# ISSI-BJ TOOLS

**January Annual Call**
**INTERNATIONAL TEAMS**

**Spontaneous Application**
**WORKSHOPS**
**FORUMS**
**VISITING SCIENTISTS**
**WORKING GROUPS**

INTERNATIONAL SPACE SCIENCE INSTITUTE - BEIJING

INTERNATIONAL SPACE SCIENCE INSTITUTE - BEIJING

TOPICAL REVIEW

1001 Space Nights

ON THINGS TO COME

# ANNUAL REPORT 2021

# IMPRINT


ISSI-BJ Annual Report

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Editor/ Graphic Design: Yinong LI




# COVER PAGE

Upper picture: Tianwen 1 Mission - Credit: China National Space Administration (CNSA)
Lower picture: Insight-HXMT X-ray Astronomy Satellite - Credit: Chinese Academy of Sciences (CAS)

# CONTENT

# MESSAGE FROM THE CHAIRMAN OF THE BOARD OF TRUSTEES

The past year ISSI-BJ were still under the aftermath of COVID-19 pandemic. While the originally planned activities and events of ISSI-BJ had to be temporarily postponed or suspended, ISSI-BJ has been aimed to turn activities into virtual meetings and organized online seminars. Under the leadership of Professor Ip, great efforts were made to keep ISSI-BJ moving forward during these difficult times. Several series of webinars are developed and held successfully, which maintain the vitalities and increase the visibility of ISSI-BJ.

"On Things to Come" series online seminars on space missions inviting PIs or famous scientists as speaker, "1001 Space Nights" outreach given by women scientists, "Topical Review" aims to leading researchers from Chinese and French Universities, and the"Space Science Bazaar" focuses on young scientists from the ISSI-BJ International Teams Program to present the development and achievement of their research projects. As of the end of April, ISSI-BJ has organized 69 online seminars in total. New cooperation opportunities between ISSI-BJ and international and local organizations were also explored. One of these kinds of cooperation is with COSPAR. Since October 2021, ISSI-BJ is acting as the online meeting supporter to COSPAR's task group TGCSS/SGRB. So far, 13 online task group meetings of SGRB have been organized successfully. Even more fruitful outcomes can be anticipated.

Despite plentiful and fruitful online activities, we find great importance of personal relations and face-to-face interactions between international communities and partners, which means that face-to-face exchanges cannot be substituted by virtual meetings and online activities. ISSI-BJ is preparing an Advanced Mars School jointly with ESA and a symposium for its 10th anniversary. Hopefully they will be held as planned in 2023, and restart ISSI-BJ's wholesome in-person activities. I hope ISSI-BJ could continue playing and being furtherly strengthened as the international cooperation hub for space science communities.

I would like to express my appreciation for Prof. Ip's work, for his generous enthusiasm and dedication to ISSI-BJ. I believe that our institute is entering a new era of development and make significant progress and achievements under his leadership. Finally, I would like to thank our staff, EN Lijuan and LI Yinong, whose efficient work contributes to making ISSI-BJ successful.

WU Ji

Beijing, May 2022

# MESSAGE FROM THE EXECUTIVE DIRECTOR

With the successful launch and checkout of the James Webb Space Telescope, many exciting discoveries in astronomy are to be expected. These include probably the detection of biosignatures in the atmospheres of some habitable super-Earths. But the big question is will there be life and/or highly intelligent life in our Galaxy? The next question is what is the chance of finding intelligent civilizations that are communicative like us.

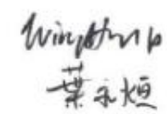
According to the famous Drake equation, the number of intelligent civilizations could be very large or very small depending on the lifetimes of these extratelligent intelligences (ET). That we have not been able to detect any so-called techno-signatures so far might tell us that the number of ET can not be very large. But how small could the number be? A recent study suggests that the number could be just a few if all technological civilizations disappear in 100 years or so after the invention of the radio. This is because these civilizations will - just like us - be subject to the threats of climate change, pandemics, thermo-nuclear wars and even superhuman AI.

