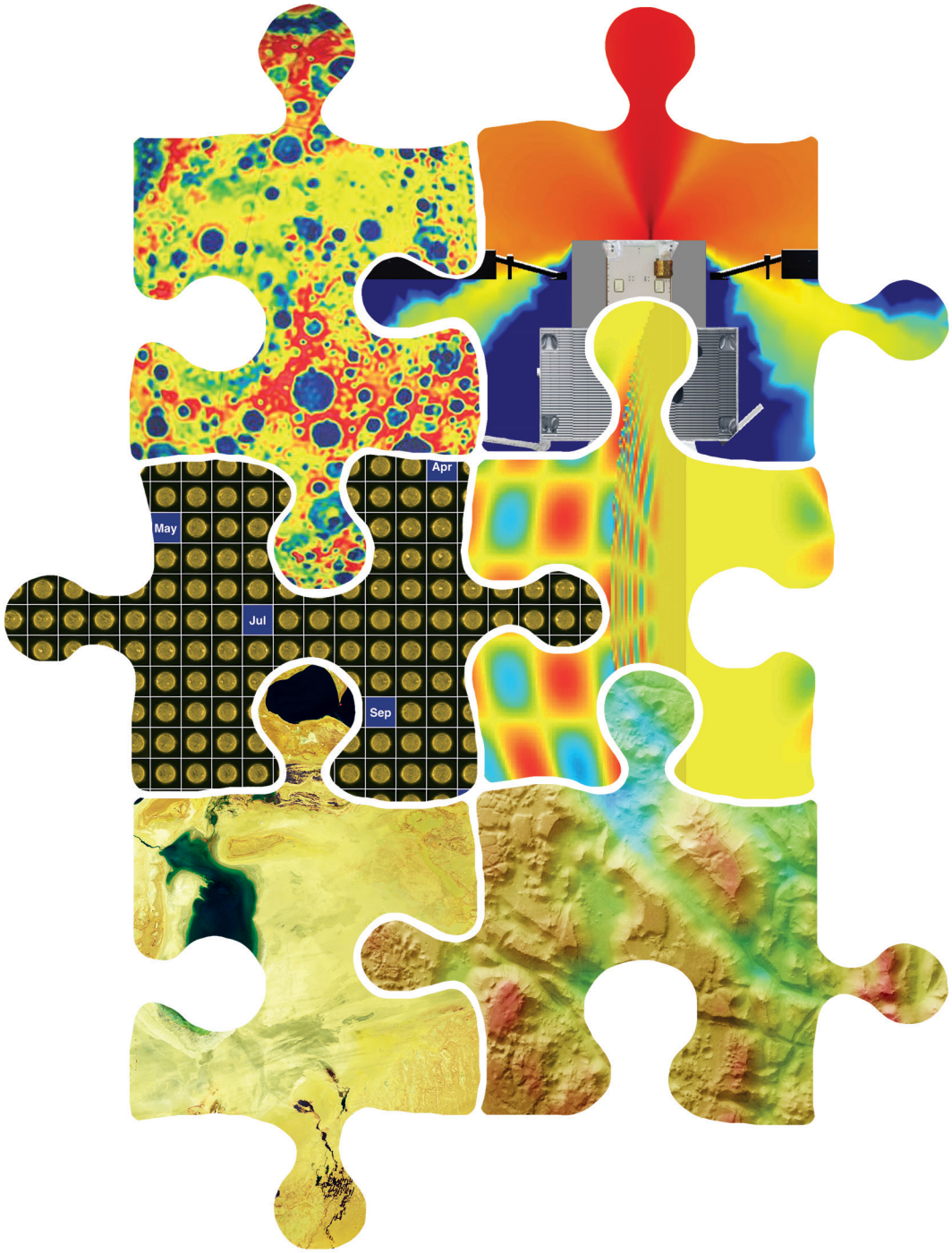
INTERNATIONAL
SPACE
SCIENCE
INSTITUTE



2018
2019 Annual Report

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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

During its 24th business year, from July 1, 2018 to June 30, 2019, our International Space Science Institute (ISSI), has experienced an essential event: the coming of a new ISSI Executive Director. After the sudden departure, at the end of June 2018, of the previous Executive Director, Rafael Rodrigo, who was called to the ministry of Science, Innovation, and Universities after a change of the Government in Spain, the BoT immediately initiated a search process in order to find a successor. Three outstanding candidates were interviewed in October 2018, out of a total of 28 excellent applicants. During its meeting on November 9, 2018, the ISSI BoT elected Professor Tilman Spohn as new ISSI Executive Director, as of January 1, 2019.

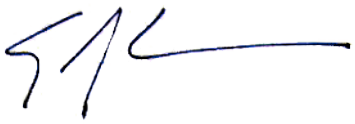
Born in Ockenheim, Germany, Tilman Spohn received his PhD degree (1978) in geophysics at the Johann Goethe University in Frankfurt. He specialized in the thermodynamics of the interiors of terrestrial planets, in planetary physics, geophysics, astrobiology, and the physics of comet nuclei. Tilman Spohn was Professor of Planetary Physics at the Westfälische Wilhelms Universität Münster (1984–2016) and the Director of the Institute of Planetary Research of the German Aerospace Center DLR in Berlin (2004–2017). He has been the Principal Investigator of various important space instruments, e.g., on the ESA Rosetta Mission and, most recently, on the NASA InSight mission to Mars. Tilman Spohn has served as a member of the ESA High-level Science Policy Advisory Committee (HISPAC), chaired the ESA Space Science Advisory Committee (SSAC), and was president of the Planetary Science Section of the American Geophysical Union (AGU). He also chaired our ISSI Science Committee from 2012 to 2016.

With his unusually wide and deep scientific, managerial, and science policy experience, Professor Tilman Spohn has the ideal profile for being the new ISSI Executive Director. We welcome him and look forward to further collaborating with him.

During and after this important transition phase, thanks to the constant dedication and efficiency of its directorate and staff, ISSI was able to maintain the flow of its usual outstanding scientific activities and world-wide visibility, through numerous International Teams, Workshops, Working Groups, Forums, and individual Visiting Scientists. We are very grateful to Rudolf von Steiger, ISSI Director, who acted as Executive Director ad interim during the last six months of 2018.

Another essential event of this past year was the signature, in June 2019, of the extension, for another three-year period, of the agreement of cooperation between ISSI Bern and ISSI Beijing, via the National Space Science Center of the Chinese Academy of Sciences. We look forward to further developing the already excellent and productive synergy between our two institutes.

All ISSI main actors, namely, its directorate and its staff, all the members of the Science Committee and of the BoT are thanked for their excellent work and continuous dedication. ISSI is extremely grateful to all its funding agencies, national and international. We aim at carefully enlarging the number and the quality of ISSI scientific activities by further increasing the financial support of ISSI funding agencies.



Georges Meylan
Chairman of the ISSI Board of Trustees
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Lausanne, July 2019

ISSI's twenty-fourth business year started with the unexpected departure of its Executive Director, Rafael Rodrigo, who followed a call to the Spanish Ministry of Science. Thanks to several factors the institute emerged unharmed from this hiatus: First, the Board of Trustees acted with urgency and managed to fill the vacant position with the shortest possible delay by Tilman Spohn who took office effective Jan 1st, 2019. Second, Rafael Rodrigo left the institute that he had led and formed for more than five years in an optimum condition. Third, the funding agencies and the science community put confidence in ISSI and its operations continued without any sign of decline. Finally, and most importantly, the ISSI staff faced the challenge of a time of uncertainty and went the extra mile without hesitation to master the situation.

Six Workshops were held in the course of the year, two of which in collaboration with the EuroPlanet project of the European Commission's H2020 program. In addition, there were two Forum meetings – one again with EuroPlanet and the other one with the Scientific Committee on Solar Terrestrial Physics (SCOSTEP). And 63 International Team meetings occurred, all activities described in more detail in this annual report. Together they brought 943 visitors to ISSI, 41% of which were coming for the first time. Three volumes in the Space Sciences Series of ISSI were added to the publication record. The impact factor of Space Science Reviews (from which the SSSI volumes are reprinted) has relaxed somewhat from 9.33 to 8.14, this after a steady increase during nearly a decade when the factor has about doubled. The journal is still placed among the top ten (rank 8) of more than 60 astronomy journals evaluated by Thomson Reuter's Web of Science.

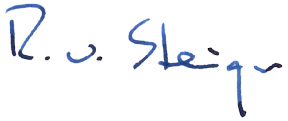
The ISSI Science Committee met for its two regular meetings, reviewing and discussing all future activities. The Fall 2018 meeting was devoted to reviewing Workshop, Working Group, and Forum proposals as well as the Earth Science Work Package and their implementation in the forthcoming year. In the Spring 2019 meeting the Committee primarily reviewed 88 Team proposals and recommended 31 for implementation, 4 of which are joint with ISSI-Beijing. This meeting was the last one under the chairmanship of Mioara Mandea, whom we thank warmly for her three years of service to ISSI. We take pleasure in welcoming the newly appointed chair, Louise Harra, and look forward to an equally fruitful collaboration.

Looking ahead, in addition to the regular program we anticipate, for the first time since 2011, to hold a retreat in the forthcoming year of 2020 together with the Board of Trustees and members of the Science Committee to discuss our future strategy, addressing questions such as how to evaluate quality and customer satisfaction, making ISSI younger and more gender balanced, and facing the challenges of digitization and using its opportunities.

The ISSI staff (without directors and postdocs) remained unchanged over the past year. Our Program Manager, Maurizio Falanga, celebrated ten years of service, for which we should like to congratulate and thank him warmly. The institute is privileged to have an extraordinarily dedicated staff with an average of almost 13 years of employment among its members.

Our postdoctoral researcher in Earth science, Teodolina Lopez, left ISSI in May 2019 after completing her two-year term. We thank her for the valuable contributions she made at ISSI, both to science and to help organizing the program, and wish her all the best for her future career. The position was once again advertised and at the time of writing we just selected Lorena Moreira to succeed her and work with one of us (AC) scientifically and support the ISSI Earth science program organizationally, starting in December 2019.

Tilman Spohn

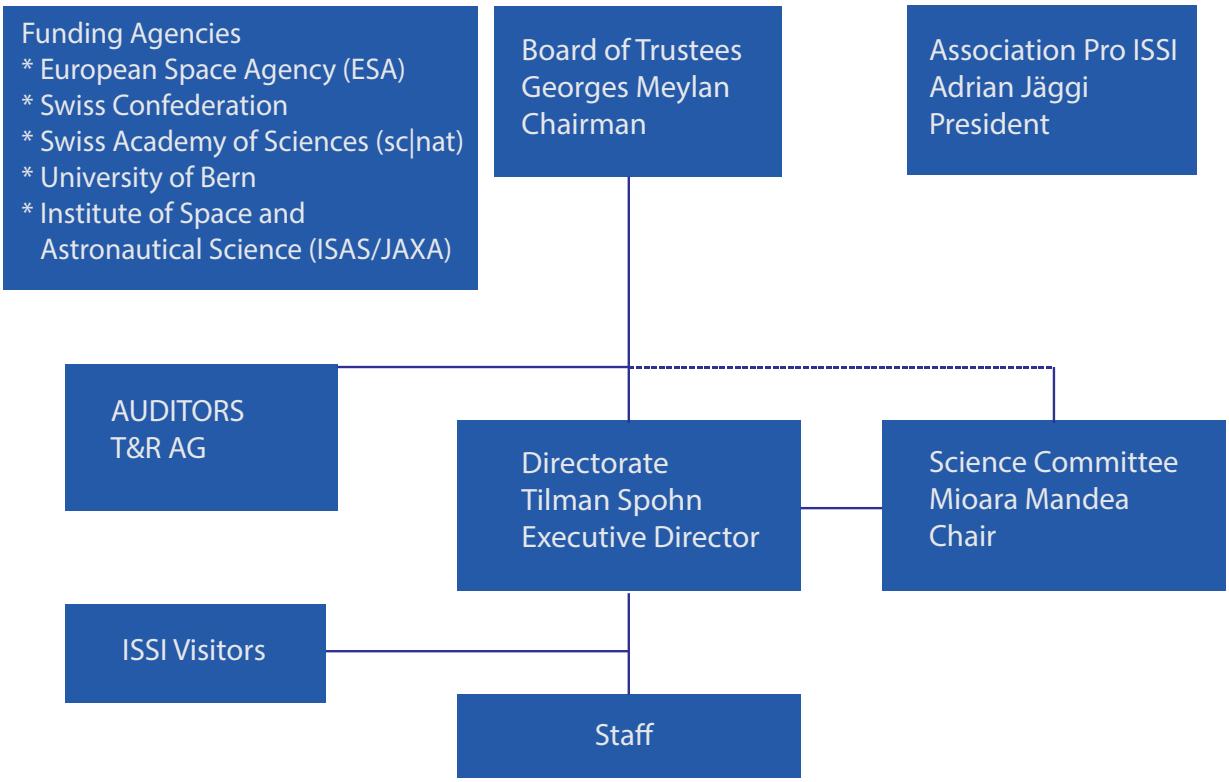


Rudolf von Steiger

Anny Cazenave

Joachim Wambsganss

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 (sc|nat) 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 Mioara Mandea, 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 Adrian Jäggi.

The 24th financial year of ISSI resulted in a deficit of about 44 kCHF as opposed to a budgeted deficit of 204 kCHF. This much better result was caused in about equal amounts by lower personnel costs due to temporarily unfilled positions and to lower expenditures for Workshops and Teams than budgeted. The result would have been even better if it hadn't been for another decline of the Euro to CHF exchange rate. The deficit is still fully covered by positive results from previous years.

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. Contributions from the EU H2020 projects, EuroPlanet and MiARD, are also acknowledged. These programs are now coming to an end: MiARD ended on August 31st, 2018, and EuroPlanet ends on August 31st, 2019.

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 24th Financial Year (1.7.2018-30.6.2019)

	Expenses	Revenues
ESA Science Directorate		1'448'944.90
ESA Earth Observation Programme		335'857.50
ESA HISPAC		25'000.00
Swiss Confederation		960'000.00
Swiss Academy of Sciences (SCNAT)		202'500.00
EC H2020 Projects: EuroPlanet, MiARD		38'429.00
ISSI Partners: ISAS/JAXA		28'535.00
Salaries and related costs [1]	1'202'975.02	
Fixed costs	282'865.50	
Operating costs [2]	224'553.90	
Investment (depreciated)	23'864.87	
Workshops, Working Groups, Teams, Visitors [3]	1'259'137.03	
Other income or cost [4]	90'054.32	
Result of the year		44'184.04
Total	**3'083'450.64**	**3'083'450.64**

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** includes extraordinary income, interest income, and exchange gain or loss.

The Board of Trustees

from left to the right:
Rudolf von Steiger, International Space Science Institute, Bern, Switzerland, *Secretary of the Board*
Joachim Wambsganss, International Space Science Institute, Bern, Switzerland
Johan A.M. Bleeker, SRON, Utrecht, The Netherlands
Daniel Fürst, RUAG, Zurich, Switzerland
Georges Meynet, Observatoire de Sauverny, University of Geneva, Sauverny, Switzerland
Georges Meylan, Ecole Polytechnique Fédérale de Lausanne, Switzerland, *Chair*
Willy Benz, University of Bern, Switzerland
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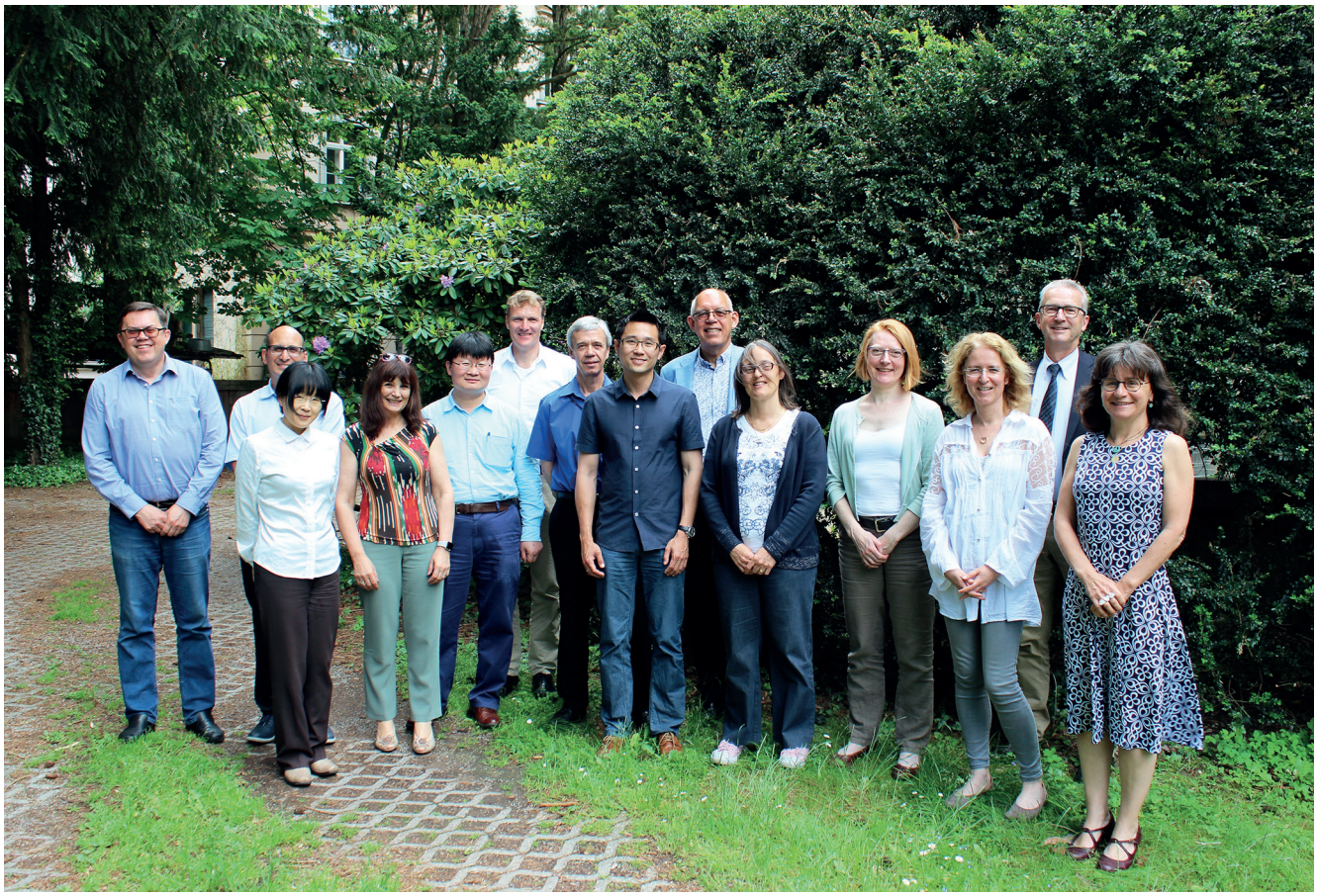
Renato Krpoun, Swiss Space Office, Bern, Switzerland
Rosine Lallement, Observatoire de Paris-Meudon, France, *Vice Chair**
Adrian Jäggi, President of the Pro ISSI Association, Bern, Switzerland
Günther Hasinger, ESA, Paris, France
Véronique Dehant, Royal Observatory of Belgium, Brussels, Belgium
Tilman Spohn, International Space Science Institute, Bern, Switzerland

missing from the picture:
Ji Wu, National Space Science Center (CAS) and International Space Science Institute Beijing, China
Lev M. Zelenyi, Space Research Institute (IKI), Russian Academy of Sciences, Moscow, Russia

