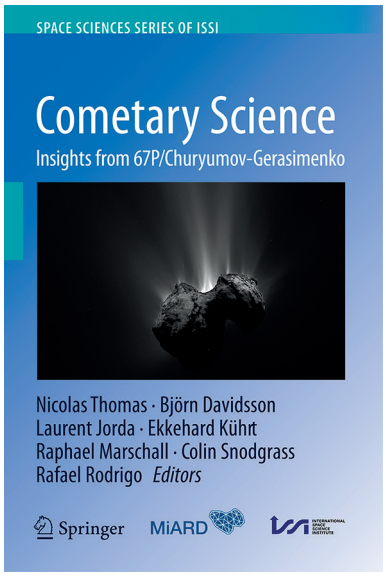

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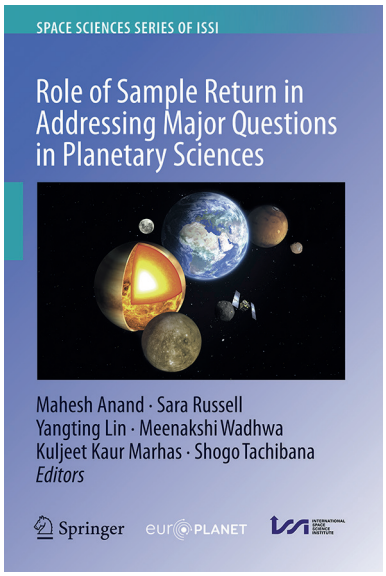

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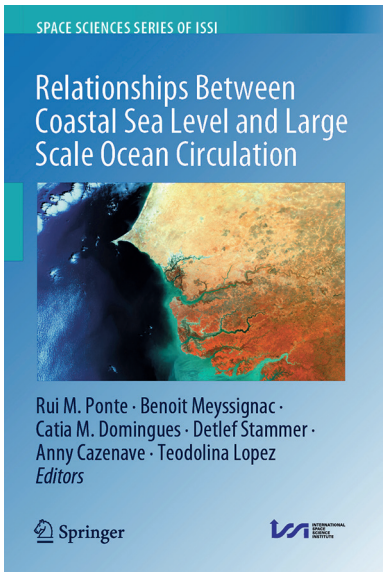

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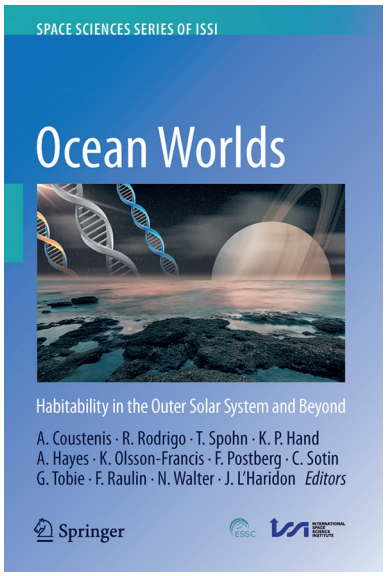

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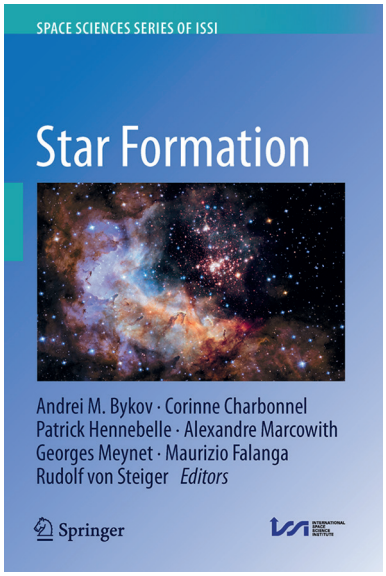

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