Now imagine that in the whole Milky Way there are only less than a dozen technological civilizations and societies that we will never be able to be in contact with because of the vast distances in between. In this scenario, humankind is utterly alone in this expanding Universe. And odds are against us to overcome these mounting crises that we are facing all at once. There is serious doubt that we can break this time limit if nothing is done. The least we should do is to build up a communication network and dialog channels, no matter how hard it is. After all, nothing can be harder than talking to an ET to learn of its history, culture, science, glories and worries - and we are still trying to pursue it.

It was said that the establishment of ISSI-Beijing - with ISSI in Bern as an operational model - was based on the romantic idea that information exchange and international cooperation will promote scientific advancement and mutual understanding of the world-wide space science community. In hindsight, the introduction of such an institution founded on the principle of scientific excellence and neutrality, and free of governmental oversight, is the outcome of rationalistic considerations. These apparently romantic, but actually cool-headed, rationalistic considerations remain true and should be adhered to more than ever.

Because of the COVID-19 pandemic, much of the planned activities of ISSI-BJ have been postponed. During this time, we had opted for online seminars and virtual talks as a way to keep the scientific communication and outreach going. Our multifaceted activities in 2021 are summarized in this annual report. We want to take this opportunity to thank the invited speakers especially for their generous support and contributions. Their communication skills in sharing their precious knowledge are very much appreciated and give us hope and impetus in promoting peaceful cooperation in space sciences. Of course, it also gives us the idea to organize a meeting on the study of technological signatures to prove that galactic intelligent civilization can move on without catastrophic disruption by working together via communications.

Wing-Huen Ip



Beijing, May 2022



# ABOUT ISSI-BJ

The International Space Science Institute Beijing (ISSI-BJ) is a non-profit research institute jointly established by the National Space Science Center (NSSC), China, and the International Space Science Institute (ISSI), Switzerland, with the support of the International Cooperation Bureau and the Strategic Priority Program on Space Science. ISSI-BJ is a close cooperation partner of ISSI in Bern. Both institutes share the same Science Committee, the same study tools, and other information of mutual relevance and interest. However, both use independent operational methods and different funding sources.

The main mission of ISSI-BJ is to contribute to the achievement of a deeper scientific and technological understanding of future space missions as well as of the scientific results from current and past missions through multidisciplinary research, possibly involving, whenever appropriate, ground-based observations and laboratory experiments. The Program of ISSI-BJ covers a wide spectrum of space science disciplines, including solar and space physics, planetary science, astrobiology, microgravity science, and earth observation. It complements the ISSI program with special emphasis on future scientific opportunities.

## History

In October 2011, Professor Ji Wu, the Director General of the National Space Science Center (NSSC), visited the International Space Science Institute (ISSI) and the Executive Director Roger Maurice Bonnet. They proposed to establish an International Space Science Institute in Beijing (ISSI-BJ) during his visit.

In February 2012, Simon Aegeter, Chairman of ISSI's Board of Trustees and Roger-M. Bonnet, Executive Director of ISSI, visited NSSC for further discussion. Both parties exchanged opinions and signed the Memorandum of Understanding (MoU) which was approved by the ISSI Board of Trustees (BoT) in June 2012. On April 19, 2013, the BoT of ISSI signed the Agreement of Cooperation with NSSC and approved the implementation plan of cooperation between ISSI and ISSI-BJ. It was decided, for the first time in the history of ISSI, to share the name with another institution. This decision was made because it was convinced that NSSC is an extremely trustworthy partner. According to this decision, ISSI and NSSC moved forward on the implementation plan for establishment of ISSI-BJ.

The inauguration ceremony of ISSI-BJ was held at the NSSC in Beijing on July 16, 2013. Professor Rafael Rodrigo, the new Executive Director of the International Space Science Institute, and Professor Wu Ji, Chairman of the BoT of ISSI-BJ and Director General of NSSC, jointly inaugurated the new institute located on the 3rd floor of the NSSC building.