*Membership ended on 30 June 2019

The Science Committee

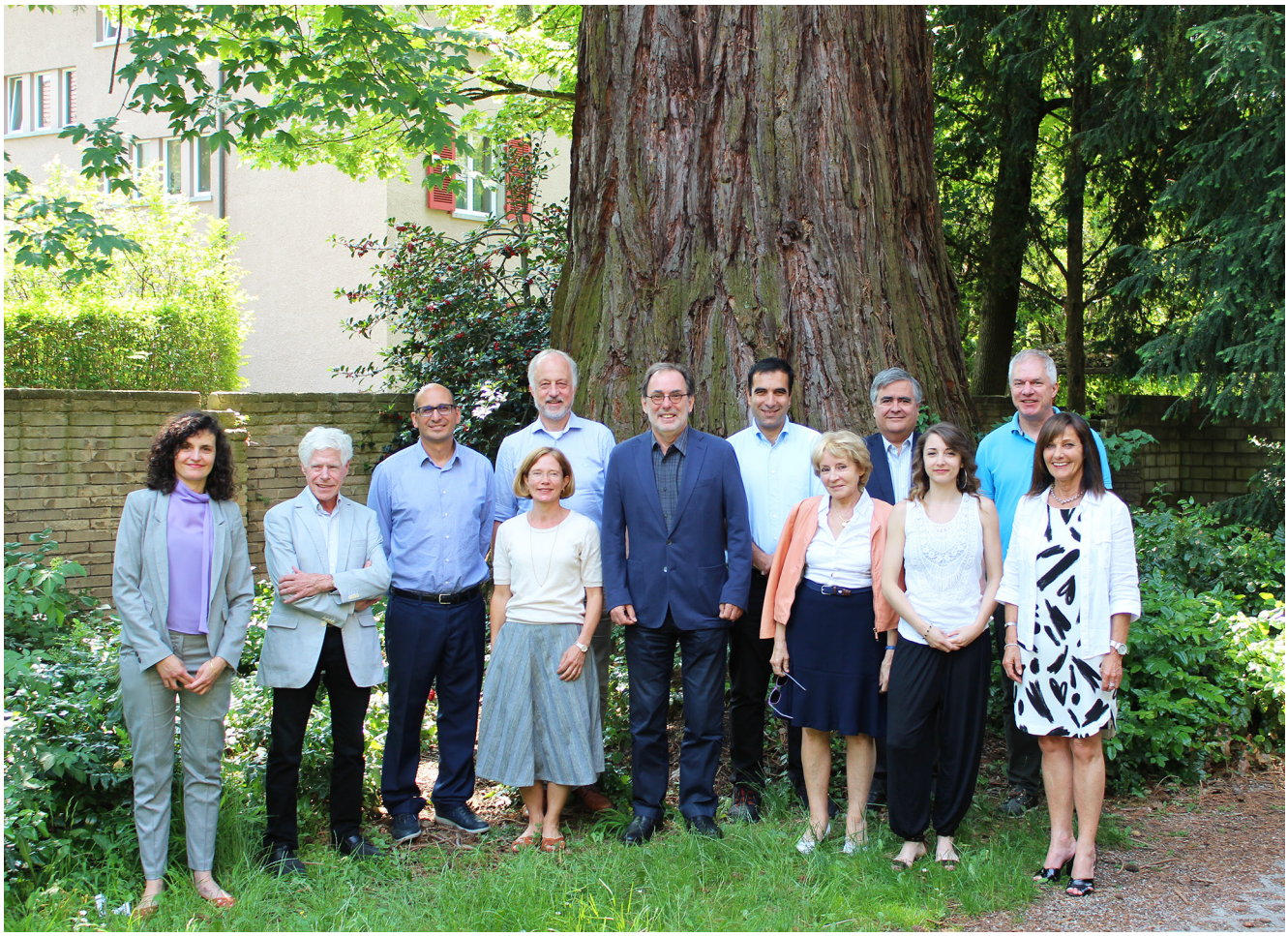


from left to the right:
Vladislav Izmodenov, IKI, Russian Academy of Sciences, Moscow, Russia (ex officio RAS)
Maurizio Falanga, International Space Science Institute, Bern, Switzerland, *Secretary of the Science Committee*
Kanako Seki, University of Tokyo, Japan
Mioara Mandea, CNES, Paris, France, *Chair**
Xiaolong Dong, International Space Science Institute Beijing, Beijing, China (ex officio)
Stein Haaland, University of Bergen, Norway
Christophe Sotin, NASA Jet Propulsion Laboratory (JPL/Caltech), Pasadena, USA
Kevin Heng, Center for Space and Habitability, University of Bern, Switzerland
Arvind Parmar, ESTEC ESA, Noordwijk, The Netherlands (ex officio ESA)
Francesca Primas, ESO, Munich, Germany
Lyndsay Fletcher, University of Glasgow, Scotland
Louise Harra, PMOD WRC, Davos, Switzerland
Michael Rast, ESA ESRIN, Frascati, Italy (ex officio ESA)
Corinne Charbonnel, Department of Astronomy, University of Geneva, Switzerland

missing from the picture:
Daniel Baker, University of Colorado, USA*
Timothy Horbury, Imperial College, London, UK
Heike Rauer, DLR Institute of Planetary Research, Berlin, Germany
Nathan Schwadron, University of New Hampshire, Durham, USA*
Sami Solanki, MPI for Solar System Research, Göttingen, Germany
Frances Westall, CNRS Orleans Campus, Orleans, France

*Membership ended on 30 June 2019

ISSI Staff



from left to the right:
Andrea Fischer, Editorial Assistant
Roger-Maurice Bonnet, Senior Discipline Scientist
Maurizio Falanga, Science Program Manager
Irmela Schweizer, Librarian
Joachim Wambsganss, Director
Tilman Spohn, Executive Director
Saliba F. Saliba, Computer Engineer and System Administrator
Anny Cazenave, Director
Álvaro Giménez, Senior Discipline Scientist
Alexandra Lehmann, Secretary
Rudolf von Steiger, Director
Silvia Wenger, Assistant to the Executive Director

missing from the picture:
Andrei Bykov, Discipline Scientist
Jennifer Fankhauser, Secretary
Johannes Geiss, Honorary Director
Julia Venturini, Post Doctoral Scientist

All lists show the status at the end of the 24th business year on 30 June 2019.

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 24th 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 24th year, six Workshops were organized, summaries of which can be found on the following pages.

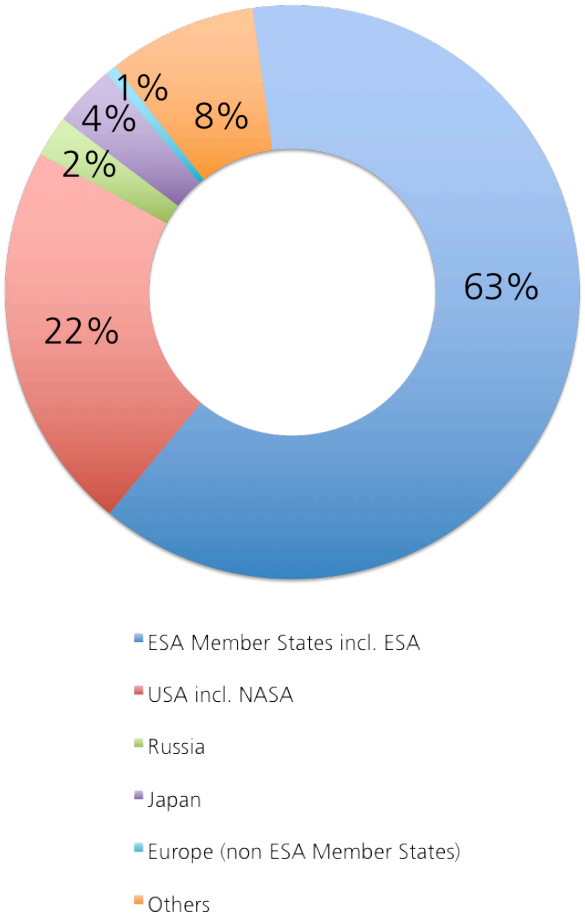
International Teams consist of about 15 external scientists, addressing a specific scientific topic in a self-organized fashion. The results of these activities are customarily reported in scientific journals. In total 63 Team meetings took place in the 24th business year. Details can be found from page 19 on forward.

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 business year, two Forums were held.

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. In the course of the reported period, there were no Working Group meetings at ISSI.

Visiting Scientists spend variable periods of scientific activity at ISSI. 10 individual visitors used the ISSI facilities during the year.

The Young Scientists Program is designed to bring PhD students and young post-docs 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. 111 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 943 scientists worked at ISSI during the 24th business year, 386 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.

Forums

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.

Solar System | Exoplanet Science Synergies (ISSI–Europlanet Forum #2)

19–20 February 2019

The second joint Forum between ISSI and Europlanet was dedicated to the discussion of how the Solar System community and the Exoplanet community can use synergetic approaches with their space projects in order to address and possibly solve similar key questions for planetary systems in the near- and mid-term future. The objectives of this Forum were to assess: i) suggestions for synergistic research studies between the two communities, ii) possibly new concepts of observation programs (space-based or ground-based) that could derive from these synergies, iii) themes for future ISSI Workshops and/or Forums which could be instrumental in helping to successfully address the key research questions.

At this Forum, 27 participants from 10 countries and 3 continents – representing the two communities – gathered and discussed intensely the common research questions and interests. Particular focus was given to the following six questions:

1) Origins of planetary systems?
2) Causes of the diversity of their architectures?
3) Causes of the diversity of the objects composing the planetary systems?
4) Atmospheric evolution and magnetic interactions?
5) Conditions for the emergence of habitable worlds?
6) Where and how to search for life?

Obviously, solar system planets on one hand and extrasolar planetary systems on the other hand are observed by very different methods with drastic differences in measurement resolutions and signal-to-noise ratios. The solar system planets are in the foreseeable future the only planets accessible to in situ investigations, whereas all exoplanet systems can be explored only with the five astronomical remote sensing techniques radial velocity, transit method, microlensing, astrometry and direct imaging. Nevertheless, the targets of interest form one common class of objects: Planetary systems. In the Forum the potential of performing synergistic studies of planetary systems was discussed for the various stages in their evolutionary paths, from the formation of protoplanetary disks to the generation of the diversity of their objects (including rings, moons, comets, asteroids), the emergence of potentially habitable ones and ultimately of life. In order to set the stage of solar system/exoplanets synergies, first the wealth of space missions currently in operation, in preparation or under study was briefly reviewed with their main scientific objectives. Our understanding of the origins and evolution of planetary systems will benefit enormously from synergies between exploration of the solar system planets – with detailed exploration of ONE planetary system with a certain age – and observations of exoplanets – with limited information for VERY MANY planetary systems in VERY DIFFERENT evolutionary stages and ages. In particular the very early phases of planet formation – protoplanetary disks – can be explored and properly understood only in exoplanet systems.

Of particular interest are spectral signatures of biomarkers, i.e. molecules produced by life forms. There are two possible ways for such observations: by transit spectroscopy or by direct imaging by large telescopes in space using coronography or interferometric techniques. Both ways are very promising avenues for the future, but they present huge technology challenges for the design of the future space-borne telescopes with the needed capabilities to perform these biosignature characterizations. The next generation of space telescopes will have the capacity of searching for biosignatures in the atmospheres of potentially habitable exoplanets. The HabEx and LUVOIR satellite projects – currently being technologically investigated – are very promising candidates for possibly finding signatures of life in exoplanets atmospheres in the not-too-distant future. The program of the Forum and the individual presentations can be accessed on the ISSI web pages, a summary report will be published.

Joachim Wambsganss

SCOSTEP – Scientific Committee on Solar-Terrestrial Physics

25–27 February 2019

The Scientific Committee on Solar Terrestrial Physics (SCOSTEP) is an interdisciplinary body of the International Council for Science (ICSU). SCOSTEP promotes ICSU's mission to strengthen international science for the benefit of society. SCOSTEP runs international interdisciplinary scientific programs and promotes solar-terrestrial physics research by providing the necessary scientific framework for international collaboration and dissemination of the derived scientific knowledge in collaboration with other ICSU bodies.

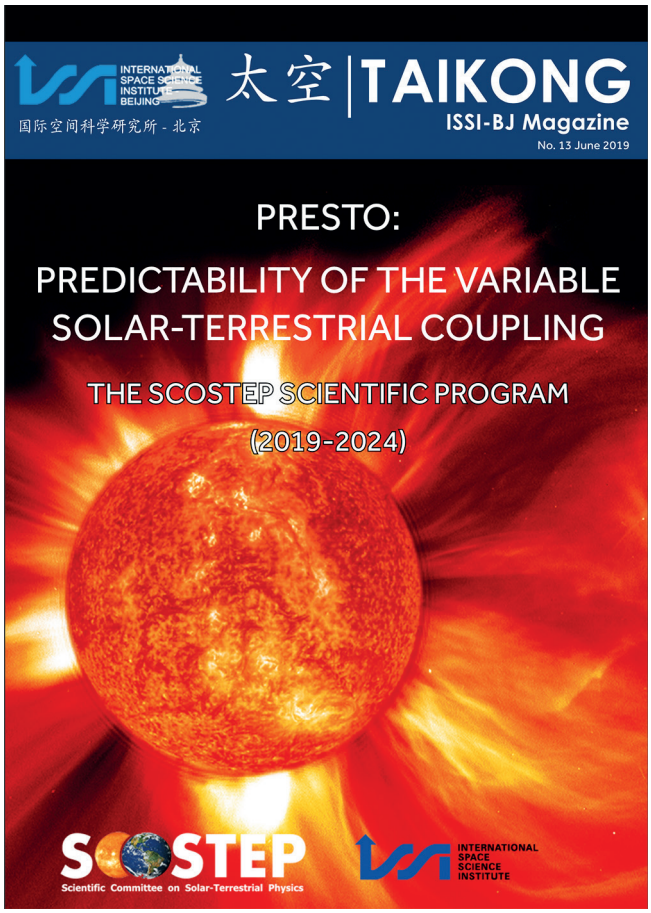
Considering the strong interest of ISSI in the fields covered by SCOSTEP, and of SCOSTEP in the interdisciplinary and international nature of ISSI, the two organizations started a collaboration long ago that has strengthened over the years. Several ISSI Teams were addressing topics related to the SCOSTEP CAWSES (Climate And Weather of the Sun Earth System, 2004–2008) and CAWSES-II (2009–2013) programs. In 2013 ISSI hosted a Forum at which VARSITI (VARiability of the Sun and Its Terrestrial Impact), the SCOSTEP program for 2014–2018, was defined. In 2016 ISSI held a mid-term Forum for VARSITI in order to address the expected evolution of the solar activity cycle after two maxima of decreasing amplitude.

It was therefore only natural for ISSI to again host the SCOSTEP Forum for defining the next 5-year program. Taking advantage of the partnership with ISSI-Beijing this was planned as a two-step affair with a first Forum held at ISSI-BJ and a second one at ISSI. Each Forum was attended by some 20+ scientists, thus covering a larger part of the community than a single Forum could have done. The two Fora, the first in Beijing in November 2018 and the second in Bern in February 2019, came up with a novel program called PRESTO (Predictability of the variable solar-terrestrial coupling), which rests on three pillars:

1. Sun, interplanetary space, and geospacer
2. Space Weather and Earth's atmosphere
3. Solar activity and its influence on the climate of the Earth system

The PRESTO program is described extensively in an issue of the TAIKONG magazine of ISSI-BJ and will run during the years 2019–2024.

Rudolf von Steiger



Cover of the TAIKONG Vol. 13. This volume is available online on the ISSI Beijing webpage: http://www.issibj.ac.cn.

Workshops

The dancing lights of the aurora provide spectacular views on the ground, but also capture the imagination of scientists who study incoming energy and particles from the sun. Aurora are one effect of such energetic particles, which can speed out from the sun both in a steady stream called the solar wind and due to giant eruptions known as coronal mass ejections or CMEs. (Image Credit: NASA/ESA)

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.

Auroral Physics

6–10 August 2018

Contrary to popular perception, there is no self-consistent explanation of the aurora, meaning one which relates a specific source in the magnetosphere on one hand, to the ionospheric manifestation (visible as well as low-frequency electric fields, particle energies and currents) on the other, including the physics of the coupling medium. Even in the case of the most recognizable auroral form, the auroral arc, there has been no direct observation of its magnetospheric source, nor identification of the essential conditions of its formation. One of the challenges in constructing such a theory is lack of a complete and authoritative review of observations to inform and constrain theories.

The Auroral Physics Workshop brought together experimentalists (ground-based and in situ), theorists and simulationists in order to produce a thorough assessment of our current state of understanding of the essential properties of auroral phenomena, and the mechanisms responsible for them. During the Workshop and subsequently, participants have carried out an extensive review of existing literature in order to assembly the best description possible of auroral morphology in time and space. For example, auroral arcs are characterized by their width, spacing, multiplicity, lifetime, energies, fluxes, variability, frequency of occurrence, location, source regions, relation to current systems, and other environmental factors (e.g. solar illumination, solar wind). All of these attributes must be explained by, or at least be consistent with, a successful theory. Auroral theories have been reviewed critically according to their ability to address observed parameters. The ultimate goal of this Workshop is not to declare a "winning" theory, but rather to identify established facts and critical gaps in our current understanding, and to establish key challenges for future research.

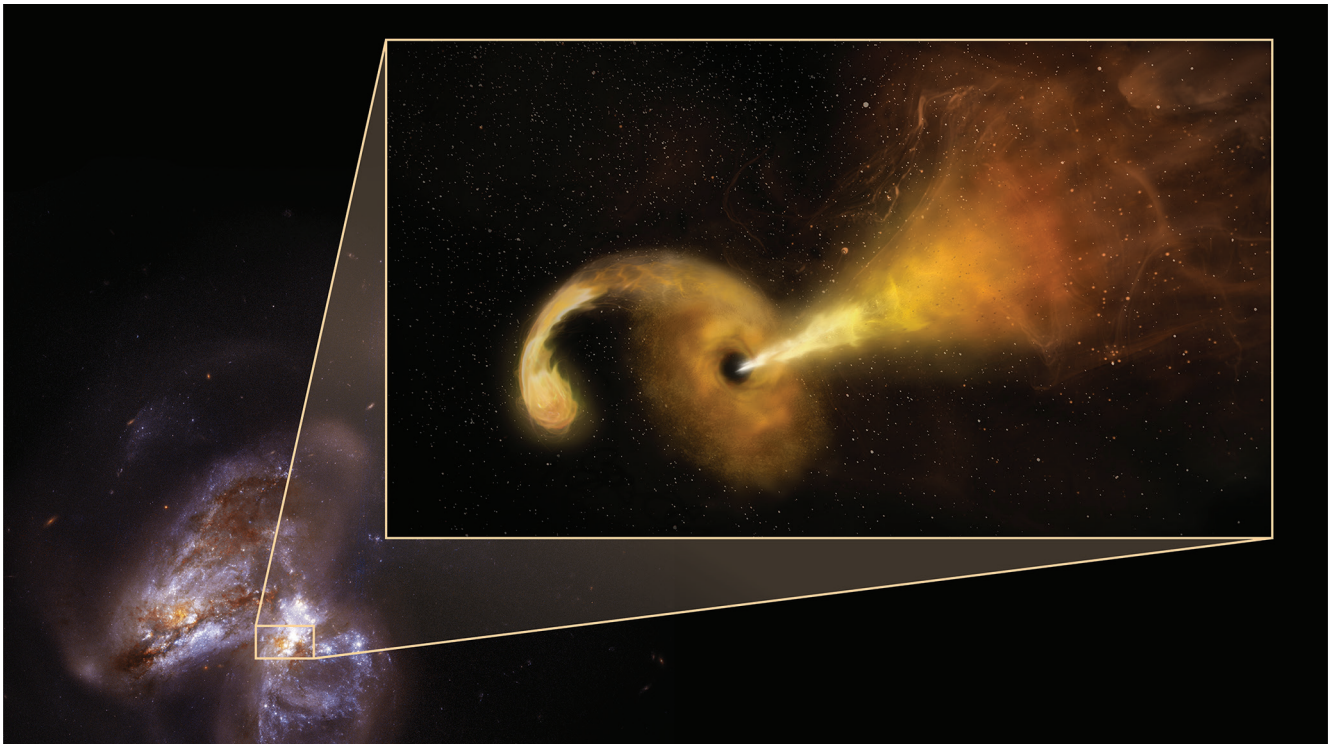
During the Workshop, ten topical reviews were outlined covering all aspects of auroral physics, including quiet, discrete auroral arcs (with separate reviews on observations, acceleration theories, and generators); diffuse and pulsating aurora; field-line-resonance arcs; polar cap arcs; dynamic aurora (large-scale and small-scale being treated separately); subauroral emissions; and cusp and dayside auroras.

The Workshop was convened by Joe Borovsky (Space Science Institute, USA), Tomas Karlsson (KTH Royal Institute of Technology, Sweden), Ryuho Kataoka (National Institute of Polar Research, Japan), David Knudsen (University of Calgary, Canada), and Noora Partamies (The University Centre in Svalbard, Norway). There were forty participants in total including four PhD students.

David Knudsen

Using Tidal Disruption Events to Study Super-Massive Black Holes

8–12 October 2018



Artist's conception of Tidal Disruption Event (TDE) in Arp 299. Powerful gravity of supermassive black hole shreds passing star, pulling material into disk rotating around the black hole, and launching jet of particles outward. (Image Credit: Sophia Dagnello, NRAO/AUI/NSF; NASA, STScI)

The Workshop has gathered around thirty scientists from 10 countries and was devoted to an in-depth examination of the complex astrophysical events, the Tidal Disruption Events (TDEs) to study SuperMassive Black Holes (SMBHs). For several decades, astronomers have speculated that a hapless star could wander too close to a SMBH and be torn apart by tidal forces. It has only been with the recent advent of numerous wide field transient surveys that such events have been detected in the form of giant-amplitude, luminous flares of electromagnetic radiation from the centers of otherwise quiescent galaxies. The discoveries, spanning the whole electromagnetic spectrum from X-rays, over UV, optical and near-infrared events, to a small number of events launching relativistic radio jets, have caused widespread excitement, as we can use these TDEs to study the mass of SMBHs in quiescent galaxies, the stellar populations and dynamics in galactic nuclei, the physics of black hole accretion under extreme conditions including the potential to detect relativistic effects near the SMBH, and the physics of radio jet formation and evolution in a pristine environment.

The Workshop started with an overview of observational properties of TDEs, from X-ray, gamma-ray, optically selected candidates to other potential imposters e.g. changing look quasars or nuclear supernovae, to close the session with a population summary. On the following Workshop days, the participants discussed the theory and simulations behind TDEs, rates, disruption, circularization, accretion disks, jets, as well as multi-messenger signals predicted to occur upon a stellar disruption and subsequent accretion of the stellar debris, such as gravitational wave radiation, neutrino and cosmic ray emission. These multi-messenger signals were recognized as exciting prospects but they are so far elusive for TDEs. Also this Session finished with an outlook for future modeling and facilities to answer outstanding and new open questions. Following the Workshop, its output will be published as a volume in the "Space Science Series of ISSI" by Springer, after publication of the around 19 expected chapters as peer-reviewed papers in the Topical Collection of "Space Science Reviews". At the end of each session, plans about the book preparation and chapter synergies were also discussed.