A brainstorm forum on the strategy of ISSI-BJ was held in November, 2014, and an international visiting assessment committee was established to evaluated the performance of ISSI-BJ. The international visiting assessment reports gave ISSI-BJ a very good credit and concluded that ISSI-BJ had a good start and had been gaining excellent reputations from the international science communities. Based on the evaluations, NSSC and ISSI agreed to continue their cooperation on ISSI-BJ. The Board of Trustees of ISSI-BJ and ISSI approved the assessment report and the new agreement in April and June, 2015, respectively. Therefore, on October 23, 2015, Professor WU Ji, director-general of NSSC and chair of the Board of Trustees of ISSI-BJ, and Professor Rosine Lallement, representative and vice chair of the Board of Trustees of ISSI in Bern, Switzerland, signed a new agreement, which confirmed the cooperation of the two sides on continuation of ISSI-BJ. According to the new agreement, the cooperation will last for at least three years and after the specified period of three years, the agreement can be extended or a new agreement will be signed to continue the cooperation. This new agreement ensures the continuation of ISSI-BJ for at least three years.

# ISSI-BJ SCIENTIFIC PROGRAM

The International Space Science Institute in Beijing (ISSI-BJ) is the only institute to share the name, the same scientific committee, the same study tools, and other information of mutual relevance and interest with the International Space Science Institute (ISSI) in Bern, Switzerland. ISSI-BJ mission's objectives are quite unique, since it is an institute to serve the space science communities in multi-lateral and multi-disciplinary activities. ISSI-BJ is open to support projects from any Asia or international scientists or institutes; therefore, ISSI-BJ is able to attract Asia as well as international scientists to work together in Beijing.

## WORKSHOPS

Workshops are study projects on specific scientific themes, selected in consultation with the Science Committee. The duration of Workshops is typically one week. Workshops are organized by a group of conveners who define the theme, set up the program, and list the group of participants. Participation is by invitation only. The size of any Workshop is usually limited to a maximum membership of 45 including a few young scientists. The results of the Workshops are published as refereed papers in issues of Space Science Reviews and in parallel as volumes of the Space Science Series of ISSI (SSSI).

## FORUMS

Forums are informal and free debates among 20- 25 high-level participants on open questions of scientific or science policy nature. A Forum may lead to formal recommendations or decisions depending upon the topic or issues addressed in the Forum. The TAIKONG magazines constitute the output of the Forums organized at ISSI-BJ. It reports the contents of the Forums and reflects in a neutral way the Forum discussions and advises from all the participants.

## WORKING GROUPS

Working Groups are set up by the Directorate for specific tasks, often of technical nature. Their life time can be of several years. The results of the Working Groups are published as volumes of ISSI-BJ Scientific Report Series (SR) or in the scientific literature.

## INTERNATIONAL TEAMS

International Teams follow a strict bottom-up approach whereby in response to a specific call issued every year at the beginning of January, scientists can propose projects corresponding to topics, which are broadly identified in the Call. The reviewing and ranking process is the responsibility of the Science Committee. International Teams are composed of about 5-15 scientists from different institutions, nationalities, and expertise. They meet at ISSI-BJ for one or several periods of time of typically one week. They are active for 12-18 months. Their project, often involves data or modelling work. Their activity is directed and organized by a team leader, generally the initiator of the proposal. Teams are largely independent in the execution of their project, but maintain close contact with ISSI-BJ.

## U.S. SEMINARS

Understanding Science is organized by the UK Royal Society of Chemistry, the Institute of Physics and ISSI-BJ. Its goal is to make a broader public aware of today's accomplishments in research through short scientific lectures in English (popularization talks) as well as to have an opportunity to talk with either international or Chinese scientists currently carrying out research in China, in a relaxed atmosphere.

## VISITING SCIENTISTS

Senior and Junior Visiting Scientists carry out scientific work in collaboration with, or under the supervision of the ISSI-BJ scientific staff on matters directly or indirectly connected with the ISSI-BJ projects. They contribute to the scientific environment at ISSI-BJ in complement to the ISSI-BJ scientific staff.

## SPACE SCIENCE BAZAAR

Space Science Bazaar is a webinar series started in 2021 that aims to invite young scientists from the ISSI-BJ International Teams Program to present the development and achievement of their research projects.

## SPACE SCIENCE SCHOOL

ISSI-BJ Space Science School: It is intended to promote a biennial School on space sciences and space science missions for international students. The School will teach the students to develop the connections between scientific objectives and requirements, mission and spacecraft design and mission cost. The aim is to develop a comprehensive approach for designing a space science mission. The students will be provided with the required scientific background relevant to produce a report, outlining a possible space science mission concept.

## ON THINGS TO COME

On Things to Come online seminars, started in September 2020, aim to introduce to the scientific community ongoing as well as new space missions organized by different space agencies and it will allow the audience to interact with the speaker and ask questions about the projects. The seminars are held in English.

## 1001 SPACE NIGHTS

1001 Space Nights（天芳夜谭）online seminars, started in January 2021, intend to introduce the research and scientific achievements of outstanding female Chinese scientists to the public. The lectures are held in Chinese.

## Statistics

In 2021, ISSI-BJ organized 30 On Things to Come online seminars, 12 1001 Space Nights online seminars and 3 Space Science Bazaar online seminars. Furthermore, six new International Teams were selected.

## How to use the ISSI-BJ Tools


**International Teams (IT)**

1. A joint call for proposals is released by ISSI/ ISSI-BJ every year in January.
2. Submit your proposal corresponding to the topics identified in the Call.
3. The proposals are evaluated, prioritized, and recommended to ISSI-BJ by the ISSI/ ISSI-BJ Science Committee.
4. The activity is managed and organized by a team leader who is also the initiator of the proposal at ISSI-BJ.
5. The IT holds a series of two to three oneweek meetings over a period of time of 12 to 18 months.
6. The results of the IT research are published in scientific journals.

**Workshops, Working Groups, and Forums**

1. There is no annual call. The scientific community can put forward suggestions for future activities at any time.
2. Submit a summary of max. one page, explaining the proposal topic, the rationale to organize the event at ISSI-BJ, and the list of proposers.
3. The proposals are evaluated, prioritized, and recommended to ISSI-BJ by the ISSI/ ISS-BJ Science Committee.
4. The activity is organized by the conveners.
5. The activity is held at ISSI-BJ.
6. The activity's outcome is prepared and published.



# ONLINE SEMINARS

## On Things to Come

| | |
|---|---|
| Jan. 13 | GAN Weiqun – CAS ASO-S Mission |
| Jan. 27 | Giovanna Tinetti – ESA Ariel Mission |
| Feb. 24 | Johannes Benkhoff – ESA BepiColombo Mission I |
| Mar. 10 | Gabriele Cremonese – ESA BepiColombo Mission II |
| Mar. 24 | Go Murakami – ESA BepiColombo Mission III |
| Apr. 7 | Yoshifumi Saito – ESA BepiColombo Mission IV |
| Apr. 14 | Daniel Mueller – ESA Solar Orbiter Mission I |
| Apr. 21 | Stefano Vitale – ESA LISA Mission |
| May 6 | Andy Cheng – NASA DART Mission |
| May 12 | Robert Pappalardo – NASA Europa Clipper |
| May 19 | Saem Krucker – ESA Solar Orbiter Mission II |
| May 25 | Sami Solanki – ESA Solar Orbiter Mission III |
| Jun. 2 | Athena Coustenis – ESA's ExoMars Missions |
| Jun. 9 | Yuan Weimin – CAS Einstein Probe Mission |
| Jun. 16 | Evgenya Shkolnik – NASA SPARCS Mission |
| Jun. 30 | René Laurelijs – ESA EUCLID Mission |
| Jul. 7 | ZHAN Hu – CMS Chinese Space Station Telescope |
| Jul. 14 | Tomoko Arai – JAXA DESTINY+ Mission |
| Aug. 25 | LI Zhengqiang – CAS Gaofen-5 |
| Sept. 9 | Lindy Elkins-Tanton – NASA Psyche Mission |
| Sept. 15 | LIN Honglei – CAS Tianwen-1 |
| Sept. 22 | Hal Levison – NASA Lucy Mission |
| Sept. 29 | Ralph McNutt – NASA Interstellar Probe |
| Oct. 27 | FAN Yizhou – CAS DAMPE Mission |
| Nov. 10 | ZHANG Peng – Fengyun Mission |
| Nov. 24 | ZHANG Shuangnan – Insight X-ray Astronomy Satellite Mission |
| Dec.17 | SHEN Xuhui – The latest Progress of CSES Mission |
| Dec. 22 | Michel Blanc - Exploring the Jupiter System from Major Science Questions to Future Space Missions |
| Dec. 29 | David J. Stevenson - Formation and Evolution of the Jupiter System |