Maurizio Falanga and Peter Jonker

Workshops

Reading Terrestrial Planet Evolution in Isotopes and Element Measurements (in Collaboration with Europlanet)

22–26 October 2018

Workshop Participants (picture taken by S.F. Saliba, ISSI)

The Workshop focused mainly on the terrestrial planet evolution during four main stages: i.) Accretion within the gas disk < 10 Myr (~3–5 Myr); ii.) Continuous accretion after the disk ≤ 10–100 Myr; iii.) Catastrophic outgassing of a steam atmosphere from final "deep" magma ocean; and, iv.) Evolution of secondary atmospheres, particularly "N_2", related to tectonics and biological processing. Initially all isotopes and elements originate within the protoplanetary disk, thus their abundances depict that of the composition of the bulk Sun. The young Sun, depending of its initial rotation (i.e., slow, moderate, fast), emitted high X-ray and EUV-flues during the first billion years. This early active young Sun was a main driver for the later modification processes of today's observed atmospheric noble gas isotope ratios.

Chondrites, the building blocks of terrestrial planets, are geologically undifferentiated meteorites whose compositional diversity reflects the complexities of processes in the solar nebula. Isotopes and elemental ratios can also be used for constraining the time-scale of accretion, the volatile delivery and the origin of the Moon. A reproduction of Venus atmospheric noble gas isotope ratios can also be used to constrain the EUV-evolution track of the young Sun. Model results that reproduce Ar and Ne isotope ratios within the error favor a young Sun that was a slow to moderate a rotating young G star.

Fast accretion of terrestrial planets points to pebble accretion. The early Earth likely obtained most of its volatiles during the main accretion phase and not during the late veneer. Three main processes stand out:

i.) collisional erosion; ii.) post-nebula volatilization; and iii.) EUV-driven hydrodynamic hydrogen escape that dragged rock-forming elements that outgassed from magma oceans. The amount of heat-producing elements (U, Th, ^{40}K) determine the planet's subsequent evolution, including tectonic activity and the build up of secondary atmospheres. It is concluded that the impact and accretion scenario and escape processes related to possible captured H_2/He envelopes from the disk and the EUV flux of the young Sun/star determines the abundance of these elements.

Planetary evolution in relation to the formation of plate tectonics and the influence of life on the origin and build up of Earth's atmosphere have also been addressed during the Workshop. One can summarize that tectonic activity (plate-tectonics) together with the oxidation state of the crust/upper mantle is crucial for the efficient outgassing of N_2 into the atmosphere. There is no $^{14}N/^{15}N$ footprint in Earth's atmosphere that point to a strong nitrogen escape during the planet's history. In contrast, Xe has been lost to space, in relation to its specific electronic structure and interaction with irradiation from the young Sun. Moreover, C, N, and S isotope data from ancient rocks indicate that life has massively influenced atmospheric pressure and composition (e.g., O_2, CO_2, and potentially CO levels) during the Archean. Finally, future space missions that are important for enhancing our understanding in terrestrial planet evolution concluded the Workshop. Precise new atmospheric isotope measurements with a future Venus mission would constrain the young Sun's EUV flux evolution track.

Helmut Lammer

Understanding the Diversity of Planetary Atmospheres (in Collaboration with Europlanet)

12–16 November 2018

Ten planetary atmospheres are currently studied in the solar system and many more will be characterized in the coming years as we remotely observe exoplanets. This upcoming revolution was the motivation for a Workshop entitled "Understanding the Diversity of Planetary Atmospheres". We realize that the examples that we find in the solar system may not be sufficient to anticipate the diversity of exo-atmospheres. Yet it is very interesting to make the most of what we have learned so far to prepare for the future. Within that context, the goal of the Workshop was to bring together planetary scientists, experts in the origins of atmospheres, planetary interior, aeronomy, escape, climatologists, and astronomers to look for commonalities among atmospheres of the solar system and the atmospheres of planets around distant stars. The Workshop started with review sessions about what has already been learned from observing exoplanets and what to expect for the future. The various cases found in the solar system were then discussed, before focusing on the key processes that govern atmospheric physics and chemistry (including their formation and evolution), the science of atmospheric dynamics, escape, etc. The Workshop also included presentations of the upcoming missions and telescopic observations that will, in the future, expand our knowledge of planetary atmospheres in the solar system and beyond. The interactions between the experts from different fields led to very interesting discussions which revealed, that many facts and theories that were thought to be common knowledge by non-experts are often questioned by the most recent studies.

Nearly forty scientists from Europe, USA, Russia, China, Japan, Israel and Australia attended this Workshop. Several discussions led to the definition of an ambitious ISSI book with 17 chapters summarizing all the Workshop results. Many chapters' title will take the form of a question such as "Do we understand atmospheric Superrotation?" or "Do intrinsic magnetic fields protect planetary atmospheres from stellar winds?". The Workshop was convened by Oleg Korablev (IKI, Moscow, Russia), Francois Forget (LMD, Paris, France), Michel Blanc (UPS-CNRS, Toulouse, France), Kevin Heng (University of Bern, Switzerland), Takeshi Imamura (The University of Tokyo, Japan), Helmut Lammer (Austrian Academy of Sciences, Graz, Austria) and Julia Venturini (ISSI, Bern, Switzerland).

François Forget

Figure showing the atmosphere of Pluto images by the New Horizons spacecraft on July 14, 2015. The thin nitrogen atmosphere is revealed by organic hazes that form multiple layers. This is the last of the ten true atmospheres than we can study in the solar system, after Venus, the Earth, Mars, Jupiter, Saturn, Titan, Uranus, Neptune and Triton.
(Image Credit: NASA/Johns Hopkins University Applied Physics Laboratory/Southwest Research Institute)

Workshops

Natural and Man-made Hazards Monitoring by the Earth Observation Missions: Current Status and Scientific Gaps

15–18 April 2019

The purpose of this Workshop with 40 participants was to investigate how the Sentinel satellites of the COPERNICUS program of the European Union, as well as other Earth Observation missions, can provide novel and useful information on natural and man-made hazards and disasters that highly impact human societies. During the Workshop a broad range of hazards observable from space were addressed, including earthquakes, volcanic hazards, extreme events (e.g., storm surges, floods, droughts), fires, pollutions, tipping points in physical and biological systems, etc. Focus was given on how space observations can improve our understanding of the driving mechanisms and their mutual interactions. Added-value information gained by combining different types of space-based and in situ observations as well as model results was also highlighted.

The program was split into seven sessions. After a series of overview talks on solid Earth, meteorological and hydrological hazards, as well as a general presentation of the ESA program in Earth Observation, following sessions successively addressed: (1) Solid Earth hazards and associated mechanisms, with focus on the seismic and volcanic hazards, land slides, tsunamis, ground subsidence in urban environments, (2) hydrological hazards (water quality, floods, ground water resources decline), (3) processes affecting land and the land sea interface (climate change and land use impacts on food security), natural and human-induced stresses on coastal zones, (4) extreme events (storm surges, thunderstorms, fires), (5) tipping points (i.e., potential irreversible changes) in physical, biological and societal systems, (6) air and sea pollutions. The program also included two keynote lectures on natural hazards during paleo time scales and on space weather hazards. Discussions showed that earth observations are essential for process understanding and, depending on the domain, are also highly useful for feeding forecast models. Concerning the latter issue, volcanic risk forecasting appeared as one of the most advanced processes, of invaluable value for risk mitigation and adaptation.

The outcome of this interesting Workshop is a collection of articles currently in preparation for publication in a special issue of the Surveys in Geophysics journal.

Anny Cazenave

Star Formation

20–24 May 2019

From their birth to their death, stars are playing a major role in the chemical evolution of the matter and the energy budget of galaxies via their radiation, their wind, and the supernovae. The complex interplay of physical processes from gas dynamics and astrochemistry to nuclear physics leading to the formation of proto-stars in molecular clouds and then their MHD and radiative feedback on the cloud are subject of a great current interest. Despite the great progress of the multi-wavelength sensitive observations and high performance modeling a number of the fundamental issues remain enigmatic yet. This is because the star formation process has a multi-scale nature with a strong non-linear feedback by radiation, MHD flows and non-thermal energetic particles. The amount of data on star formation, obtained recently with the Herschel, HST, Gaia, XMM-Newton, Chandra and Fermi space telescopes with the ground based VLBI, LOFAR, ALMA, VLT and H.E.S.S. observatories, is growing fast. The missions have produced large and high quality databases. The forthcoming missions ATHENA, JWST, SPICA, EUCLID and the others will uncover new phenomena in star formation.

The Workshop "Star Formation" was devoted to an in-depth examination of complex astrophysical phenomena of star formation via multi-wavelength observations and modeling. About forty leading experts in astrophysics over the world including a number of early career researchers discussed the state of art and future perspectives in star formation and the related subjects in physics and astronomy.

Among the fundamental issues discussed were:

- The role of gravity in the formation and evolution of molecular clouds, the nature of supersonic and magnetized turbulence in the giant molecular clouds.
- The role of stellar feedback (supernovae, HII regions, winds) in regulating star formation, the radiation transfer, magnetic fields and gas ionization by cosmic rays.
- The role of radiation feedback, jets and magnetic fields in star clusters.
- The origin of the stellar initial mass function and how universal it is across various environments.
- The origin of first stars and the star formation rate across the cosmic evolution.

Andrei Bykov

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 24th business year. A rationale is given only for the selected teams in 2018; for the others see the previous Annual Reports.

Teams selected in 2015

New Diagnostics of Particle Acceleration in Solar Coronal Nanoflares from Chromospheric Observations and Modeling

Team leader: Paola Testa, Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
Session: 5–8 November 2018

Teams selected in 2016

Ultraluminous X-ray Sources: from the Local Group to the Very First Galaxies

Team leaders: Tassos Fragos and Andreas Zezas, University of Crete, Greece
Session: 19–21 September 2018

The Physics of the Very Local Interstellar Medium and its Interaction with the Heliosphere

Team leaders: Joe Giacalone and Randy Jokipii, University of Arizona, USA
Session: 17–20 September 2018

A New View of the Solar-stellar Connection with ALMA

Team leaders: Sven Wedemeyer, University of Oslo, Norway, Tim Bastian, National Radio Astronomy Observatory, Charlottesville, USA, and Hugh Hudson, University of Glasgow, United Kingdom
Session: 4–7 September 2018

Rossby Waves in Astrophysics

Team leader: Teimuraz Zaqarashvili, University of Graz, Austria
Session: 2–6 July 2018

Teams selected in 2017

SOFAR – Seismology of Fast Rotating Stars

Team leader: Jérôme Ballot, Institut de Recherche en Astrophysique et Planétologie IRAP, Toulouse, France
Session: 25–29 March 2019

Electrostatic Manipulation of Nano-Scale Objects of Lunar Regolith

Team leader: Elena Besley, University of Nottingham, United Kingdom
Session: 29 January – 1 February 2019

The Evolution of Rich Stellar Populations & Black Hole Binaries

Team leader: Christian Boily, University of Strasbourg, France
Session: 9–12 July 2018

The Solar and Stellar Wind Connection: Heating Processes and Angular Momentum Loss

Team leaders: Allan Sacha Brun, CEA Saclay, Gif-sur-Yvette, France and Sean Matt, University of Exeter, United Kingdom
Session: 17–21 June 2019

Plasma Heating and Particle Acceleration by Collisionless Magnetic Reconnection

Team leaders: Jörg Büchner, Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany and Masahiro Hoshino, University of Tokyo, Japan
Session: 15–18 October 2018

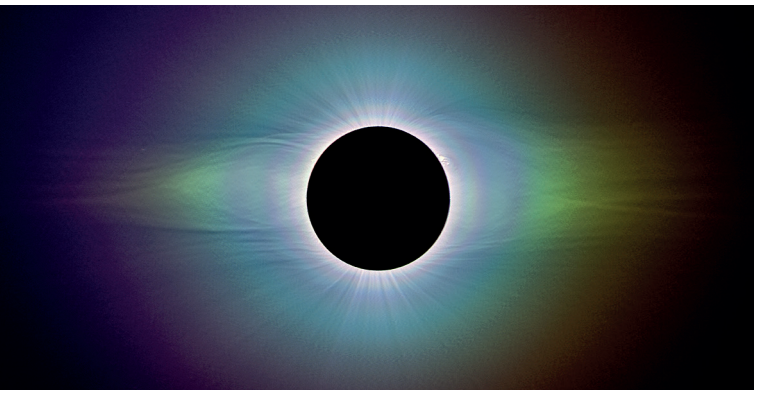
Comet 67P/Churyumov-Gerasimenko Surface Composition as a Playground for Radiative Transfer Modeling and Laboratory Measurements

Team leader: Mauro Ciarniello, INAF-Osservatorio Astronomico di Roma, Italy
Session: 26–30 November 2018

Towards a Unified Sea Level Record: Assessing the Performance of Global Mean Sea Level Reconstructions from Satellite Altimetry, Tide Gauges, Paleo-Proxies and Geophysical Models

Team leaders: Sönke Dangendorf, Universität Siegen, Germany and Marta Marcos, University of the Balearic Islands, Esporles, Spain
Session: 28 January – 1 February 2019

International Teams



This image has been composed from different combinations of polarized images during totality on July 2, 2019, to bring out the details of the structures in the corona. (Image Credit: ESA/CESAR)

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: 21–25 January 2019

Current Sheets, Turbulence, Structures and Particle Acceleration in the Heliosphere

Team leaders: Antonella Greco, Università della Calabria, Arcavacata di Rende, Cosenza, Italy and Olga Khabarova, Institute of Terrestrial Magnetism (IZMIRAN), Troitsk, Russia
Sessions: 1–5 October 2018 and 13–17 May 2019

Satellite-Derived Estimates of Antarctic Snow- and Ice-Thickness

Team leaders: Petra Heil, University of Tasmania, Hobart, Australia and Rachel Tilling, University of Leeds, United Kingdom
Session: 20–24 May 2019

Low Frequency Imaging Spectroscopy with LOFAR – New Look at Non-Thermal Processes in the Outer Corona

Team leader: Eduard P. Kontar, University of Glasgow, United Kingdom
Session: 1–5 October 2018

Spacetime Metrology, Clocks and Relativistic Geodesy

Team leaders: Sergei Kopeikin, University of Missouri-Columbia, USA and Jürgen Müller, Leibniz Universität Hannover, Germany
Session: 25–28 March 2018

New Features in the Meteor Radar Observations and Applications for Space Research

Team leader: Alexander Kozlovsky, University of Oulu, Sodankylä, Finland
Session: 20–24 August 2018

Kappa Distributions: From Observational Evidences via Controversial Predictions to a Consistent Theory of Suprathermal Space Plasmas

Team leaders: Marian Lazar, University of Leuven, Belgium and Horst Fichtner, Ruhr-Universität Bochum, Germany
Session: 3–7 June 2019

Large-Amplitude Oscillations as a Probe of Quiescent and Erupting Solar Prominences

Team leader: Manuel Luna Bennasar, Instituto de Astrofisica de Canarias, La Laguna Tenerife, Spain
Session: 13–17 May 2019

Physics of Dust Impacts: Detection of Cosmic Dust by Spacecraft and its Influence on the Plasma Environment

Team leader: Ingrid Mann, The Arctic University of Norway, Tromsø, Norway
Session: 31 October – 2 November 2018

Understanding the Origins of Problem Geomagnetic Storms

Team leaders: Nariaki Nitta, Lockheed Martin Solar and Astrophysics Laboratory, Palo Alto, USA and Tamitha Mulligan Skov, The Aerospace Corporation, Los Angeles, USA
Session: 1–5 April 2019

Linking the Sun to the Heliosphere using Composition Data and Modeling

Team leader: Susanna Parenti, Univ. de Paris Sud, Orsay, France
Session: 11–15 February 2019

Multi-technique Characterization of Near-Earth Space Environment

Team leader: Ashik Paul, University of Calcutta, India
Sessions: 4–8 February 2019 and 13–17 May 2019 (Ed. Mt.)

Reconstructing Solar and Heliospheric Magnetic Field Evolution Over the Past Century

Team leader: Alexei A. Pevtsov, National Solar Observatory, Sunspot, USA
Sessions: 28–31 August 2018 and 12–15 February 2019

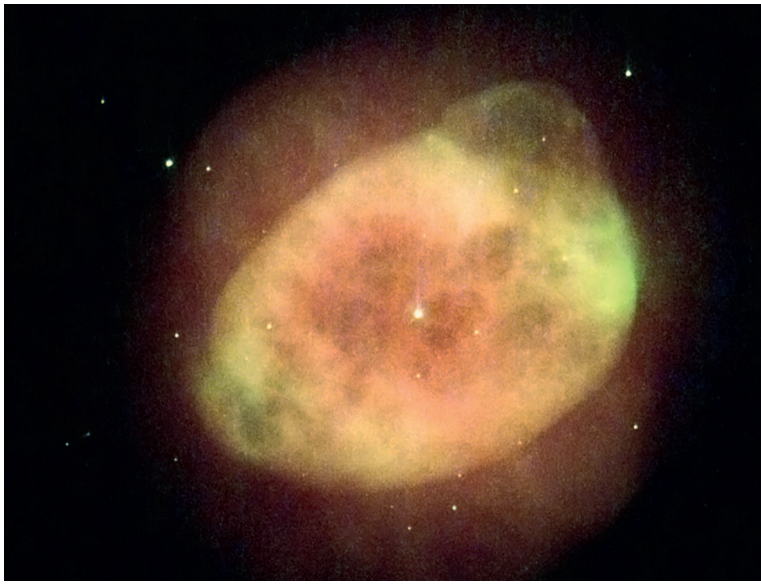
Towards Unified Error Reporting (TUNER)

Team leaders: Thomas von Clarmann, Karlsruhe Institute of Technology, Germany and Douglas Degenstein, University of Saskatchewan, Canada
Session: 1–5 April 2019

Teams selected in 2018

New Quantitative Constraints on Orographic Gravity Wave Stress and Drag: Satisfying Emerging Needs in Seasonal-to-Subseasonal and climate prediction

Team leader: Joan Alexander, NorthWest Research Associates, Boulder, USA
Session: 1–5 April 2019
Scientific Rationale: The Team utilizes recent advances in the analysis of high-resolution satellite data for studies of the full three-dimensional (3D) properties of orographic gravity wave (OGW) events, and evaluation of existing and new parametrizations of OGW drag in global models. The Team brings together experts on the satellite data and their analysis, high-resolution wave-resolving models, global prediction models, and parametrization methods. OGW drag is one of the fundamental physics parametrizations employed in every global prediction model across timescales from weather to climate. Orographic waves are part of the complex dynamical interaction of winds with topography, and one piece in the puzzle that is topography's effect on global circulation. Despite its importance in global models, OGW parametrization tuning is still only weakly constrained by observations in today's models, while new issues related to shortcomings in OGW parametrization are arising.



This NASA/ESA Hubble Space Telescope image shows the planetary nebula IC 289, located in the northern constellation of Cassiopeia. Formerly a star like our Sun, it is now just a cloud of ionized gas being pushed out into space by the remnants of the star's core, visible as a small bright dot in the middle of the cloud. (Image Credit: Hubble/ESA/NASA)

Probing the Core of the Sun and the Stars

Team leader: Thierry Appourchaux Institut d'Astrophysique Spatiale, Orsay, France
Session: 11–15 March 2019
Scientific Rationale: The structure and dynamics of the energy-generating core of the Sun and other stars remain poorly constrained, and poorly understood, in spite of their fundamental role in determining the overall structure and evolution of stars. The detection of solar normal modes of pressure oscillations (p modes) permitted the development of helioseismology, which has allowed us to accurately describe the internal structure and dynamics of the solar outer radiative and convective zones. The recent tentative detection of buoyancy or gravity modes (g modes) in the Sun as well as the impact of the detection of mixed (p and g) modes in low-mass evolved stars have rejuvenated the quest for understanding the central zone of the stars: the stellar core. The aim of this Team is to understand the impact of the inferences about the structure and dynamics of stellar cores for solar and stellar evolution, of the solar g-mode detection on spatially resolved inversions of the Sun's core rotation and subsequently for the detection potential of other data sets of solar and stellar g modes. All of these should have an important, direct impact on the understanding of solar and stellar structure and evolution.

International Combination Service for Time-variable Gravity Field Solutions

Team leaders: Richard Biancale, GFZ German Research Centre for Geosciences, Potsdam, Germany and Adrian Jäggi, University of Bern, Switzerland
Session: 14–18 January 2019
Scientific Rationale: The Team is proposed for gravity field modeling in the context of the GRACE and GRACE-FO missions. These missions are dedicated to determining gravity field variations, hence mass transfers on the Earth at a daily to monthly periodicity. This work should help promoting and developing the recently established gravity field service COST-G (International Combination Service for Time-variable Gravity Field Solutions) currently being installed under the umbrella of the International Association of Geodesy (IAG) as the product center of the International Gravity Field Service (IGFS) for time-variable gravity fields. The aim is to join the efforts for gravity field modeling in order to generate combined time-variable models and consequently to establish improved reference models like it has been demonstrated by the EGSIEM project of the European Commission.