The ASO-S Mission
Gan Weiqun
(Purple Mountain Observatory, CAS, China)
& the ASO-S teams
ISSI-BJ Online Seminar
Jan. 13, 2021

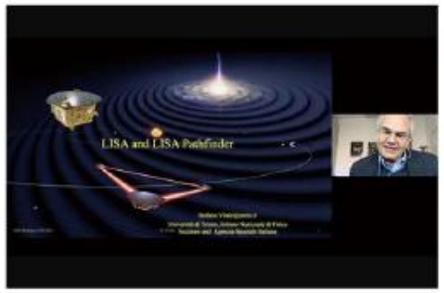

Ariel


Mercury Plasma Particle Experiment (MPPE) onboard Mio
Quest for Plasma Environment around Airless Bodies


ESA Solar Orbiter Mission
太阳轨道探测器
Wednesday, April 14, 2021
4 pm GMT+8
free registration
with Daniel Müller


BepiColombo
General Overview with a Special Focus on
ESA's Mercury Planetary Orbiter, MPO
Johannes Benkhoff


The BepiColombo Mission pt. 2
SIMBIO-SYS
Gabriele Cremonese
Astronomical Observatory of Padua, INAF, Italy
10 MARCH 2021
4 PM GMT+8
9 AM CET


LISA and LISA Pathfinder


DART
NASA
Double Asteroid Redirection Test
Prof. Andy Cheng
John Hopkins University/APL
May 6, 9 am (GMT+8)

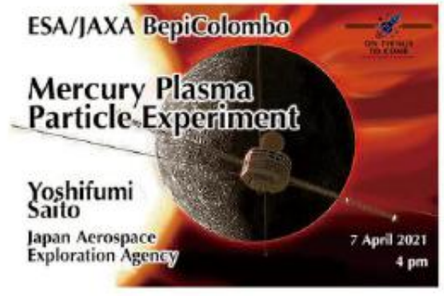

Spectrometer and Imagers for MPO
Bepicolombo Integrated Observing SYStem
G. Cremonese
SIMBIO-SYS Team


ON THINGS TO COME
GO MURAKAMI
JAXA, Japan
24 March 2021
4 PM
THE BEPICOLOMBO MISSION TO MERCURY
Mercury Magnetospheric Orbiter
MIO


Solar Orbiter:


The SO/PHI magnetograph on Solar Orbiter and first preliminary data

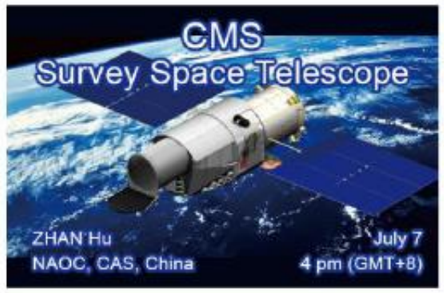

BepiColombo mission part 3:
Mercury Magnetospheric Orbiter Mio
Go Murakami
JAXA/ISAS


ESA/JAXA BepiColombo
Mercury Plasma Particle Experiment
Yoshifumi Saito
Japan Aerospace Exploration Agency
7 April 2021
4 pm


ESA's Exploration programme for Mars:
the ExoMars missions
Athena Coustenis
Director of Research, CNRS

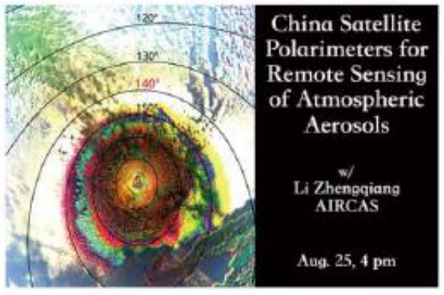

NASA
SPARCS MISSION
16 JUNE 2021
10 AM GMT+8
STAR-PLANET RESEARCH ACTIVITY CUBESAT
EVGENIYA SHKOLNIK
ARIZONA STATE UNIVERSITY, USA