International Teams

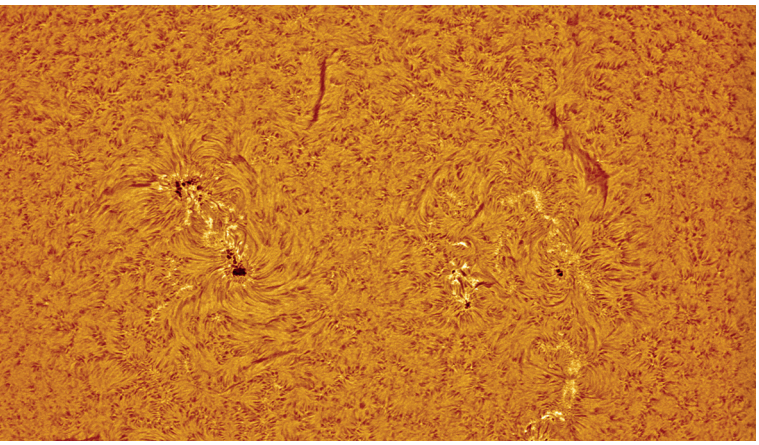


Image showing a snippet of the Sun up close, revealing a golden surface marked by a number of dark, blotchy sunspots, curving filaments, and lighter patches known as 'plages' – brighter regions often found near sunspots. (Image Credit: ESA/ESAC/CESAR – A. de Burgos)

Origins of 3He-Rich Solar Energetic Particles

Team leaders: Radoslav Bucik, Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany and James Drake, University of Maryland, College Park, USA
Session: 21–25 January 2019
Scientific Rationale: Our Sun provides a rare opportunity to observe energetic particles and their sources jointly. The acceleration mechanism in solar flares, tremendously enhancing (up to factors of ten thousand) abundances of rare elements like 3He and ultra-heavy nuclei (like 197Au and 207Pb), has been puzzling for more than 50 years. Flares associated with 3He-rich solar energetic particles have been commonly observed in jet-like forms indicating acceleration in magnetic reconnection on field lines open to interplanetary space. The goal is to advance our understanding of the ion enhancement mechanisms by combining scientists with knowledge in different disciplines and research methods. The Team includes experimentalists with expertise regarding in-situ heliospheric and remote solar observations, as well as theoreticians and modelers of ion acceleration. The aims are to 1) summarize the properties of 3He-richsolar sources, gathered with the recent high-resolution, extreme ultraviolet and photospheric magnetic field observations, 2) determine how these properties correlate with the in-situ energetic particle observations, and 3) conclude how these properties could constrain different models of particle fractionation and acceleration.

An Exploration of the Valley Region in the Lowlatitude Ionosphere: Response to Forcing from Below and Above and Relevance to Space Weather

Team leader: Jorge Chau, Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany
Session: 11–15 March 2019
Scientific Rationale: In order to further our understanding of lower atmospheric forcing of low-latitude valley region (LLVR) and, in turn, low latitude space weather, the Team brings together a multi-disciplinary group of expert scientists to contribute to the 4D (altitude, longitude, latitude, time) exploration of the region. The Team evaluates ground, satellite, and rocket observations as well as atmosphere-ionosphere coupled numerical models. In addition, since radar echoes can be used as responses of the different atmospheric/ionospheric drivers, expertise in plasma physics and plasma simulations is needed to connect the coupling processes with the plasma irregularities responsible of the echoes. In the process of understanding the echoes, the Team members improve the understanding of the region, since the required information, e.g., gravity wave forcing, is not well known. Among other outputs, the scientists expect to plan future observational campaigns that take into account the expertise gathered. By this effort, the Team envisions that the understanding of upper atmosphere electrodynamics will be enhanced by yet unexpected mechanisms hidden in the Valley region.

An Intercomparison of 1D Chemical Kinetics Codes for Exoplanet Atmospheres

Team leader: Benjamin Drummond, University of Exeter, United Kingdom
Session: 14–18 January 2019
Scientific Rationale: Recent observations and results from theoretical works suggest that 3D processes are key in shaping the structure (temperature and circulation) and composition of real exoplanet atmospheres. Modeling the gas-phase chemistry of these atmospheres with 3D models is on the horizon, however one of the main challenges to overcome is the high computational cost of the chemistry calculations. Therefore, 1D codes are vital in the development and validation of reduced chemical networks and chemical relaxation schemes that provide the required efficiency gains to make 3D modeling of exoplanet atmospheres computationally feasible. A significant number of 1D chemical kinetics codes have now been applied to hot exoplanet atmospheres in the literature. The Team investigates the differences that are introduced by the choice of numerous model inputs (including the chemical network) but mainly by the codes themselves, by performing simulations with identical model input. The project identifies the most important sources of variation in model output,

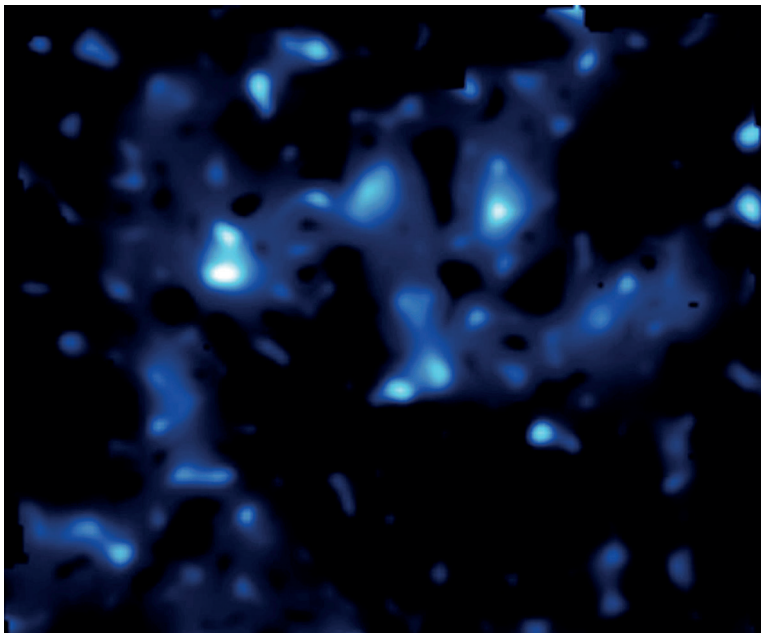
providing a clear focus for future developments. The improvements to theoretical tools that will follow this project are vital for keeping pace with advances in observational techniques and facilities.

Witnessing the Culmination of Structure Formation in the Universe

Team leader: Stefano Ettori, INAF-Osservatorio Astronomico di Bologna, Italy
Session: 15–19 October 2018
Scientific Rationale: The Heritage program for the ESA's X-ray satellite XMM-Newton has been activated for the first time in the last Announcement of Opportunity. It has registered a large response from the community, with an oversubscription factor of 10, and has assigned about 3 Msec of XMM exposure time to two only projects, one led by the Team. The project is focused on the ultimate products of structure formation in mass and time: A large, unbiased, signal-to-noise limited sample of 118 galaxy clusters detected by Planck via their Sunyaev-Zel'dovich effect. Completing the high-fidelity XMM coverage of this sample has extraordinary legacy value. The Team is obtaining an accurate vision of the statistical properties of the local cluster population, and in the highest mass regime; uncovering the provenance of non-gravitational heating; measuring how their gas is shaped by the collapse into dark matter haloes and the mergers that built today's clusters; resolving the major uncertainties in mass determinations that limit cosmological inferences; building the foundation for cluster science with next-generation surveys.

Weak Gravitational Lensing Studies from Space Missions (ISSI – ISSI Beijing Team)

Team leader: Zuhui Fan, Peking University and Yun Nan University, China
Session: 18–20 December 2018
Scientific Rationale: Arising from light deflections by large-scale structures in the Universe, the weak gravitational lensing (WL) effect has been identified as one of the most important probes in cosmological studies, in particular for understanding the nature of dark matter and dark energy, and the law of gravity. WL effects result in only tiny shape distortions (namely shear) and flux magnifications on background objects. Extracting their signals accurately is therefore highly challenging observationally, methodologically, and statistically. Space-borne missions have unique advantages of being devoid of terrestrial atmospheric impacts to achieve stable high-resolution observations. For both the ESA Euclid mission and the Chinese Space Station Optical Survey (CSS-OS), WL studies are the key science driver. They target at accurate photometric measurements for over a billion galaxies to extract WL signals. Together with the 3-D galaxy distribution from spectroscopic observations, precision cosmological studies can be achievable with an order of magnitude higher statistical power compared to the current surveys. To realize such huge capabilities, systematic errors need to be thoroughly understood and controlled. Developing different statistical methods to fully use the data is also greatly important. The Team investigates these critical issues and explores the synergy and complementarities of Euclid and CSS-OS.

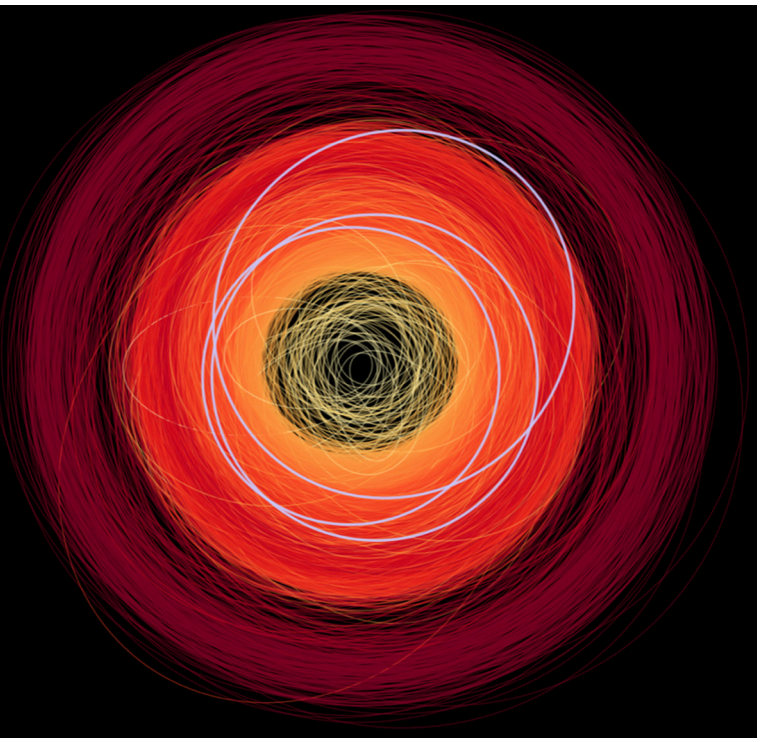


This map shows the distribution of dark matter in a portion of our Universe. It was created with the help of "weak gravitational lensing" – a natural phenomenon that occurs when light from distant galaxies is slightly warped by the mass of galaxies and clumps of dark matter in the foreground. (Image Credit: NASA/ESA/ Caltech)

Synergy between Satellite and Ground Based Observations for the Study of Middle Atmosphere Dynamics

Team leader: Alain Hauchecorne, LATMOS, CNRS, Guyancourt, France
Session: 4–8 March 2019
Scientific Rationale: The middle atmosphere (MA; stratosphere and mesosphere, 12 to 90 km altitude) is a transition region between the troposphere under the direct influence of anthropogenic activity and the upper atmosphere (thermosphere and ionosphere) at the edge of the space and strongly impacted by the solar activity. The MA is then under the conjugated influence of climate changes, due to anthropogenic activities and natural vari-

International Teams



While scanning the sky to chart a billion stars in our Milky Way galaxy, ESA's Gaia satellite is also sensitive to celestial bodies closer to home, and regularly observes asteroids in our Solar System. This view shows the orbits of more than 14,000 known asteroids (with the Sun at the center of the image) based on information from Gaia's 2nd data release in 2018. (Image Credit: ESA/Gaia/DPAC)

ability. The goal is to bring experts from different middle atmospheric observational communities together in order to evaluate and benefit from the complementarity and synergy between data recorded by ground based and by satellite based platforms. A better representation of the MA dynamics will be beneficial not only to the MA research community, but it will also pave the way for enhanced use of these data in the a broader atmospheric modeling context, in numerical weather prediction, and in climate modeling communities.

Can Magnetic Reconnection Explain the Discrete Aurora?

Team leader: Michael Hesse, University of Bergen, Norway
Session: 29 April – 3 May 2019
Scientific Rationale: Despite a multitude of past research activities, we still do not understand the physical mechanism behind one of the most captivating space phenomena visible to humans: the aurora. A diverse number of processes have been identified to operate in context with auroral activity, including double layers, various features of ion and electron distribution functions, wave activity, as well as convection associated with converging electric fields. All these processes are, without a doubt, important pieces of the puzzle, the elusive solution of which will reveal to us how the auroral acceleration region works as a combination of all these processes. A hint of a possible solution has been recognized a long time ago. We know that auroral acceleration occurs in conjunction with current sheets and parallel electric fields. Consequently, it has been suggested by Atkinson and by Haerendel that aurora should, in some form, be associated with magnetic reconnection at the auroral acceleration site. With the measurements of the Magnetospheric Multiscale mission and the rapid development of reconnection theory and modeling, the Team is now in the position to explore this idea. The scientists combine knowledge of auroral processes with knowledge of the kinetic physics of reconnection to explore whether magnetic reconnection in the auroral acceleration region can be the glue between the known auroral phenomena, and whether it can ultimately explain the nature of auroral acceleration.

Pristine

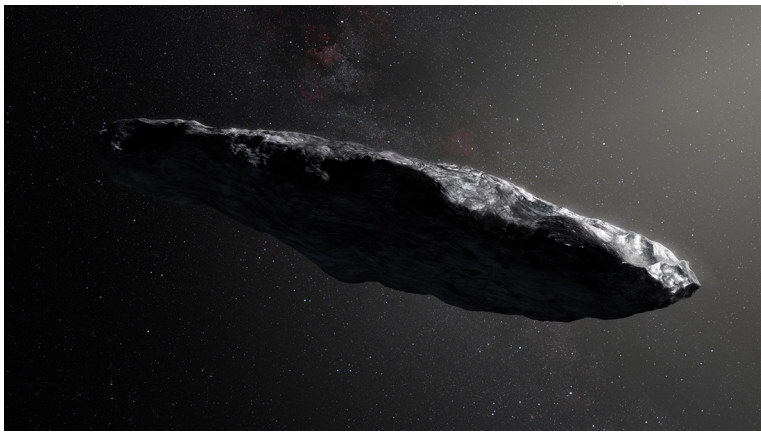
Team leader: Pascale Jablonka, École Polytechnique de Lausanne, Sauverny, Switzerland
Session: 7–11 January 2019
Scientific Rationale: The Team has designed the largest and most efficient survey of the very metal-poor tail of the Milky Way stellar halo, Pristine. A total 3,000 deg^2 has been imaged with MEGACAM in a new narrow band CaH&K filter at the Canada France Hawaii telescope. As such, Pristine will produce the most unbiased photometric metallicity distribution and substructure search of the metal-poor Galactic halo. At full completion, it will clearly change the observational landscape of near-field cosmology. A companion survey, targeting the Milky Way dwarf satellites in the Northern Hemisphere, has been designed with a similar strategy. For the first time, one is able to reach the outskirts of these small systems, opening new venues such as the ability i) to derive accurate dynamical masses – this is essential to the quest of the nature of the dark matter –, and ii) to conduct robust comparisons with the Milky Way halo – a crucial step forward for our quest to understand galaxy formation. The goals are successfully reached in full synergy of a large variety of expertises. This includes: low and high resolution spectroscopic follow-ups – with in particular the preparation of WEAVE – precision photometry, derivation of chemical abundances, NLTE corrections, dynamical modeling. While the ESA Gaia mission's data releases will each be an invaluable boon for Pristine, the Team is also committed to provide calibrators to Gaia, in the extremely metal-poor regime.

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: 25 February – 1 March 2019
Scientific Rationale: The Sun is an efficient particle accelerator. However, the relation between different energetic particle populations is not well-established. Observational studies during the RHESSI era demonstrated the still poorly understood existence of a connection between solar flare signatures of accelerated electrons at the Sun and the corresponding solar energetic particles (SEPs) detected at 1 AU. A fundamental question then arises: can these distinctly observed electron populations come from the same flare-acceleration region or be drawn from the same population of electrons. Observational and theoretical studies alone cannot satisfactorily address this question. Therefore, the Team aims to combine state-of-the-art multi-instrument observations with kinetic modeling that simultaneously studies the acceleration and transport of flare-accelerated electrons toward and away from the Sun in the varying plasma conditions of the extended solar atmosphere. The Team probes various electron transport mechanisms (collisional and non-collisional) in different parts of the solar atmosphere, and combines them with detailed interplanetary transport modeling and multi-spacecraft observations. This will lead to a greater understanding of the important physical processes that modulate the populations during their transport, helping them to study flare particle acceleration from multiple perspectives.

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: 26–30 November 2018
Scientific Rationale: The first interstellar object detected in our sßolar system, 1I/'Oumuamua, was the subject of a short but intense observing campaign after its discovery in October 2017. Its faintness meant that most observations were restricted to the first week post-discovery. Yet because the existence of these objects had been anticipated for decades, within weeks a wealth of papers had already been published, and the literature continues to expand rapidly as researchers in diverse fields consider its implications. The astronomical community (and general public) remain excited with interest in 'Oumuamua. It is possible that another 1–2 interstellar objects will be discovered in the next 4–5 years, after which it is anticipated that future large surveys like the Large Synoptic Survey Telescope will discover approximately one per year. The variety of fields impacted by the discovery of 'Oumuamua underscores the need for experts in several areas to collaborate and form a coherent picture of this object and what it tells us about the population from which it came. The Team brings a diverse set of observational and theoretical expertise in small body physical properties and evolutionary processes, solar system formation and evolution, planetary dynamics, stellar kinematics, population statistics, solar system surveys, and space missions.



Artist's impression of the first interstellar asteroid 'Oumuamua. In July 2019, the 'Oumuamua Team published a paper in Nature Astronomy explaining how this asteroid was consistent with natural phenomena. The paper used the Team members' broad expertise in planetary system formation and evolution, star clusters, dynamics, small solar system bodies, and surveys to synthesize the community's rapidly expanding studies of 'Oumuamua into a concise and accessible overview of this puzzling object. (Image Credit: ESO/M. Kornmesser)

Are We Doing the Right Satellite Observations and Analyses for Quantifying Cloud-Mediated Aerosol Climate Forcing?

Team leaders: Alexander Kokhanovsky, VITROCISET, Darmstadt, Germany and Daniel Rosenfeld, The Hebrew University of Jerusalem, Israel
Session: 4–8 March 2019
Scientific Rationale: The magnitude and scale of global aerosol-cloud interactions and their influence on the anthropogenic radiative forcing remain key unanswered questions in atmospheric science. The aerosol-cloud mediated radiative forcing uncertainty has remained stubbornly high in global climate models throughout the IPCC reports, playing a major role in the overall uncertainty of anthropogenic climate forcing. The answers to these questions require deep understanding of aerosol and cloud distributions both in space and time, based on

global observations that are practical only from satellites. The lack of significant advancement occurs despite the tremendous amount of data that is accumulating at an accelerating pace. This calls for innovative thinking about the fundamentals of these measurements and their relevance for quantifying aerosol-cloud interactions and their climatic effects. In particular, there is emerging evidence that the optical signature is frequently too weak to retrieve accurate cloud condensation nuclei (CCN) from atmospheric aerosol particles in the marine boundary layer. At low CCN concentrations, small variations in absolute concentration, indiscernible from satellites, constitute very large relative changes that may strongly affect cloud cover and albedo. Another obvious limitation is that cloud properties are determined by both aerosols and updrafts and, further, by mixing processes and by precipitation, but satellites generally constrain only the former. Further, standard remote-sensing retrievals provide cloud drop effective radius and optical depth (two extensive quantities that are dependent on cloud liquid- or ice water path), whereas what is needed are cloud particle concentrations (droplets or ice crystals) and water path. There is therefore an urgent need to evaluate the quality and limitations of the available datasets and propose new approaches of analyses of the existing data. In particular, techniques to develop simultaneous aerosol and cloud retrieval algorithms for global observations are urgently needed. Essential remaining gaps will be identified and addressed by recommending new satellite missions targeted at filling these gaps. The Team aims to solidify our understanding of these issues and make substantial progress towards quantifying the strength of aerosol-cloud interactions and their associated radiative forcing.