The Promise of the
ESA EUCLID Mission
René Laureijs
ESA at ESTEC
June 30, 2021
4 pm (GMT+8)

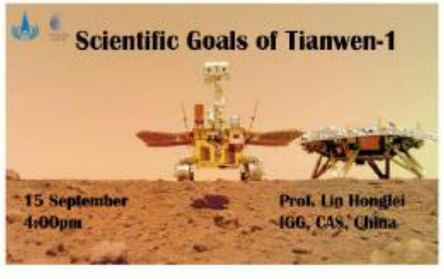

CMS
Survey Space Telescope
ZHAN Hu
NAOC, CAS, China
July 7
4 pm (GMT+8)


JAXA
DESTINY+
July 14
4 pm
Tomoko Arai
Chiba Institute of Technology


ESA
HERA Mission
July 21
4 pm
Michael Küppers
ESA, Spain


China Satellite
Polarimeters for
Remote Sensing
of Atmospheric
Aerosols
w/
Li Zhengqiang
AIRCAS
Aug. 25, 4 pm


NASA PSYCHE Mission
Journey to a Metal-Rich World
Prof. Lindy Elkins-Tanton
NASA/Arizona State University, USA
9 September 2021
4 pm GMT+8


Scientific Goals of Tianwen-1
15 September
4:00pm
Prof. Lin Honglei
IGG, CAS, China

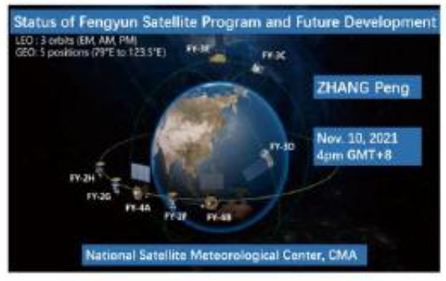

NASA LUCY Mission
Hal Levison (SwRI Boulder)
22 September 2021
9 am GMT+8


NASA Interstellar Probe Mission
Ralph L. McNutt, Jr.
(The Johns Hopkins University Applied Physics Laboratory, USA)
29 September 2021
9 am GMT+8


Recent Status and Results of
the Dark Matter Particle Explorer
FAN Yizhong
Purple Mountain Observatory, CAS
Wednesday, 27 October 2021
4 pm GMT+8


Weimin Yuan
Einstein Probe


Highlights of the Insight-HXMT
X-ray Astronomy Satellite
ZHANG Shuangnan
Institute of High Energy Physics, CAS, China
Wednesday, 24 November 2021
4 pm GMT+8


Status of Fengyun Satellite Program and Future Development
ZHANG Peng
Nov. 10, 2021
4pm GMT+8
National Satellite Meteorological Center, CMA

## 1001 Space Nights

| | |
|---|---|
| Jan. 11 | JIANG Jie – Solar, Heliospheric and Space Physics |
| Feb. 8 | WANG Linghua – Solar, Heliospheric and Space Physics |
| Mar. 8 | SHEN Fang – Solar, Heliospheric and Space Physics |
| Apr. 12 | XU Yi – Planetary Science |
| May 10 | QIN Liping – Planetary Science |
| Jun. 21 | ZHAO Yuhui – Planetary Science |
| Jul. 12 | LAI Hairong – Planetary Science |
| Aug. 9 | YUE Chao – Solar, Heliospheric and Space Physics |
| Sept. 13 | YU Yiqun – Solar, Heliospheric and Space Physics |
| Oct. 18 | WANG Xuesong – Astronomy and Astrophysics |
| Nov. 1 | ZHAO Yuyan – Planetary Science |
| Dec. 6 | GUO Jingnan – Planetary Science |