Cross-Calibration of Laser-Induced Breakdown Spectroscopy (LIBS) Instruments for Planetary Exploration (ISSI – ISSI Beijing Team)

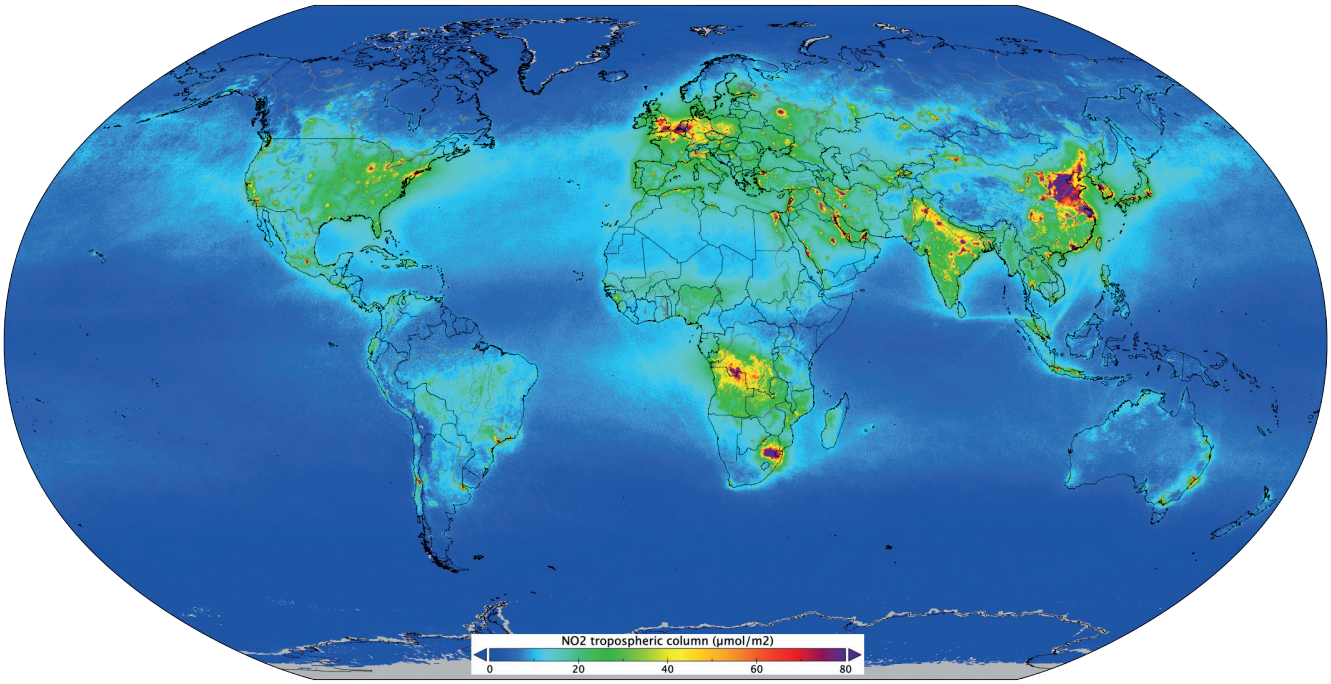
Team leaders: Jérémie Lasue, Université de Toulouse, IRAP, France and Roger Wiens, Los Alamos National Laboratory, USA
Session: 29 April – 3 May 2019
Scientific Rationale: LIBS is a revolutionary new technique to study planets. It uses a pulsed laser to ablate material of interest at a distance. The light from the spark can be analyzed by spectrometry to determine the elemental composition of the target. Since 2012, LIBS is successfully used on Mars to explore the geology of Gale Crater with the Mars Science Laboratory rover and the ChemCam instrument. LIBS in space is becoming international. In the next couple of years, more LIBS instruments will be sent for planetary exploration by teams in China, Europe, India, Japan and the US. The goal is to discuss the technique and its calibration and share tools to help further planetary exploration using LIBS.

Negative Ions in the Solar System

Team leader: Charles Lue, Swedish Institute of Space Physics, Kiruna, Sweden
Session: 21–25 January 2019
Scientific Rationale: Though no negative ion sensor has flown outside of the Earth, a range of measurements have been done using electron data sets. Such observations have taught and will teach a lot about space-planet interactions, aeronomy, atmospheric chemistry, and surface evolution. The Team makes data analyses of electron, energetic neutral atom, and radar data sets, informed by model simulations and the experience from recent observations, to constrain negative ion populations at different objects in the Solar System. The Team addresses three science questions linked to three distinct types of planetary negative ion distributions: 1) What is the release and escape rate of volatiles from the Moon?, 2) What is the role of meteoric dust and negative ion cluster formation for the atmospheric chemistry at Mars?, 3) What is the extent of overlap between solar wind plasma and neutral atmospheres/exospheres of Mars and Comet 67P/Churyumov-Gerasimenko?. Each of these questions are addressed by specifically targeting the negative ions aspect. These findings strongly complement previous positive ion and neutral observations.

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: 18–22 February 2019
Scientific Rationale: The magnetosphere, ionosphere and thermosphere (MIT) act as a coherently integrated system (geospace), driven in part by solar influences and characterized by variability and complexity. The manifestation of this variability and complexity is known as space weather, which refers to the effects of solar energy in geospace that threaten the technological infrastructure that powers the world. Space weather events also known as "geomagnetic storms" can disrupt the operation of power grids, magnetic surveying and directional drilling for oil and gas. These storms also heat the ionosphere-thermosphere (~100–1000 km altitude), changing density and composition and disrupting radio communications and Global Navigation Satellite Systems (GNSS). Storm-driven charged particles and radiation throughout geospace are a hazard to the health of astronauts, passengers on high altitude flights and all space-based technologies. The Team investigates the following questions: 1.What are the quantitative uncertainties in (existing) particle precipitation and ion



Measurements gathered by the Copernicus Sentinel-5P mission between April and September 2018 have been averaged to reveal nitrogen dioxide in the atmosphere. The data were averaged and gridded on a regular latitude-longitude grid of about 2 x 2 km. Nitrogen dioxide pollutes the air mainly as a result of traffic and the combustion of fossil fuel in industrial processes. (Image Credit: Copernicus data (2018), processed by KNMI)

outflow models? 2. To what extent do these uncertainties propagate to uncertainties in critical space weather parameters of the magnetosphere and ionosphere (e.g., magnetospheric composition, ionospheric conductivity)? 3. To what extent can neural networks yield improved models of particle precipitation and ion outflow, and, ultimately, improve space weather forecasts?

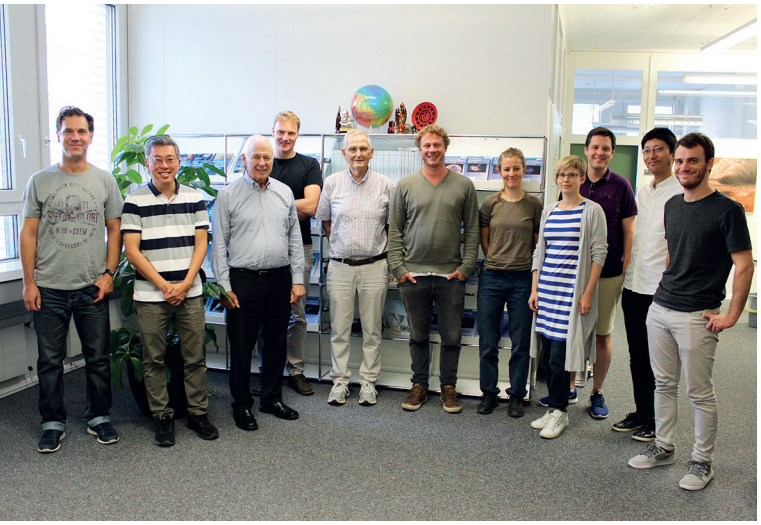
Relativistic Electron Precipitation and its Atmospheric Effect (ISSI – ISSI Beijing Team)

Team leader: Irina Mironova, St. Petersburg State University, Russia
Session: 14–18 October 2018
Scientific Rationale: The goal is to obtaining progress in understanding of High Energy Electron Precipitation (HEEP) into the Earth atmosphere and their atmospheric effects. In order to reach the goal, the Team combines world-class experts in complementary disciplines, such as space physics, atmospheric chemistry and climate, theoretical modeling, experimental setups, etc. Many issues are related to determination of characteristics of spectra, magnitude and temporal duration of HEEP, beginning burst and continuance of precipitation in different magnetic latitudes during and without a geomagnetic storm; chemical and electrical atmospherical changes are induced by HEEP and to many other issues that are defined during the Team meetings.

Looking at the Disc-Jet Coupling from Different Angles: Inclination Dependence of Black-Hole Accretion Observables

Team leaders: Sara Elisa Motta, University of Oxford, United Kingdom and Piergiorgio Casella, National Institute for Astrophysics (INAF), Monteporzio Catone, Italy
Session: 29 October – 2 November 2018
Scientific Rationale: The Team intends to investigate the dependence of the observed properties of (black hole / neutron star) X-ray binary systems on their orbital inclination, and the inflow/outflow coupling in accreting systems. The Team addresses the following major questions: which properties of accreting X-ray binaries are inclination-dependent (e.g., related to the jet and inner accretion flow emission)? Can we unify any of the observed phenomenology by considering the inclination dependence? What can the inclination-dependence of X-ray absorption lines / radio jet emission tell us about the geometry of the disc winds / the jet Lorentz factors? Are these properties constant with time, or do they evolve throughout the different spectral-timing states of an outburst? Answering these fundamental questions requires a multi-wavelength approach as well as the development of improved theoretical models.

International Teams



Members of the G. Paschmann and T. Phan Team studying on the Physical Processes in Magnetopause and Magnetosheath Current Sheets Using a Large MMS Database met in September 2018. (picture taken by S.F. Saliba, ISSI)

High EneRgy sOlar partICle Events Analysis (HEROIC)

Team leader: Athanasios Papaioannou, National Observatory of Athens, Greece
Session: 26–30 November 2018
Scientific Rationale: Ground-level enhancements (GLEs) comprise the high-energy end of solar energetic particle (SEP) events and constitute a special class of events in which ions are accelerated to relativistic energies, causing a significant sudden increase of solar cosmic rays at ground level, as detected by e.g., neutron monitors (NMs). Given their extremity, these high energy SEP events are also being recorded by spacecraft in the space covering a wide energy range (up to a few GeV). Evidently, the existence of such high-energy SEP events poses a challenge and creates new opportunities for a breakthrough in our understanding of energetic particle acceleration. The Team members identify a number of such events to be analyzed in detail, employing both remote and in-situ observations. The scientists bring together, particle measurements from the ground (NMs), and the inner heliosphere (Solar and Heliospheric Observatory – SOHO, Solar and Terrestrial Relations Observatory – STEREO, Advanced Composition Explorer – ACE, Geostationary Operational Environmental Satellite – GOES, Alpha Magnetic Spectrometer – AMS-02, Payload for Antimatter Matter Exploration and Light-nuclei Astrophysics – PAMELA), which will be further inter-calibrated. Comparisons will be made with the modeling output and the current theories on the particle acceleration will be tested against our findings.

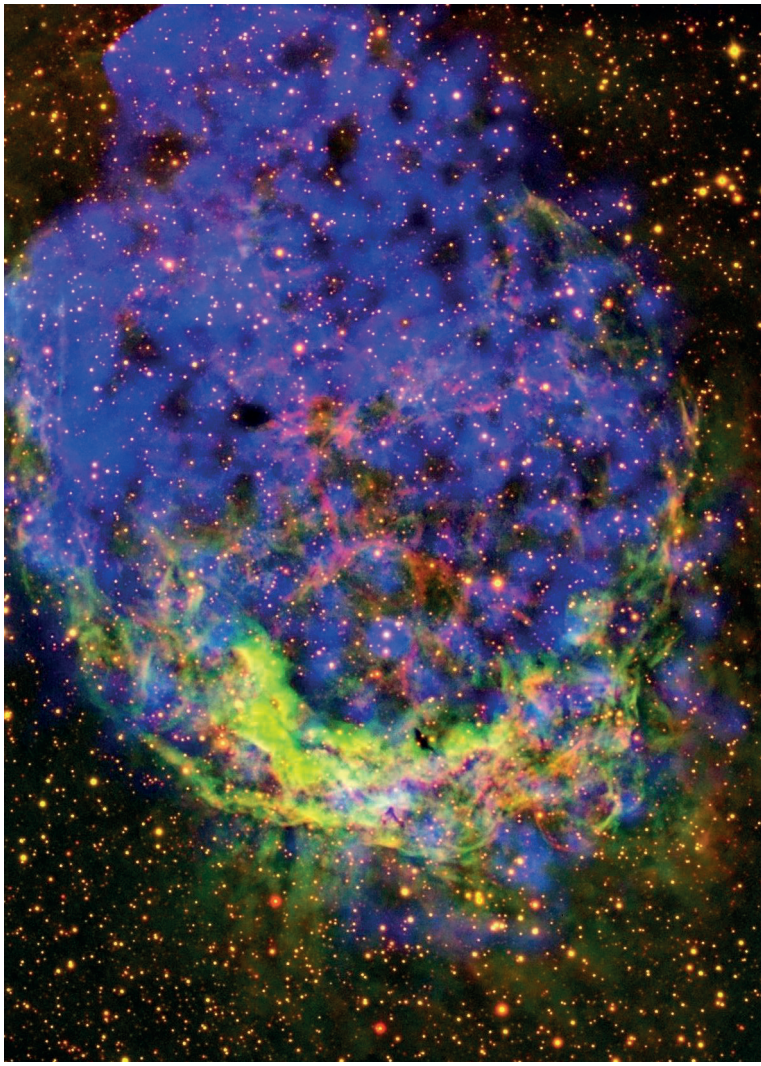
Study of the Physical Processes in Magnetopause and Magnetosheath Current Sheets Using a Large MMS Database

Team leaders: Götz Paschmann, Max-Planck-Institut für extraterrestrische Physik, Garching, Germany and Tai Phan, University of California, Berkeley, USA
Session: 10–13 September 2018
Scientific Rationale: The primary objective of the Magnetospheric Multiscale mission is to study the physics of magnetic reconnection in current sheets using plasma and field measurements of unprecedented resolution. A major obstacle to answering fundamental reconnection questions with MMS is being able to efficiently and quickly examine the basic properties of a large number of current sheets captured by MMS and identify events for further study. A new database of MMS current sheet observations, initially built by the Team and hosted by ISSI, includes 8670 magnetopause and magnetosheath current sheet crossings. This database remains to be fully exploited, and so the Team uses this database to address some key unanswered questions concerning the structure and dynamics of magnetic reconnection and other processes in current sheets. The studies require the examination of a large number of current sheet crossings by MMS, and benefit from the existence of a large database of MMS current sheet observations. The initial data base is expanded as part of the Team's activities. Some of the studies are built on previous single-event studies and establish the statistical properties of the processes and their dependence on a variety of boundary conditions, while others use the large data base to identify promising candidates for further analysis, or to select rare events of importance. The database is expanded as part of the Team's activities, documented, and promoted to the community.

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: 19–23 November 2018
Scientific Rationale: The Team aims at constraining the knowledge of our Galaxy formation and evolution using the coming second data release of the Gaia mission. The availability of the Gaia data gives the opportunity to improve our understanding of the physical processes on-going in Galaxy formation and evolution. Gaia provides complete samples with an accuracy never reached before on parallaxes and proper motions, 6D space informations for million of stars. Gaia data are also very well complementary with ground based spectroscopic surveys such as APOGEE, Gaia-ESO and forthcoming WEAVE surveys.

In the last 30 years, we have developed a method to interpret complex data sets for Galaxy evolution studies, based on the population synthesis approach. The Besançon Galaxy Model (BGM) incorporates a scenario for the formation and evolution of the Milky Way and translate it into simulations of observations, taking into account selection effects and observational errors. This approach allows to confront our understanding of the physics of Galaxy evolution in detail, including various aspects, dynamics, stellar evolution, interstellar matter distribution, with real data through simulations. Changing the scenario and the underlying hypotheses, and confronting the resulting simulations with real survey data, will allow us to constrain our knowledge about galactic evolution, and to reach a global self-consistent view of the installation of the Galaxy components along the evolution of the Milky Way, including non-stellar components, such as interstellar matter and dark matter. The Team aims at combining the expertises in the development of this approach in the analysis of Gaia data. Meetings help to discuss in detail and to exploit Gaia data to 1) Compare model simulations, testing several hypothesis, with Gaia data, allowing to detect possible inconsistencies, and correcting hypothesis via Monte Carlo Markov Chain methods; 2) obtain a comprehensive view of the Galactic plane sub-structures, in particular the bar, spiral arms, warp and flare, taking into account the dynamics; 3) set constraints on stellar physics by confronting the star models used in the population synthesis with luminosities measured by Gaia, complemented by spectroscopy and asteroseismology; 4) provide efficient tools to compute orbits for stars observed with Gaia, and make these tools available on line for the community.



This turbulent celestial palette of purple and yellow shows a bubble of gas named NGC 3199, blown by a star known as WR18 (Wolf-Rayet 18). (Image Credit: ESA/XMM-Newton; J. Toalá; D. Goldman)

Chemical Abundances in the ISM: The Litmus Test of Stellar IMF Variations in Galaxies Across Cosmic Time (ISSI – ISSI Beijing Team)

Team leaders: Donatella Romano, INAF-Osservatorio Astronomico di Bologna, Italy and Zhi-Yu Zhang, University of Edinburgh, United Kingdom

Session: 7–11 January 2019

Scientific Rationale: For three decades it has been speculated that the stellar initial mass function (IMF) is more biased towards massive stars in starburst environments, especially in massive galaxies at high-redshift, which could explain the overabundance of magnesium (mostly synthesised in high-mass stars) with respect to iron (mostly produced by type Ia supernovae with relatively low-mass progenitors) observed in local elliptical galaxies. However, differences in star-formation time scales and/or the presence of selective galactic outflows could act in a similar way. The scientists aim at building up an international collaboration whose members have all the necessary expertise to (i) reduce significantly the uncertainties present in abundance measurements, (ii) extend the measurements to different types of galaxies, from dwarfs to ellipticals, at both high and low redshifts, (iii) improve – or develop from scratch – the theoretical tools that are necessary for a full exploitation and interpretation of the data. The Team is composed of ten scientists from five European countries and from China. It includes experts in numerical simulations, semi-analytical models of galaxy formation in a cosmological context, state-of-the-art hydro-dynamical simulations, stellar evolution and nucleosynthesis, chemical evolution, IGIMF theory, as well as experts in ISM physics, molecular line observations and data analysis.

International Teams

Artist's impression showing the view from the surface of one of the planets in the TRAPPIST-1 system. At least seven planets orbit this ultra cool dwarf star 40 light-years from Earth and they are all roughly the same size as the Earth. They are at the right distances from their star for liquid water to exist on the surfaces of several of them. (Image Credit: ESO/N. Bartmann/spaceengine.org)

COSWEB: The Cosmic Web and Galaxy Evolution

Team leader: Gregory Rudnick, University of Kansas, Lawrence, USA

Session: 21–25 October 2019 (BY 25)

Scientific Rationale: Starting over thirty years ago, astronomers began to suspect that the density of a galaxy's surrounding, orit's "environment" affects its evolution. Compared to the average galaxy, or "field" galaxy, those residing in high density regions have systematically older stellar populations, lower star formation rates (SFR), and are most dominated by spheroidal morphologies. In the past decade, large surveys of galaxies with ground-based telescopes have cemented the existence of these environmentally-dependent differences. However, the physical mechanisms by which galaxies are altered as they enter dense environments have not yet been conclusively identified and we do not know where different processes dominate. Two elements are largely missing from current analyses: 1) information about the gaseous fuel for starformation (SF) and 2) a proper treatment of dense filamentary environments, rather than a simplistic focus on clusters, groups, and field populations. The Team has a unique approach to addressing these shortcomings by both characterizing the stellar and gaseous contents of galaxies over a large range in look back time and by focusing much of our effort on studying galaxies in filaments, the site where many galaxies first encounter a dense environment. This powerful approach requires bringing together many different data sets and comparing them in a consistent way to the theoretical models.

Linking Solar and Stellar Variabilities

Team leader: Alexander Shapiro, Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany

Session: 11–15 February 2019

Scientific Rationale: The aim is to bring together experts in solar variability, stellar physics, and data analysis to achieve two fundamental goals: 1. Apply our knowledge of the Sun to understand stellar brightness variations and thus improve the techniques for detection and characterization of exoplanets. 2. Analyze newly-available stellar photometric data to assess the full possible range of solar variability. These goals are prompted by the recent progress in modeling of solar/stellar atmospheres and new state-of-the-art stellar photometric data. In particular: The understanding of solar brightness variations has dramatically improved over the last few years due to extended measurements having improved precision and stability; New 3D magneto-hydrodynamic (MHD) simulations of flows and magnetic fields in the near-surface layers of the Sun and stars as well as time-efficient radiative transfer codes now make it possible to extend very successful models of solar brightness variations to other stars; An unprecedented level of photometric precision of broadband stellar photometry has been achieved by the CoRoT and Kepler space-based missions and is anticipated with the launch of the TESS, CHEOPS, and PLATO missions, while automated ground-based telescopes have dramatically increased the number of stars observed over their activity cycles. Intrinsic stellar brightness variation is a limiting factor for exoplanet characterization via transit photometry. Similarly, solar brightness variability is one of the main natural forcings of Earth's climate system. Consequently, the stated goals G1 and G2 have far-reaching implications that go well beyond solar and stellar physics. Furthermore, by helping experts in stellar and solar brightness variations work together the Team aims to bring closure to the long-time question of whether solar variability is typical or anomalous with respect to stars with near-solar age.

Cold Plasma of Ionospheric Origin: Implication for Magnetospheric Dynamics

Team leader: Sergio Toledo-Redondo, IRAP CNRS, Toulouse, France

Session: 6–10 May 2019

Scientific Rationale: The Team advances the current understanding of the importance of cold ionospheric plasma that is present in the Earth's magnetosphere. Low energy (1–100 eV) light and heavy ions as well as electrons are known to escape from the ionosphere and populate most regions of the magnetosphere. Together with the solar wind, they are the main source of magnetospheric plasma, and there are a large number of studies

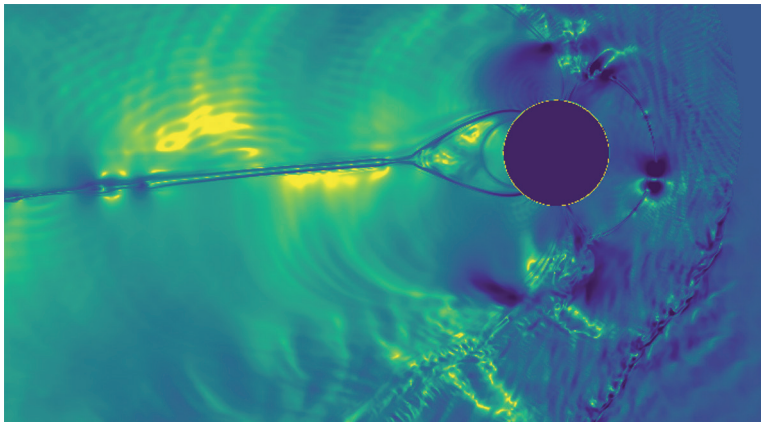
addressing their occurrence and variability. Past studies have also demonstrated that ionospheric cold plasma is important to the global dynamics of the Earth's magnetosphere. For instance, it constitutes a non-negligible fraction of the plasma density in the outer magnetosphere, where magnetic reconnection with the solar wind takes place, changing the reconnection rate between the solar wind and the Earth's magnetosphere. Moreover, ionospheric outflows are an important source of cold plasma in the Earth's magnetotail, where magnetic reconnection also occurs and a large amount of energy stored by magnetic fields is converted into kinetic energy of the ionospheric particles, which can then populate the plasma sheet and the ring current.