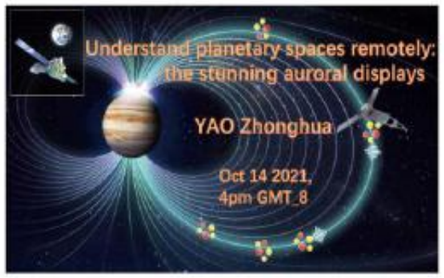







## Space Science Bazaar

| | |
|---|---|
| Oct. 14 | YAO Zhonghua – Understand Planetary Spaces Remotely |
| Nov. 18 | ZHAO Lulu - Using Energetic Electron And Ion Observations To Investigate Solar Wind Structures And Infer Solar Wind Magnetic Field Configurations |
| Dec. 2 | JIN Chichuan and Riccardo Middei – Active Galaxies in Crisis: A Statistical Study of Ultra-Violet Variability |






# COSPAR TGCSS/SGRB MEETING

New cooperation opportunities between ISSI-BJ and COSPAR were explored. Since October 2021, ISSI-BJ is acting as the online meeting supporter to COSPAR's task group TGCSS (The Task Group on establishing a Constellation of Small Satellites) /SGRB (Sub-Group on Radiation Belt). Till now, 13 online task group meetings of SGRB have been organized successfully.



# INTERNATIONAL TEAMS

Since 2014, every year in January ISSI-BJ and ISSI release a joint Call for International Teams in Space and Earth Sciences to encourage proposals for study projects from internationally collaborating teams of scientists from different institutions.

The Call is open to scientists of any nationality actively involved in the following research fields:

1. Space Sciences (Solar and Heliospheric Physics, Solar-Terrestrial Sciences, Space Plasma and Magnetospheric Physics, Planetary Sciences, Astrobiology, Cosmology, Astrophysics, and Fundamental Physics in Space)

2. Earth Sciences using space data

## Teams Selected in 2018

**1.Romano D. (INAF, IT) & Zhang Z. (University of Edinburgh, UK)**

**Chemical Abundances in the Ism: the Litmus Test of Stellar IMF Variations in Galaxies Across Cosmic Time**

Last Session: November 11, 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 with respect to iron observed in local elliptical galaxies.

The team members possess all the necessary expertise to 1. reduce significantly the uncertainties present in abundance measurements; 2. extend the measurements to different types of galaxies, from dwarfs to ellipticals, at both high and low redshifts; 3. improve or develop from scratch the theoretical tools that are necessary for full exploitation and interpretation of the data.

The team is composed of ten scientists from five European countries and 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.

**2.Fan Z. (PKU & YNU, CN)**

**Weak Gravitational Lensing Studies from Space Missions**

Last ISSI-BJ Session: November 4-8, 2019

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. To investigate critical issues and explore the synergy and complementarities of Euclid and CSS-OS, the team consists of key WL members of the Euclid project and the CSS-OS.

The research will focus on the following three aspects: 1. Investigate different statistical tools and possible systematic effects. 2. Develop and test different shear measurement methods taking into account specific survey designs, especially CSS-OS which is less systematically studied yet than Euclid. 3. Explore the synergistic power of the two surveys, particularly the photometric redshift measurements by combining the multiband observations in the optical from CSS-OS and that of NIR from Euclid.

The goal is that through the program, an improvement in the readiness of WL analyses for the two surveys, in terms of both observational analyses and statistical and cosmological studies, will be achieved. In particular, the build-up of the WL data analysis pipeline for CSS-OS can greatly benefit from working together with the Euclid team and the world-leading experts in the field.

**3.Lasue J. (IRAP, FR) and Wiens R. (LANL, USA)**

**Cross-calibration of Laser-Induced Breakdown Spectroscopy (LIBS) Instruments for Planetary Exploration**

Last Session: April 29 - March 3, 2019

Scientific Rationale: A revolutionary technique for planetary science: Laser-induced Breakdown Spectroscopy (LIBS) is an active analytical technique that makes use of a pulsed laser to ablate material of interest at a distance.

The goals of the team will be fourfold: 1. Assess the potential for combined analysis of the data by sharing and discussing the technical details of each instrument design; 2. Discuss the calibration procedures of each instrument and share the relevant tools (databases, software, calibration targets, etc.) to determine the best methods to develop potential cross-calibration between the four instruments; 3. Develop and share the tools necessary for comparing the analyses made by the four instruments for the 2020 timeline, as an international effort; 4. Define a set of recommendations to facilitate the use of the technique for future planetary missions.