Global Study of the Transmission of Foreshock ULF Waves into the Magnetosheath and the Magnetosphere

Team leaders: Lucile Turc and Minna Palmroth, University of Helsinki, Finland
Session: 6–10 May 2019
Scientific Rationale: ULF waves play a central role in the dynamics of the inner magnetosphere. They are thought to be an important mechanism for energy transfer from the solar wind to magnetosphere and for accelerating and scattering higher energy particles in the radiation belts. They can also result in adverse space weather effects, such as errors in GPS signals, enhanced Joule heating, and geomagnetically-induced currents. The generation of magnetospheric ULF waves remains however an outstanding question in the field. The aim is to advance significantly the understanding of the foreshock-driven magnetospheric ULF waves. The scientists study in a global manner their transmission across the foreshock-magnetosheath-magnetosphere system, using a combination of spacecraft and ground-based measurements and numerical simulations. The work focuses on the detailed analysis of several events, corresponding to different solar wind conditions and levels of geomagnetic activity. This observational study is complemented with a numerical study using the Vlasiator simulation code (see image on the right). Vlasiator provides global simulations of the magnetosphere while retaining ion kinetic processes, and is thus an ideal tool to investigate the transmission of foreshock waves across geospace.

The Nature and Physics of Vortex Flows in Solar Plasmas

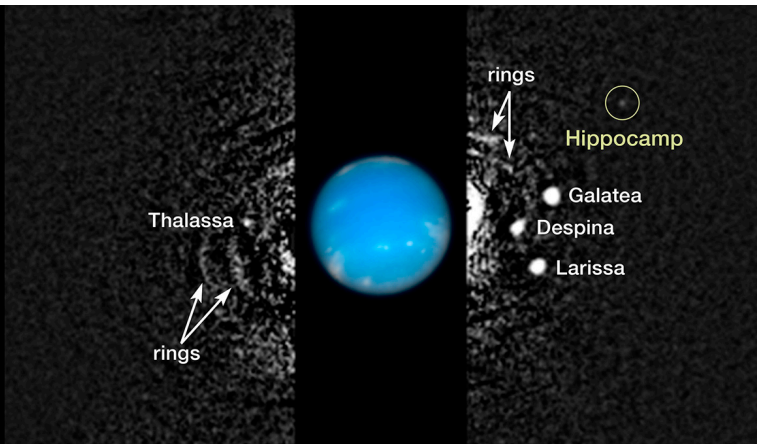
Team leaders: Kostas Tziotziou, National Observatory of Athens, Greece and Eamon Scullion, Northumbria University, Newcastle upon Tyne, United Kingdom
Session: 4–8 February 2019



Ultra-low frequency waves in near-Earth space, as simulated with the Vlasiator global model. Color-coded is the magnitude of the electric field, whose fluctuations reveal wave activity in the Earth's plasma environment. This model allows the Team, led by L. Turc and M. Palmroth, to study the propagation of the waves from their source region into the other regions of near-Earth space. (Image Credit: Vlasiator)

Scientific Rationale: High-resolution and high-cadence solar observations from the ground and from space have revealed the existence of abundant vortex motions observed both in quiet and active regions and at all layers of the solar atmosphere. Such motions are present across a broad range of temporal and spatial scales, result mainly from the interaction between turbulent convection and magnetic fields and play a crucial role in the plasma dynamics at the different solar atmospheric layers, hence providing a mechanism for channeling energy from the photosphere up to the low corona. The Team includes experts in plasma physics and in solar physics (theory, observations and advanced 3D Magneto-HydroDynamic (MHD) simulations). It investigates the detailed physics and dynamics of vortex flows as seen in high-resolution, multi-wavelength observations and predicted from state-of-the-art simulations in an attempt to understand the nature and physics of vorticity in the solar atmosphere, its association to atmospheric structuring, magnetic field and generation/propagation of waves and its implications for chromospheric and coronal heating. The Team is timely as it coincides with first-light observations in 2019 from the 4-m Daniel K. Inouye Solar Telescope (DKIST) that is going to be the most powerful solar telescope ever built, opening a new window for the observation of small-scale structures, such as swirls, down to a 20-km spatial resolution and where Team members participate in its Critical Science Plan with a Science Use Case concerning the multi-scale nature of vorticity in the solar atmosphere. Advancements in observations, theory and simulations are discussed, thus generate new results and collaborations in this field.

International Teams



This composite image shows the location of Neptune's moon Hippocamp, formerly known just as S/2004 N 1, orbiting the giant planet Neptune. (Image Credit: NASA, ESA, M. Showalter (SETI Institute))

Magnetic Helicity in Astrophysical Plasmas

Team leaders: Gherardo Valori, University College London, United Kingdom and Etienne Pariat, Observatoire de Paris-Meudon, France
Session: 17–21 December 2018
Scientific Rationale: Magnetic helicity is a general measure of the twist and mutual linking of magnetic field lines that has recently received wide attention from different areas of Astrophysics. The Team formed by experts in magnetic helicity studies from different disciplines, such as stellar dynamos, solar corona and coronal mass ejections, magnetic turbulence and reconnection, both in theoretical models as well as in numerical simulations and solar observations. The main objective is to bring helicity estimation methods that were developed in different fields under the same theoretical framework, so that they can be meaningfully compared with each other, and quantitatively benchmarked. In particular, the Team considers helicity computations based on spectral methods applied to periodic domains (as used in free decaying turbulence and solar wind studies) and non-periodical domains (more typical of low-corona solar applications), and compares them with the finite-volume and flux-injection methods typically used in magneto-hydrodynamical simulations as well as in solar observations. Novel methods applying helicity estimations to individual field lines and their application to volume-filling fields are also included. The comparison between different methods is performed using numerical simulations as controlled test-cases to provide quantitative benchmarking and clear indications of the methods' limitations and assumptions. Their application to observed solar data, on the other hand, will allow to confront such methods with the additional complexity of real observations.

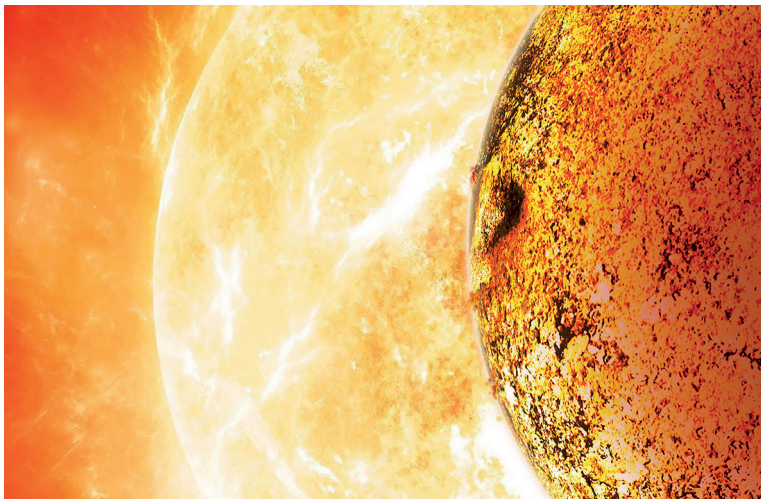
Ice Giants: Formation, Internal Structure, and the Link to Exoplanets

Team leaders: Julia Venturini, International Space Science Institute, Bern, Switzerland and Ravit Helled, University of Zurich, Switzerland
Session: 5–8 February 2019
Scientific Rationale: The formation of Uranus and Neptune is still an open question in planetary science. According to the standard model of giant planet formation, protoplanets in the mass regime of ~15 Earth masses are expected to accrete gas rapidly. Therefore, the termination of gas accretion at the exact mass of the ice giants needs to be explained. In addition, exoplanets with sizes (and masses) similar to Uranus and Neptune are found to be very abundant in the galaxy, suggesting that their formation mechanism is very efficient. The aim is to discuss and explore the possible formation pathways of such planets (i.e., Neptune-like, mini-Neptunes). The Team also concentrates on the predicted compositions and internal structure of Uranus and Neptune, their long-term evolution, and how a better understanding of these planets can be used for exoplanetary characterization. This will be used for the interpretation of data from the upcoming exoplanetary space missions (e.g., CHEOPS, TESS).

Outcome of Collisions in the Early Outer Solar System

Team leader: Jean-Baptiste Vincent, DLR German Aerospace Center, Berlin, Germany
Session: 30 January – 1 February 2019
Scientific Rationale: The processes leading to the formation of planetary systems leave behind a significant mass of small bodies orbiting at large heliocentric distance, up to 35 Earth masses depending on the models, observed around 20% of Sun-like stars. It is established that those bodies play an important role in the migration of gas giants away from their stars and may be necessary for life to develop on the smaller planets. Yet, the conditions within these primitive populations are not well understood, especially their collisional environment. In the last decade, space missions have brought fascinating new data which challenge our concepts of impacts in the Early Solar System. The mission Rosetta at comet 67P, for instance, has revealed a complex cometary world where collisions, from small to catastrophic, played a significant role. Recent work suggests that the topography of cometary nuclei and potential layering are shaped by processes, which are primarily ancient. On a larger scale, dynamical simulations argue that objects like the Jupiter Family Comets may have been totally disrupted by catastrophic collisions. While models show that the high porosity and volatile content of cometary nuclei would

survive such impacts, it is not clear whether the deeper structural features like layers can be preserved. From the same data set, different authors (Blum, Davidsson, Morbidelli, Rickman) come to different conclusions with respect to collisions in the early outer planetary system. Furthermore, different modeling approaches (de Niem, Jutzi, Schwartz) lead to distinct results. The concept of the Team is to bring together for the first time experts on collisions and cometary morphology. Over the last few years, modelers have developed new numerical simulations, which are now able to properly treat cometary-like material. In parallel, thanks to the Rosetta mission, small bodies morphologists have a much better understanding of the type of landform that can exist on comets, and measurements of the material physical properties. By combining the expertise, the Team aims to assess the role of impacts in the formation and evolution of comets, as well as properly benchmarking and comparing the different modeling approaches. This work will lead to a new understanding of impact processes in the Solar System history and provide very strong constraints on the formation and evolution of objects at large heliocentric distance, with applications beyond our own system.



Exoplanet Kepler-78b whizzes around its host star every 8.5 hours, making it a blazing inferno and not suitable for life as we know it. (Image Credit: D.A. Aguilar, CfA)

Towards Earth-like Alien Worlds: "Know thy Star, Know thy Planet"

Team leader: Christopher Watson, Queen's University Belfast, United Kingdom
Session: 10–14 December 2018
Scientific Rationale: While over 3,000 exoplanets have been discovered to date, no planet has been found that remotely resembles an Earth-analogue (here defined as an Earth-like planet in an Earth-like orbit around a solar-like star). While planets have been found that resemble Earth in terms of their radius and mass, many of these are in extreme orbits. This includes planets such as the lava-world Kepler-78b, which orbits its host star in just 8.5 hours! Terrestrial planets have also been found orbiting within the temperate zone of low-mass cool stars, where their far shorter orbital periods make them relatively easy to detect (e.g., Trappist-1). However, the tight orbits of these planets raise severe questions as to their true potential for habitability. Lying in such close proximity to their stars, flares may strip away any atmosphere. Furthermore, the accompanying X-rays would also be harmful to biological material and deplete water via disassociation. Tidal locking may also slow the planet's spin period to match its orbital period – potentially shutting down the planet's protective magnetic shield. In addition, this could cause a global collapse in the atmosphere as it freezes out on the permanent night-side. For these reasons there is a drive towards the discovery of true Earth-analogues. The Team brings together experts in planet-hunting, solar physics, stellar activity, instrumentation, as well as theoretical stellar astrophysics and sophisticated signal processing techniques to probe these issues.

Resolving the Microphysics of Collisionless Shock Waves

Team leader: Lynn Wilson, NASA Goddard Space Flight Center, Greenbelt, USA
Session: 18–22 March 2019
Scientific Rationale: The Team takes advantage of the current, unprecedented temporal, angular, and energy resolution measurements from the THEMIS, Magnetospheric Multiscale (MMS), and Wind missions to conduct focused research on collisionless shock waves. The motivation for the effort derives from several key unresolved questions about the microphysical processes that regulate the dynamics of collisionless shock waves. Despite years of investigation the relative importance of quasi-static vs. high frequency electromagnetic fluctuations is not well established, the generation mechanisms and mutual interactions of several ion foreshock phenomena are not well understood, and the partition of energy among the components, including both thermal and non-thermal/accelerated populations of different particle species, lacks any quantitative understanding. The Team prioritizes the outstanding questions that can be addressed by a focused effort and resolve those issues in the collaboration. The effort is primarily drawn on bow shock observations by MMS but will coordinate with THEMIS and Wind observations. Complementary state of the art multi-dimensional, kinetic, numerical simulations is providing exploration of the context and detailed microphysical processes at work.

International Teams approved in 2019

The following listed teams have been selected for implementation from the proposals received in response to the 2019 Call for International Teams:

Complex Systems Perspectives Pertaining to the Research of the Near-Earth Electromagnetic Environment
Team leader: Georgios Balasis (GR)

Towards a Universal Framework for Merging Atmospheric Observations from the Ground and Space
Team leaders: William Ball (CH) and Daan Hubert (BE)

The Role of Partial Ionization in the Formation, Dynamics and Stability of Solar Prominences
Team leaders: José Luis Ballester (ES) and Manuel Luna (ES)

Can We Use X-Ray Reflection Spectroscopy for Precision Measurements of Accreting Black Holes?
Team leader: Cosimo Bambi (CN)

Models of VHE Emission In Pulsars: Evaluation of the Current State-Of-The-Art and Future Prospects
Team leaders: Ionnis Contopoulos (GR) and Demosthenes Kazanas (US)

Tropical Width Impacts on the Stratosphere (TWIST)
Team leader: Sean Davis (US)

Provenances of our Solar System's Relics
Team leaders: Maria Drozdovskaya (CH) and Cyrienne Opitom (CL)

A Reference Quality Model for Ocean Surface Emissivity and Backscatter from the Microwave to the Infrared
Team leaders: Stephen English (UK) and Catherine Prigent (FR)

Exploring the Solar Wind in Regions Closer than ever Observed before
Team leader: Louise Harra (CH)

The Role of Solar and Stellar Energetic Particles on (Exo)Planetary Habitability (ETERNAL)
Team leaders: Konstantin Herbst (DE) and John Lee Grenfell (DE)

Foreshocks across the Heliosphere: System Specific or Universal Physical Processes?
Team leaders: Heli Hietala (UK) and Ferdinand Plaschke (AT)

A New View of Ring-Planet Interactions from Cassini's Grand Finale
Team leaders: Hsiang-Wen Hsu (US) and Ali Sulaiman (US)

Space Weather Induced Direct Ionisation Effects on the Ozone Layer
Team leader: Antti Kero (FI)

Interrogating Field-Aligned Solar Flare Models: Comparing, Contrasting and Improving
Team leaders: Graham Kerr (US) and Vanessa Polito (US)

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 (US) and Linghua Wang (CN)

Characterization of Cometary Activity of 67P/ Churyumov-Gerasimenko Comet
Team leader: Andrea Longobardo (IT)

Understanding the Properties of the Terrestrial Gamma-Ray Flash Population
Team leader: Martino Marisaldi (NO)

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 leader: Raphael Marschall (US) and Oleksandra Ivanova (SK)

Searching for Subglacial Water on Mars with Orbiting Ground Penetrating Radars (ISSI – ISSI-Beijing Team)
Team leader: Roberto Orosei (IT)

What Determines the Dynamo Effectivity of Solar Active Regions?
Team leader: Kristof Petrovay (HU)

Modeling Space Weather and Total Solar Irradiance over the Past Century (ISSI – ISSI-Beijing Team)
Team leader: Alexei Pevtsov (US)

Cluster Physics from Space to Reveal Dark Matter: Current and Future Challenges
Team leader: Johan Richard (FR)

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 (FR) and Geoffrey Reeves (US)

A New Non-Equilibrium Model of "Iron Snow" in Planetary Cores
Team leaders: Tina Rückriemen-Bez (DE) and Chris Davies (UK)

Magnetic Open Flux and Solar Wind Structuring of Interplanetary Space
Team leader: Manuela Temmer (AT)

Understanding our Capabilities in Observing and Modeling Coronal Mass Ejections
Team leaders: Christine Verbeke (BE) and Marilena Mierla (BE)

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

Zooming in on Rocky Planet Formation
Team leaders: Rens Waters (NL) and Inga Kamp (NL)

The Identification and Classification of 3D Alfvén Resonances
Team leader: Andrew Wright (UK)

Why Ionospheric Dynamics and Structure Behave Differently in the African Sector?
Team leaders: Endawoke Yizengaw (US) and Keith Groves (US)

Deciphering Compositional Processes in Inner Airless Bodies of our Solar System
Team leader: Francesca Zambon (IT)

This image, taken by OmegaCAM on the VLT Survey Telescope at Paranal Observatory, shows a section of the Ara OB1 stellar association. (Image Credit: ESO)

Johannes Geiss Fellow 2018 and Visiting Scientists

Karel Schrijver giving a Pro ISSI talk with the title "Solar Magnetic Activity in a Nutshell, and How Stars and Exoplanets Can Help Us Understand It All" on May 8, 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 Karel Schrijver

Karel Schrijver (Lockheed Martin, Palo Alto, USA) was elected as the Johannes Geiss Fellow 2018. In the following paragraphs he answers a few questions asked by Julia Venturini, ISSI Postdoc, about his scientific work.

Julia Venturini: Why is it important to study solar magnetic activity?
Karel Schrijver: The Sun is the only star that we can observe in detail. That makes the Sun an important study object for astronomers: most of what happens in the distant cosmos is so different from what we experience in our daily lives on Earth that we need the guidance of what we can see on the Sun as a stepping stone to the conditions on other stars. I have experienced what that means first-hand in my career: I started early on by looking at a variety of vaguely Sun-like stars, but soon realized that I needed guidance from solar observations. Later on, I focused on the Sun and its environment also for another reason: the Sun's variable magnetism affects our technological infrastructure, both in space and on the ground. We call that space weather. For example, enormous explosions on the Sun can easily envelop the entire Earth. And although the Earth's atmosphere shields us effectively from detrimental impacts, satellites orbiting outside that atmosphere can be damaged, and sometimes even fail when a solar storm passes by. We may see only northern lights when that happens, but our GPS navigation may suffer in accuracy because the satellite signals are bent irregularly as they travel through an upset upper atmosphere. On Earth, large conductors such as electrical power lines, oil and gas pipelines, and railroads can pick up the magnetic perturbations of space storms, and this can lead to problems in these systems. In rare severe events, electrical power systems can even fail. We need to learn to forecast space weather and to prevent its impacts.
Now that astronomers have discovered that virtually every star in the sky has at least one planet orbiting it, there is a growing interest in the Sun and how it affects planets because those studying the distant exoplanets need information on how their stars can affect them. And that brings astronomers back to the place where they can see these effects in action: our own Sun and its planets.

Julia Venturini: In which ways has ISSI contributed to your scientific career?
Karel Schrijver: I have always thought of ISSI as a wonderfully effective setting to learn and discover: its mission is to bring together astronomers and space scientists from around the world so that they can exchange ideas in a place where they can focus on a particular problem as members of teams made up of the best experts in the world. I have been a member of four international study teams. Every time, I learned so much from sitting down with my colleagues. Each time there were surprises in the discoveries made by the team. You can read publications by your colleagues over and over, but somehow what they have learned never comes across as clearly as in discussions. Working at ISSI stimulates you in your thinking, and dares you to ask questions that you may think are naïve and that you ought to know the answer to, but so often do you discover that there is more to the answer than you thought of, and sometimes you discover that your perspective causes others to realize that they didn't have it all correct either. Now that I have the honor of the Johannes Geiss Fellowship at ISSI, I find the same is true even if you are not involved in a team or a workshop: you run into colleagues, or can reach out to those working in Bern and beyond, and you can focus on a task, supported by the exceptionally friendly, supportive and efficient staff. I hope ISSI will have a long, successful future, and that many others can experience the excitement I have always felt when visiting.

Julia Venturini: There was a women strike on 14 June 2019 in Switzerland. Researchers have written the following Manifesto: https://www.feminist-academic-manifesto.org. Do you consider that the presence of women in science should increase? If yes, how do you think we could do that? What changes should be implemented in the system to retain more women in academia after the PhD level?

Karel Schrijver: Science is the activity by which we endeavor to discover how the universe works. That immense challenge requires that we engage the best and brightest minds in the world, regardless of race, gender, or nationality. Essential attributes that enable someone to shine as a scientist include curiosity, education, ability, and dedication. Curiosity for the world around us needs to be stimulated from the beginning, and it should not matter whether you come into the world as a girl or as a boy. For a scientist, the initial formative phase of the curious mind is followed by decades of formal education, all the way through to PhD level. In both of these we need to eliminate society's pernicious biases that cause career choices for men and women to diverge. Ability and dedication are always important as internal qualities, but they become more significant after we complete our PhDs: young scientists generally go through several short-term postdoctoral positions, and then enter the exacting competition to land a more or less permanent job. This often coincides with committing to a partner, and perhaps with adding children to the mix. This is where we end up with less than one female for every two males in research professions worldwide. I think we need to fight gender bias in early education and in societal norms; gender pay inequality should be eliminated; it should be standard practice that parental leave is equally available to both partners and is readily sharable; postdoctoral positions should be more flexible to reduce stress within a young partnership. Some of these changes can and should be implemented by employers, while some require mindset changes to permeate society. It will take effort and time to made these changes, but all would benefit science and society at large.

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.

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-fourth year:

Emmanuele Battista, University of Naples, Italy, working period: 6.–25.2.2019.

Vittorio di Falco, Silesian University of Opava, Czech Republic, working period: 6.–25.2.2019.

Bill Hartmann, Planetary Science Institute, Tucson, USA, working period: 19.6.–10.7.2018.

Peter Hoppe, Max-Planck-Institut für Chemie, Mainz, Germany, working period: 27.5.–15.6.2019.

Ricardo La Placa, University of Rome, La Sapienza, Italy, working period: 20.2.–2.3.2019.

Felix Mirabel, Service d'Astrophysique, CEA Saclay, Gif-sur-Yvette, France, working period: 20.–28.5.2019.

Eberhard Möbius, University of New Hampshire, USA, working periods: 12.–31.3. and 1.–23.5.2019.

Volodymyr M. Reshetnyk, Kyiv National Taras Shevchenko University, Ukraine, working period: 19.–30.11.2018.

Karel Schrijver, Johannes Geiss Fellow 2018, Lockheed Martin, Palo Alto, USA (retired), working periods: 3.–27.12.2018 and 6.–17.5.2019.

Yuri Skorov, Institute for Geophysics and Extraterrestrial Physics, University of Braunschweig, Germany, working period: 19.–30.11.2018.

Events

"Sample Return from Small Solar System Bodies" Alpbach Summer School 2018

Alpbach Summer School students and mentors. (Copyright: MA Jakob / WINart AT 2018)

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 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 Forschungsförderungs-Gesellschaft (FFG), represented by the Director of the Summer School, Michaela Glitsch 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 Oscar for the most competitive mission was granted to the OWL mission, a dust-growth mission addressing the Origin of Water and Life in micro-gravity conditions and the formation of planetesimals from molecules and dust in the protoplanetary disks. The mission was judged as highly innovative and creative. The Team was also rewarded with the second "Quality of Presentation" Oscar.

The Oscar for the Best Science Case was awarded to the CARINA Mission (Comet Asteroid Relation Investigation and Analysis) for willing to bridge the gap between comets and asteroids through sample return from the near-Earth D-type asteroid 2002 AT4. The team was in addition awarded the special Head Tutor Oscar for providing a complete and logical mission, with a competitive value for money model, and an appealing presentation of the technical case.

The CALATHUS Mission (Calathus refers to the basket used by the agriculture and fertility goddess Ceres, which she used to deliver grain to the people), was awarded the Oscar of the best Technical Test. The mission aims at returning a sample of the Ceres main asteroid belt body and characterizing Ceres' white spots. The jury also found the mission best suited for further studies during Post-Alpbach 2018 held at the ESA Academy Training and Learning Facility, ESEC-Galaxia in Transinne, Belgium in November 2018.

A Special Jury Oscar for the best written report of the 2018 School was awarded to the DESIRE (D-type Explorer Subsurface Interior Sample Return) Mission to return sample material from the Near-Earth D-type asteroid 2002 AT4.

Roger-Maurice Bonnet

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 counts presently 125 members, meets once per year for its general assembly. The Board of Pro ISSI consists of Adrian Jäggi (President), Anuschka Pauluhn (Editor Spatium), Annette Jäckel (Treasurer) and Yasmine Calisesi (Secretary).

Covers of the SPATIUM No. 42 and 43 published in the 24th ISSI Business Year.

Public Lectures

Pro ISSI organized three public lectures in the period of this report:

The General Assembly was held on 31st October 2018 followed by a lecture given by the ISSI Director for Astrophysics and Cosmology, Joachim Wambsganss. In his talk "Exoplanets: In Search of Terra-2" Joachim Wambsganss spoke about one of the fastest growing branches in Astrophysics and explained the various search techniques and the extreme precision required for exoplanet detections.

On 27th March 2019, Nils Olsen from the Technical University of Denmark spoke about "Exploring Earth's Magnetic Field using the Swarm Satellite Constellation Trio". The presentation described the objective of the best-ever survey of the Earth's magnetic field to explore the deep interior and environment of our planet.

On 8th May 2019, Karel Schrijver, Johannes Geiss Fellow 2018, spoke about "Solar Magnetic Activity in a Nutshell, and How Stars and Exoplanets Can Help Us Understand It All". His lectures addressed what we have learned about the dynamo that drives solar activity, how magnetism heats the solar atmosphere and drives the solar wind.

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. 42 was published in October 2018, reporting on Cassini's journey to Saturn. Michel Blanc, the former Director of the International Space Science Institute in Beijing (ISSI-BJ), elaborated on the unique scientific understanding this outstanding mission has enabled on Saturn, its ring system and its moons. In contrast, issue no. 43, published in June 2019, reports on the Earth's magnetic field. The author, Nils Olsen from the Technical University of Denmark, portrayed recent scientific highlights, including fast changes in Earth's core field, new details of the lithospheric magnetization, and the determination of the very weak magnetic signal produced by ocean tides and its use to investigate the electrical conductivity of Earth's interior.

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

Adrian Jäggi

International Space Science Institute in Beijing

The International Space Science Institute in 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.

Activities

Between July 2018 and June 2019, ISSI-BJ organized three Forums. On November 14–16, a joint ISSI-BJ/ISSI Forum on "Variability and Predictability of Solar-Terrestrial Coupling: the Next Scientific Program of SCOSTEP" was held. On January 23–25, ISSI-BJ organized a Forum on "Discover the Sky by Longest Wavelength with Small Satellite Constellation". On June 6–7, a joint ISSI-BJ/APSCO Forum on "Science Missions using CubeSats" took place in Thailand. To make the Forum discussions and its conclusions accessible to the broad scientific communities and the public, the insights gained from these Forums were and will be published in the ISSI-BJ "TAIKONG" magazine.

Between July 2018 and June 2019, 9 International Team meetings took place at ISSI-BJ. At the beginning of 2019, ISSI-BJ and ISSI released a joint Call for Proposals for International Teams in Space and Earth Sciences. Seven Teams have been selected by the Science Committee, which will hold a series of meetings at the Institute in Beijing. Four out of seven Teams will share the meetings between Beijing and Bern.

ISSI-BJ is promoting outreach and education activities to the general public and to young scientists as a co-organizer of the "Understanding Science" seminars. In the reported period, ISSI-BJ held two of these scientific seminars, namely:
-"How does Nature beat the Large Hadron Collider? Cosmic Rays, the most energetic particles in the Universe" by Luke Drury (DIAS), and
- "Traveling to the Black Hole" by Pavel Bakala (SLU).

Participants of the 2nd Space Science School

Space Science School

On October 10–19, 2018, the 2nd ISSI-BJ and APSCO Space Science School with EISCAT on "Study Space Weather Effects: From the Sun to the Ground" was held at the Sanya Institute of Remote Sensing (RADI) in Sanya, Hainan Province, China. Guided by lecturers and tutors from Asia and beyond, 57 students from 10 countries were analyzing in groups several extreme Space Weather events, such as the ones in September 2017. The School provided the young space researchers and engineers with an opportunity to gain the in-depth knowledge of the science of Space Weather, observational methods and its relevance to applications from the Sun to the ground. The final report with the summaries written by all working groups was published in the special issue of TAIKONG magazine No. 12.

Publications

ISSI-BJ published four issues of the "TAIKONG" magazine. The magazine reports the contents of the Forums and reflects in a neutral way the Forum discussions and advises from all the participants:
- "Roads Towards Sample Return From Comets and Asteroids" (No. 11)
- "Study Space Weather Effects: from the Sun to the Ground" (No. 12, Space Science School Issue)
- "Variability and Predictability of Solar-Terrestrial Coupling: the Next Scientific Program of SCOSTEP" (No. 13)
- "Discover the Sky by Longest Wavelength with Small Satellite Constellation" (No. 14)
The magazines are available at: http://www.issibj.ac.cn/Publications/.
As a result of the ISSI-BJ Workshop held in 2016, a volume of the Space Science Series of ISSI was published:
- Astronomical Distance Determination in the Space Age, R. de Grijs, M. Falanga (Eds.), Space Science Series of ISSI, Volume 66, 2018. The complete table of contents of this book can be found on page 56.

Anna Yang

Presentations

Listed are activities in which ISSI staff scientists participated between 1 July 2018 and 30 June 2019. This includes presentations given, meetings attended, outreach, honors received, and chairmanships held.

4 July 2018 – A. Cazenave: "The 25-year sea level record from satellite altimetry: lessons learned, remaining gaps, new scientific questions", National Oceanographic Center Liverpool, UK.

11 July 2018 – A. Cazenave: "Remote sensing of the oceans and Climate Change, ocean warming, land ice melt and sea level rise" (two invited lectures), Shanghai Astronomical Observatory, Shanghai, China.

16 July 2018 – R. von Steiger: "27 years of observations with SWICS on Ulysses and ACE" and "Small Satellites for Space Science (4S) COSPAR Roadmap", two invited talks, 42nd COSPAR Scientific Assembly, Pasadena, CA, USA.

30 July 2018 – A. Cazenave: "The earth system, past and present and Sea level and climate" (two invited lectures), ESA Summer School, Frascati, Italy.

13 September 2018 – M. Falanga: ISSI-BJ and It's Connection with ISSI and Switzerland, The Second Sino-Swiss Space Science Workshop, Beijing, China.

24 and 26 September 2018 – A. Cazenave: "A 25-Year Record of Global Mean Sea Level Change: What have we learned? What are the new challenges?" and "Closure of the global sea level budget over the altimetry era", 25 year of Satellite altimetry, Azores.

25 September 2018 – R.-M. Bonnet: "Le Soleil: Danger pour l'Humanité?", Conf. Air and Space Academy, Bordeaux, France.

10–19 October 2018 – R.-M. Bonnet: "From Nuclear Fusion to Space Weather", ISSI-BJ 2018 Summer School, Sanya, Thailand.

22 and 23 October 2018 – J. Venturini: "Jupiter's formation" (two talks), Prof. Ikoma's group and at ELSI (Host: Prof. S. Ida), Tokyo, Japan.

25 October 2018 – M. Falanga: "Future plans on the Pointing Robertson effect in Astronomy", Astronomical Observatory of Rome, Italy.

8 November 2018 – J. Venturini: "Gas-rich planets: towards an understanding on the formation of mini-Neptunes and Neptunes", ISSI Science Committee Mt., Bern, Switzerland.

12 November 2018 – J. Venturini: "Planet Formation and the Origin of Water", review talk, Workshop, ISSI, Bern, Switzerland.

3 December 2018 – J. Venturini: "Jupiter's formation: heavy element content and link to gaseous exoplanets", PLATO Theory Workshop, Cambridge, UK.

11–14 December 2018 – A.M. Bykov: "Cosmic ray acceleration and Escape from sources – Searching for the Sources of Galactic cosmic rays", APC Conf., Paris, France.

12 and 13 December 2018 – A. Cazenave: "Global, Regional and Coastal Sea Level (present and future); What do we need in terms of observations and modelling?" and "Implications of land ice loss on present and future sea level from global to local scales", AGU Fall Meeting, Washington, USA.

18 December 2018 – M. Falanga: "GR ray-tracing simulations", Lecture, Silesian University, Opava, Czech Republic.

15 January 2019 – R.-M. Bonnet: "Mars Express at ESA", 45th Science Team meeting, ESTEC, Noordwijk, The Netherlands.

19 January 2019 – M. Falanga: "Millisecond X-ray pulsars: 15 years of progress", Peking University, Beijing, China.

23 January 2019 – A. Cazenave: "Need for space-based and in-situ observing systems to monitor coastal zone changes in the Atlantic region", ESA Atlantic Workshop, Southampton, UK.

6 February 2019 – J. Venturini: "The formation of mini-Neptunes and Neptunes", Team Meeting "Ice giants: formation, structure and link to exoplanets", ISSI, Bern, Switzerland.

12 February 2019 – M. Falanga: "Magnetic Cataclysmic Variables discovered in hard X-rays", 12th INTEGRAL conf. and 1st AHEAD Gamma-ray Workshop, Geneva, Switzerland.

7 February 2019 – A. Cazenave: "Climate change and sea level rise", University College, London, UK.

27 and 28 February 2019 – A. Cazenave: "Climate Change and sea level rise and Satellite altimetry", Asian School of Environment, University of Singapore, Singapore.

Staff Activities

12 March 2019 – T. Spohn: "Could Earth have an ExoOcean Planet Sister? Or, a Rare-Earth Story", Seminar talk, NASA Jet Propulsion Laboratory, Pasadena, CA, USA.

18 March 2019 – T. Spohn: Talk on HP3 on InSight, Lunar Planetary Science Conference, Houston, USA.

11 April 2019 – T. Spohn: Talk on HP3 on InSight, European Geophysical Union Conference, Vienna, Austria.

2 and 3 May 2019 – A. Cazenave: "Climate change, ocean warming, land ice melt and sea level rise" and "Remote Sensing of the oceans; Focus on satellite altimetry" (two invited lectures), Welsh Lecture, University of Toronto, Canada.

7 May 2019 – R.-M. Bonnet: "Battre la NASA? Impossible?", Public Conf. of the Institut d'Astrophysique de Paris, Paris, France.

9 May 2019 – R. von Steiger: "50 Jahre Mondlandung – Die Schweiz im Weltraum2, Presentation at State Secretariat for Education, Research and Innovation (SERI), Bern, Switzerland.

10 May 2019 – T. Lopez: "Thermal infrared observation of pre-seismic vertical permeability changes – The Boumerdes-Zemmouri (M = 6.8) case (oral session)", EGU, Vienna, Austria.

16 May 2019 – T. Lopez: "Pre-seismic thermal anomalies detected from space – The Boumerdes-Zemmouri earthquake", Workshop, ISSI, Bern, Switzerland.

27 May 2019 – T. Spohn: "Geophysical Observations to Constrain Interior Models: The InSight Mission", Max-Planck Institut für Sonnensystemforschung, Göttingen, Germany.

30 June 2019 – R. von Steiger: "Das Erbe von Johannes Geiss", Public talk at the festival "Bern im All", Bern Bundesplatz, Switzerland.

Meetings

14–22 July 2018 – R.-M. Bonnet, R. von Steiger, S. Wenger: COSPAR 42nd Scientific Assembly, Pasadena, USA.

17–26 July 2018 – S. Wenger: Alpbach Summer School, Alpbach, Austria.

23–27 July 2018 – R.-M. Bonnet: Alpbach Summer School, Alpbach, Austria.

10–13 September 2018 – J. Venturini: Bern Exoplanet Retreat (Chair of session 2), Monte Verita, Ascona, Switzerland.

3–5 September 2018 – R. von Steiger: Evaluation Commission of SNSF Eccellenza Grants and Fellowships, Bern, Switzerland.

13–14 September 2018 – M. Falanga: The Second Sino-Swiss Space Science Workshop, Beijing, China.

14–27 October 2018 – J. Venturini: Visit to Tokyo to collaborate with Prof. Masahiro Ikoma, Japan.

24–26 October 2018 – M. Falanga: Visiting the "Astronomical Observatory of Rome", Italy.

3–4 December 2018 – R.-M. Bonnet: COSPAR Strategic Action Plan for 2019–2023, A Return to Prominence, Carnon, Montpellier, France.

17–19 December 2018 – M. Falanga: Visiting the "Silesian University", Opava, Czech Republic.

19 December 2018 – R. von Steiger: Award ceremony of the Greinacher Foundation, Bern, Switzerland.

11 January – 31 March 2019 – T. Spohn: Stay at Jet Propulsion Laboratory for commanding the deployment and installation of the Heat Flow and Physical Properties Package on Mars for the NASA InSight mission, California, USA.

24 January 2019 – R.-M. Bonnet: Alpbach Summer School 2019 Program Committee, Vienna, Austria.

28–30 January 2019 – J. Venturini: 5th NCCR PlanetS General Assembly, Beatenberg, Switzerland.

7–8 February 2019 – R.-M. Bonnet: Jungfraujoch Historic Site EPS Symposium and Celebration, Bern and Jungfraujoch, Switzerland.

12 February 2019 – M. Falanga: 12th INTEGRAL conference and 1st AHEAD Gamma-ray Workshop, Geneva, Switzerland.

13–15 February 2019 – J. Venturini: Machine Learning Workshop, Geneva Observatory, Switzerland.

25 February 2019 – R.-M. Bonnet: Awarding of the IFHE Aubiniere Price to Journalist Philippe Henarejos, Paris CNES, France.

28 February–1 March 2019 – R. von Steiger: Evaluation meeting of the Swiss Space Center, Gunten, Switzerland.

4–9 March, 2019 – M. Falanga: Visiting the "Astronomical Observatory of Rome", Italy.

18–21 March 2019 – S. Wenger: COSPAR – Annual meetings, Paris, France.

28 March 2019 – R. von Steiger: Editorial Board meeting of Living Reviews in Solar Physics, Göttingen, Germany.

13 May 2019 – R. von Steiger: Evaluation Commission of SNSF Eccellenza Grants and Fellowships, Bern, Switzerland.

16–17 May 2019 – M. Falanga: A&A Journal Board of Directors meeting, Paris, France.

29–31 May 2019 – T. Spohn: Constitutional Meeting of the European Astrobiology Institute, Liblice, Czech Republic.

23 June 2019 – R. von Steiger: Inauguration of bronze stele to the honor of Johannes Geiss on the occasion of the 50th anniversary of the first lunar landing, Bern, Switzerland.

ISSI Scientists in the Media

13–21 July 2018 – Interview with R-M. Bonnet, at the occasion of COSPAR 60th Anniversary, Pasadena, USA.

8 November 2018 – "Jupiter dirigiert", Article by R. Fischer with J. Venturini, UZH Magazin die Wissenschaftszeitschrift 4/18, https://www.magazin.uzh.ch/de/issues/magazin-18-4.html.

13 March 2019 – "Neural networks predict planet mass" Media Release of the paper "Using Deep Neural Networks to compute the mass of forming planets" by Y. Alibert and J. Venturini, http://tinyurl.com/UniBE-Deep-Learning-planets.

8 May 2019 – Interview with R-M. Bonnet by A-M. Retif, L'Europe à la Conquête de l'Espace, AXA publication.

13 June 2019 – TV Broadcast with R-M. Bonnet, Le Choix de Kourou, French National Channel, France Ô.

29 June 2019 – "Bern greift nach immer neuen Sternen", Article with R. von Steiger, der Bund.

Chairman- and Memberships, Honors

R-M. Bonnet:
- President of IFHE's Aubinière Price Award, France
- President of the Alpbach Summer School Jury 2018 and 2019, Austria
- Member of Institut Français d'Histoire de l'Espace, France
- Member ISSI-BJ Board of Trustees

A. Cazenave:
- Elected Fellow of the IUGG (International Union of Geodesy and Geophysics), February 2019
- Recipient of the BBVA Frontiers of Knowledge Award (category Climate Change), June 2019

M. Falanga:
- Member of the Astronomy & Astrophysics Journal Board of Directors, Swiss representative since 2011
- Member of the International Astronomical Union (IAU)
- Member of the International Acad. of Astronautics (IAA)

T. Spohn
- Fellow American Geophysical Society
- Full member Academy of Astronautics
- Secretary Commisssion 1 "Space Physical Sciences" of the Academy of Astronautics
- Member Academia Europaea
- Member LABEX evaluation committee
- Member Europlanet Science Advisory Board
- European Astrobiology Inst. provisional board member
- Volume ed. Solar System, Encyclopedia of Astrobiology
- Principal Investigator for the Heat Flow and Physical Properties Package HP3 on the NASA InSight mission to Mars
- Asteroid 12062 1998FB10 named TILMANSPOHN

R. von Steiger:
- President of the Heinrich Greinacher Foundation
- Board member, Phil.-nat. Faculty, University of Bern, Switzerland
- Member of the Evaluation Committee for Eccellenza Fellowships and Grants of the Swiss National Science Foundation
- Co-chair of the COSPAR Roadmap Committee on Small Satellites for Space Science
- Full member of the International Acad. 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

J. Wambsganss:
- President of German Astron. Society
- Member of the Evaluation Marie Skłodowska-Curie Individual Fellowships
- Chairman of Council of German Observatories

Staff Publications

Listed are all papers written or co-authored by ISSI staff that were submitted or that appeared between 1 July 2018 and 30 June 2019. The papers that are published in the Space Science Series of ISSI (SSSI) can be found from page 56 on.

Alibert Y., J. Venturini, Using Deep Neural Networks to compute the mass of forming planets, Astron. Astrophys., 626, A21, 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, Icarus, submitted, 2019.

Benveniste, J., A. Cazenave et al., Requirements for a Coastal Zone Observing System, Front. Mar. Sci., in press, 2019.

Bernardini, F., D. de Martino, K. Mukai, M. Falanga, IGR J14257-6117, a magnetic accreting white dwarf with a very strong strong X-ray orbital modulation, MNRAS, 478, 1185, 2018.

Bernardini, F., D. de Martino, K. Mukai, M. Falanga, The true nature of Swift J0746.3-1608: a possible Intermediate Polar showing accretion state changes, 2019, MNRAS, 484, 101, 2019.

Bykov, A.M., D.C. Ellison, P.E. Gladilin, S.M. Osipov, Supernovae in compact star clusters as sources of high-energy cosmic rays and neutrinos, Adv. Space Res., 62, 10, 2764–2772, 2018.

Bykov, A.M., D.C. Ellison, M.E. Kalyashova et al., High-energy cosmic rays from supernovae in young clusters of massive stars, Rend. Fis. Acc. Lincei, 1–4, doi: 10.1007/s12210-019-00788-7, 2019.

Bykov, A.M., A.E. Petrov, A.M. Krassilchtchikov, K.P. Levenfish, S.M. Osipov, G.G. Pavlov, GeV–TeV Cosmic-Ray Leptons in the Solar System from the Bow Shock Wind Nebula of the Nearest Millisecond Pulsar J0437–4715, Astrophys. J. Lett., 876, 1, L8, 2019.

Cazenave, A., H. Palanisamy, Sea Level Rise and Future Earth, In: T. Beer, J. Li, & K. Alverson (Eds.), Global Change and Future Earth: The Geoscience Perspective (Special Publications of the International Union of Geodesy and Geophysics), Cambridge University Press, 144–158, doi:10.1017/9781316761489.015, 2018.

Cazenave A. and the WCRP Global Sea Level Budget Group, Global sea level budget, 1993-present, Earth Syst. Sci. Data, 10, 1551–1590, 2018.

Cazenave, A., H. Palanisamy, M. Ablain, Contemporary sea level changes from satellite altimetry: What have we learned? What are the new challenges? Adv. Space Res., 62, 7, 1639–1653, 2018.

Cazenave, A. et al., Climate Change and Impacts on Variability and Interactions, in R. Mechoso (eds.), 'Interacting Ocean Climates: Observations, Mechanisms, Predictability, and Impacts', Cambridge University Press, in press, 2019.

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

Chariton, C., S. Kokou Dadzie, N. Thomas, R. Marschall, P. Hartogh, L. Jorda, E. Kührt, I. Wright, R. Rodrigo, Gas flow in near surface comet like porous structures: application to 67P/Churyumov-Gerasimenko, Planet. Space Sci., 161, 57–67, 2018.

De Falco, V., P. Bakala, E. Battista, D. Lancová, M. Falanga, L. Stella, Three-dimensional general relativistic Poynting-Robertson effect: Radial radiation field, Phys. Rev. D, 99, 3014, 2019.

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

Delchambre, L. et al. (including J. Wambsganss), Gaia GraL: Gaia DR2 Gravitational Lens Systems. III. A systematic blind search for new lensed systems, Astron. Astrophys., 622, A165, 2019.

De Rosa, A., P. Uttley et al. (including M. Falanga), Accretion in strong field gravity with eXTP, Sci. China Phys. Mech. Astron., 62, 2, 29504, 2019.

Dominik, M. et al. (including J. Wambsganss), OGLE-2014-BLG-1186: gravitational microlensing providing evidence for a planet or orbiting the foreground star or for a close binary source?, MNRAS, 484, 5608–5632, 2019.

Ducourant, C. et al. (including J. Wambsganss), Gaia GraL: Gaia DR2 gravitational lens systems. II. The known multiply imaged quasars, Astron. Astrophys., 618, A56, 2018.

Fisk, L., R.-M. Bonnet et al., COSPAR Strategy Action Plan 2019-2023. A Return to Prominence, COSPAR internal report, 2019.

Godolt, M., N. Tosi, B. Stracke, J.L. Grenfell, T. Ruedas, T. Spohn, H. Rauer, The habitability of stagnant-lid Earths around dwarf stars, Astron. Astrophys., 625, A12, 2019.

Grott, M., T. Spohn et al., Calibration of the Heat Flow and Physical Properties Pachage (HP3) for the InSight Mars mission, Earth and Space Sci., submitted, 2019.

Groussin, O., N. Attree, Y. Brouet et al., (including T. Spohn), The Thermal, Mechanical, Structural, and Dielectric Properties of Cometary Nuclei After Rosetta, Space Sci. Rev., 215, 29, 2019.

Höning, D., N. Tosi, H. Hansen-Goos, T. Spohn, Bifurcation in the growth of continental crust, Phys. Earth Planet. Inter., 287, 37–50, 2019.

Höning, D., N. Tosi, T. Spohn, Carbon cycling and interior evolution of water-covered plate tectonics and stagnant-lid planets, Astron. Astrophys., 627, A48, 2019.

Klüter, J., U. Bastian, M. Demleiter, J. Wambsganss, Ongoing astrometric microlensing events of two nearby stars, Astron. Astrophys., 615, L11, 2018.

Klüter, J., U. Bastian, M. Demleiter, J. Wambsganss, Prediction of astrometric microlensing events from Gaia DR2 proper motions, Astron. Astrophys., 620, A175, 2018.

In't Zand, J.J.M., E. Bozzo et al. (including M. Falanga), Observatory science with eXTP, Sci. China Phys. Mech. Astron., 62, 2, 29506, 2019.

Li, Z., V. De Falco, M. Falanga, E. Bozzo, L. Kuiper, J. Poutanen, A. Cumming, D.K. Galloway, S. Zhang, Mixed H/He bursts in SAX J1748.9-2021 during the spectral change of its 2015 outburst, Astron. Astrophys., 620, 114, 2018.

Li, Z., V.F. Suleimanov, J. Poutanen, T. Salmi, M. Falanga, J. Nättilä, R. Xu, Evidence for the Photoionization Absorption Edge in a Photospheric Radius Expansion X-Ray Burst from GRS 1747-312 in Terzan 6, Astrophys. J., 866, 53, 2018.

Liao Y., R. Marschall, C.C. Su, J.S. Wu, I.L. Lai, O. Pinzon, N. Thomas, Water Vapor Recondensation from Inner Gas Coma onto the Nucleus of Comet 67P/Churyumov-Gerasimenko, Planet. Space Sci., 157, 1–9, 2018.

Marschall, R., L. Rezac, D. Kappel, A comparison of multiple Rosetta data sets and 3D model calculations of 67P/Churyumov-Gerasimenko coma around equinox (May 2015), Icarus, 328, 104–126, 2019.

Marti F., A. Cazenave, F. Birol et al., Altimetry-based sea level trends along the coasts of western Africa, Adv. Space Res., doi:10.1016/j.asr.2019.05.033, in press, 2019.

Meyssignac, B. et al. (including A. Cazenave), Measuring Global Ocean Heat Content to estimate the Earth Energy Imbalance, Front. Mar. Sci., in press, 2019.

Millan, R., R. von Steiger, M. Ariel et al., Small Satellites for Space Science: A COSPAR Scientific Roadmap, Adv. Space Res., 64, 8, 1466–1517, 2019.

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., in press, 2019.

Reershemius, S., M. Fittock, T. Hudson, K. Sasaki, M. Scharringhausen, T. Spohn et al, Structure development of the HP³ instrument Support System for the Mars mission InSight, Acta Astronaut., 164, 9–22, 2019.

Street, R.A. et al. (including J. Wambsganss), OGLE-2018-BLG-0022: A Nearby M-dwarf Binary, Astrophys. J., 157, 215, 2019.

Thomas, N. et al. (including R. Marschall, R. Rodrigo), Regional unit definition for the nucleus of comet 67P/Churyumov-Gerasimenko on the SHAP7 model, Planet. Space Sci., 164, 19–36, 2018.

Vincent, J.-B. et al. (including R. Marschall), Local manifestations of cometary activity, Space Sci. Rev., in press, 2019.

Watts, A.L.; W. Yu et al. (including M. Falanga), Dense matter with eXTP, Sci. China Phys. Mech. Astron., 62, 2, 29503, 2019.

Wippermann, T., T.L. Hudson, T. Spohn et al., Penetration and Performance Testing of the HP³ Mole for the InSight Mars Mission, Planet. Space Sci., submitted, 2019.

Sibeck, D.G., R. Allen, H. Aryan et al. (including R. von Steiger), Imaging Plasma Density Structures in the Soft X-Rays Generated by Solar Wind Charge Exchange with Neutrals, Space Sci. Rev., 214, 79, 2018.

Zhang, M., L. Zhao, R. von Steiger, R.F. Wimmer-Schweingruber, G.M. Gloeckler, M. Desai, N.V. Pogorelov, Determination of Plasma, Pickup Ion, and Suprathermal Particle Spectrum in the Solar Wind Frame of Reference, Astrophys. J., 871, 2019.

Visitor Publications

Listed are all papers written or co-authored by ISSI visitors, with acknowledgment to ISSI, that appeared or were accepted for publication in refereed journals between 1 July 2018 and 30 June 2019.

Adam, O., K.M. Grise, P. Staten, et al., The TropD software package (v1): standardized methods for calculating tropical-width diagnostics, Geosci. Model Dev., 11, 4339–4357, 2018.

Adhikari, L., O. Khabarova, G.P. Zank, L.-L. Zhao, The Role of Magnetic Reconnection–associated Processes in Local Particle Acceleration in the Solar Wind, Astrophys. J., 873, 1, 2019.

Adhikari, L., G.P. Zank, L.-L. Zhao, Does Turbulence Turn off at the Alfvén Critical Surface?, Astrophys. J., 876, 1, 2019.

Anastasiadis, A., D. Lario, A. Papaioannou, A. Kouloumvakos, A. Vourlidas, Solar energetic particles in the inner heliosphere: status and open questions, Philos. Trans. R. Soc. London, Ser. A, 2019.

André, Q., S. Mathis, A. J. Barker, Layered semi-convection and tides in giant planet interiors II. Tidal dissipation, Astron. Astrophys., 626, A82, 2019.

Archer, M.O., H. Hietala, M.D. Hartinger, F. Plaschke, V. Angelopoulos, Direct observations of a surface eigenmode of the dayside magnetopause, Nat. Commun., 10, 615, 2019.

Asensio Ramos, A., J. de la Cruz Rodríguez, A. Pastor Yabar, Real-time, multiframe, blind deconvolution of solar images, Astron. Astrophys., 620, A73, 2018.

Baillié, K., B. Noyelles, V. Lainey, S. Charnoz, G. Tobie, Formation of the Cassini Division – I. Shaping the rings by Mimas inward migration, MNRAS, 486, 2, 2933–2946, 2019.

Behar, E., B. Tabone, M. Saillenfest, P. Henri, J. Deca, M. Holmström, Solar wind dynamics around a comet, A 2D semi-analytical model, Astron. Astrophys., 620, A35, 2018.

Bienayme, O., Integrals of motion for non-axisymmetric potentials, Astron. Astrophys., in press, 2019.

Birn, J., M. Chandler, T. Moore, A. Runov, Ion velocity distributions in dipolarization events: Beams in the vicinity of the plasma sheet boundary, J. Geophys. Res. Space Phys., 122, 8, 2017.

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Bjørgen, J.P., J. Leenaarts, M. Rempel, et al., Three-dimensional modeling of chromospheric spectral lines in a simulated active region, Astron. Astrophys., in press, 2019.

Burlaga, L.F., V. Florinski, N.F. Ness, Turbulence in the Outer Heliosheath, Astrophys. J., 854, 1, 2018.

Chau, J.L., J.M. Urco, J.P, Vierinen, et. al., Meteor radar using coherent MIMO, Atmos. Meas. Tech., 12, 4, 2113–2127, 2019.

Chatterjee, S., D. Banerjee, S.W. McIntosh et al., Signature of Extended Solar Cycles as Detected from Ca II K Synoptic Maps of Kodaikanal and Mount Wilson Observatory, Astrophys. J. Letters, 874, 1, L4, 2019.

Chatzistergos, T., I. Ermolli, N.A. Krivova, S.K. Solanki, Analysis of full disc Ca II K spectroheliograms. II. Towards an accurate assessment of long-term variations in plage areas, Astron. Astrophys., 625, A69, 2019.

Christophe, S., J. Ballot, R.-M. Ouazzani, V. Antoci, S.J.A.J. Salmon, Deciphering the oscillation spectrum of γ Doradus and SPB stars, Astron. Astrophys., 618, A47, 2018.

Chrysaphi, N., E.P. Kontar, G. D. Holman, M. Temmer, CME-driven Shock and Type II Solar Radio Burst Band Splitting, Astrophys. J., 868, 2, 2018.

Cliver, E.W., S.W. Kahler, M. Kazachenko, M. Shimojo, The Disappearing Solar Filament of 2013 September 29 and Its Large Associated Proton Event: Implications for Particle Acceleration at the Sun, Astrophys. J., 877, 1, 2019.

Cohen, I.J., S.J. Schwartz, K.A. Goodrich, et al., High-Resolution Measurements of the Cross-Shock Potential, Ion Reflection, and Electron Heating at an Interplanetary Shock by MMS, J. Geophys. Res. Space Phys., in press, 2019.

Criscuoli, S., V. Penza, M. Lovric, F. Berrilli, The Correlation of Synthetic UV Color versus Mg ii Index along the Solar Cycle, Astrophys. J., 865, 1, 2018.

Criscuoli, S., Effects of Continuum Fudging on Non-LTE Synthesis of Stellar Spectra. I. Effects on Estimates of UV Continua and Solar Spectral Irradiance Variability, Astrophys. J., 872, 1, 2019.

Cristini, A., R. Hirschi, C. Meakin, D. Arnett, C. Georgy, I. Walkington, Dependence of convective boundary mixing on boundary properties and turbulence strength, MNRAS 484, 4645, 2019.

Dacie, S., T. Torok, P. Demoulin, M.G. Linton, C. Downs,L. Van Driel-Gesztelyi, Sequential Eruptions Triggered by Flux Emergence: Observations and Modeling, Astrophys. J., 862, 2, 2018.

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Davis, S.M., B. Hassler, K.H. Rosenlof, Revisiting ozone measurements as an indicator of tropical width, Prog. Earth Planet. Sci., 5, 56, 2018.

De Boer, T.J.L., M. Gieles, E. Balbinot, V. Hénault-Brunet et al., Globular cluster number density profiles using Gaia DR2, MNRAS, 485, 4, 4906–4935, 2019.

De la Cruz Rodríguez, J., J. Leenaarts, S. Danilovic, H. Uitenbroek, STiC: A multiatom non-LTE PRD inversion code for full-Stokes solar observations, Astron. Astrophys., 623, A74, 2019.

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Du, S., F. Guo, G.P. Zank, X. Li, A. Stanier, Plasma Energization in Colliding Magnetic Flux Ropes, Astrophys. J., 867, 1, 2018.

Dunlop, M.W., S. Haaland, X.-C. Dong, et al., Multipoint Analysis of Electric Currents in Geospace Using the Curlometer Technique, AGU books, Electric Currents in Geospace and Beyond, Chapter 4, 2018.

Effenberger, F., V. Petrosian, The Relation between Escape and Scattering Times of Energetic Particles in a Turbulent Magnetized Plasma: Application to Solar Flares, Astrophys. J. Lett., 868, 2, 2018.

Esteban Pozuelo, S., J. de la Cruz Rodríguez, A. Drews, et al., Observationally Based Models of Penumbral Microjets, Astrophys. J., 870, 2, 2019.

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Fichtner, H, K. Scherer, M. Lazar, H.J. Fahr, Z. Vörös, Entropy of plasmas described with regularized κ-distributions, Phys. Rev. E, 98, 053205, 2018.

French, M., N. Nettelmann, Viscosity and Prandtl Number of Warm Dense Water as in Ice Giant Planets, Astrophys. J., 881, 81, 2019.

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Fuselier, S.A., M.A. Dayeh, E. Möbius, The IBEX Ribbon and the thickness of the inner heliosheath, Astrophys. J., 861, 1, 2018.

Fuselier, S.A., K.J. Trattner, S.M. Petrinec, M.H. Denton, S. Toledo-Redondo, M. André et al., Mass Loading the Earth's Dayside Magnetopause Boundary Layer and Its Effect on Magnetic Reconnection, Geophys. Res. Lett., 46, 2019.

Galsgaard, K., M.S. Madjarska, D.H. Mackay, C. Mou, Eruptions from quiet Sun coronal bright points II. Non-potential modelling, Astron. Astrophys., 623, A78, 2019.

Galli, A., P. Wurz, F. Rahmanifard, E. Möbius, et al., Model-free Maps of Interstellar Neutral Hydrogen Measured with IBEX between 2009 and 2018, Astrophys. J., 871, 1, 2019.

Galsgaard, K., M.S. Madjarska, D.H. Mackay, C. Mou, Eruptions from quiet Sun coronal bright points, Astron. Astrophys., 623, A78, 2019.

Ganushkina, N.Y., M.W. Liemohn, S. Dubyagin, Current systems in the Earth's magnetosphere, Reviews of Geophysics, 56, 2, 309–332, 2018.

Giacobbo, N., M. Mapelli, The progenitors of compact-object binaries: impact of metallicity, common envelope and natal kicks, MNRAS, 480, 2, 2011–2030, 2018.

Giacobbo, N., M. Mapelli, The impact of electron-capture supernovae on merging double neutron stars, MNRAS, 482, 2, 2234–2243, 2019.

Visitor Publications

Gieles, M., C. Charbonnel, M.G.H. Krause, V. Hénault-Brunet et al., Concurrent formation of supermassive stars and globular clusters: implications for early self-enrichment, MNRAS, 478, 2, 2461–2479, 2018.

Goodrich, K.A., R. Ergun, S.J. Schwartz, et al., MMS Observations of Electrostatic Waves in an Oblique Shock Crossing, J. Geophys. Res. Space Phys., 123, 11, 2018.

Goodrich, K.A., R. Ergun, S.J. Schwartz, et al., Impulsively Reflected Ions: A Plausible Mechanism for Ion Acoustic Wave Growth in Collisionless Shocks, J. Geophys. Res. Space Phys., 124, 3, 2019.

Gordovskyy, M., E. Kontar, P. Browning, A. Kuznetsov, Frequency–Distance Structure of Solar Radio Sources Observed by LOFAR, Astrophys. J., 873, 1, 2019.

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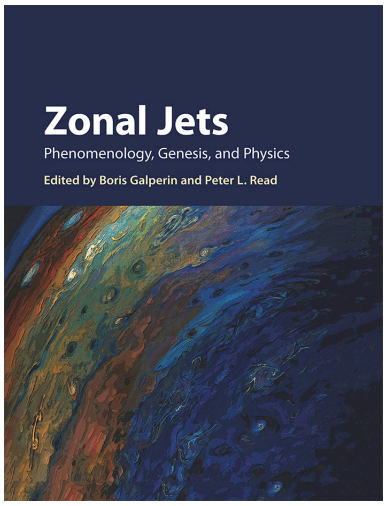

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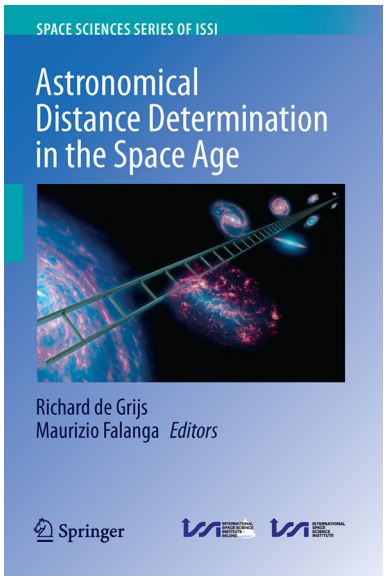

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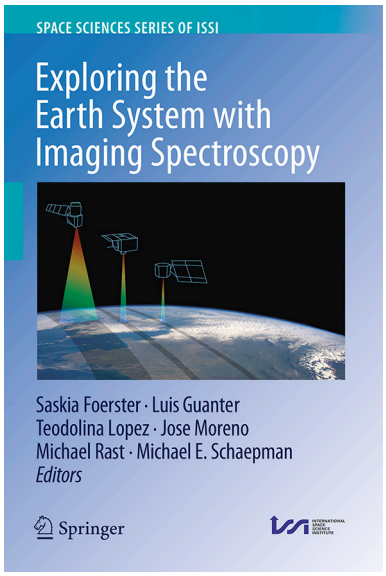

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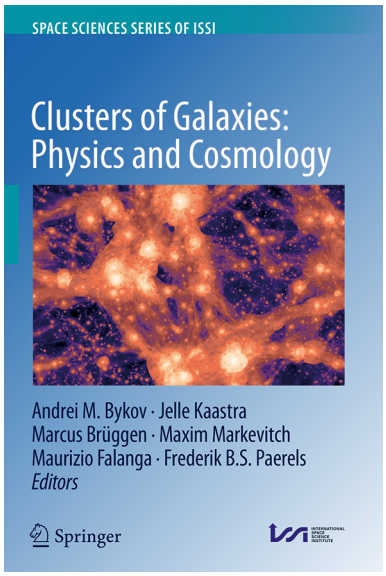

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The puzzle is composed of six images (from the upper left to the lower right):

1. GRAILS's Gravity Map of the Moon (Image Credit: NASA/JPL-Caltech/MIT/GSFC)

2. BepiColombo plasma simulation (Image Credit: ESA/F. Filleul)

3. The Sun in 2018 (Image Credit: ESA/Royal Observatory of Belgium)

4. Oscillations in a Solar-like star (artist's impression) (Image Credit: ESO)

5. Proba-V view of Aral Sea (Image Credit: ESA/Belspo – produced by VITO)

6. Color-coded topographic view of Aurorae Chaos located in the Margaritifer Terra region on Mars (Image Credit: ESA/DLR/FU Berlin)

International Space Science Institute ISSI
Hallerstrasse 6
CH-3012 Bern
Switzerland
Tel. +41 31 631 48 96
www.issibern.ch
info@issibern.ch