ISSI being located both in Bern and in Beijing will provide ideal facilities to allow fruitful interactions and meetings between the members from the different countries involved in such projects.

**4.Li J. (Deutsches ElektronenSynchrotron, DE)**

**Understanding and Unifying the Gamma Rays Emitting Scenarios in High Mass and Low Mass X-ray Binaries**

Last ISSI-BJ Session: March 4-8, 2019

Scientific Rationale: The physical mechanisms responsible for particle acceleration and the nature of the resulting high energy emission are two of the key questions of current astrophysics research. X-ray binary systems visible in gamma rays are especially interesting laboratories for this investigation. This gamma-ray emission has been explained by wind interactions, microquasar jets, and the propeller effect. All of these are realized both in high mass X-ray binaries (HMXBs) and low mass X-ray binaries (LMXBs). However, even with the same underlying scenario, the gammaray emission observed from HMXBs and LMXBs are found to be different.

With this project, we plan to enlarge the sample of sources and systematically investigate similarities and differences between different systems, finally seeking to unify the gamma-ray launching conditions for HMXBs and LMXBs. In this project, we plan to extend the sparse population of known systems and search for commonalities, differences, and unification between the different classes.

**5.Mironova I. (St. Petersburg State University, RU)**

**Relativistic Electron Precipitation and its Atmospheric Effect**

Last Session: October 14-18, 2019

Scientific Rationale: The main goal of our Team project is obtaining progress in the understanding of precipitating of electrons of relativistic energies (especially more than 1 MeV) into the Earth's atmosphere and their atmospheric effects.

In order to reach the goal, we have formed a Team that combines world-class experts in complementary disciplines, such as space physics, atmospheric chemistry, and climate, theoretical modeling, experimental setups, etc. The Team members of our project have experience in measurements and analyzing spacecraft and balloon data, modeling of ionization induced by energetic particles as well as modeling atmospheric and climate effects of energetic particle precipitation. Measurements and modeling of relativistic electron precipitation into the Earth's atmosphere as well as its atmospheric and climate applications is a multi-disciplinary problem that requires the collaboration of specialists looking at this problem from different points of view.

One of the outputs of the Team project is the preparation of international balloon experiments (measurements of relativistic electron precipitation) above subauroral regions and around the arctic circle. We expect to publish peer-review papers, acknowledging the important facilitating role of ISSI/ISSI -BJ in allowing these interdisciplinary activities to develop new synergies.

**6.Vial J.-C. (IAU, FR) and Chen P. (Nanjing University, CN)**

**The Eruption of Solar Filaments and the Associated Mass and Energy Transport**

Last ISSI-BJ Session: October 29 - November 1, 2019

Scientific Rationale: Eruptions of solar filaments are associated with flares and coronal mass ejections but are often considered as playing a secondary role in the whole process. The objective of the Team is to focus on evaluating the associated mass and energy transport from the lower solar corona to the orbit of the Earth and beyond with the partially ionized and warm plasma, which is an important issue in Space Weather. The Team will investigate the whole chain of filament eruptions starting from their initiation to their impact on the Earth through evolution and transport, to determine the mechanisms at work. It will gather complementary expertise in magnetohydrodynamics, plasma diagnostic, radiative transfer, etc.

It will rely upon past and present observations from the ground (e.g., ONSET, NVST) and from Space (SDO, IRIS, Proba2) and will help the science preparation of future missions such as the Chinese ASO-S and Hα Telescope and Indian Aditya L1 missions.

## Teams Selected in 2019

**1.Orsolini Y. (NILU, NO) and He S. (University of Bergen, NO)**

**Dynamical Signatures of Energetic Particle Precipitation in Atmospheric Re-analyses**

Upcoming Session: TBD

Scientific Rationale: The goal of the proposed team is to re-assess the ozone, temperature, and potential dynamical signatures of energetic particle precipitation (EPP) from the stratosphere down to the troposphere in existing, state-of-theart global atmospheric re-analyses. While some studies attributed large surface temperature anomalies to geomagnetic activity in re-analyses, these findings remain highly controversial. The team will primarily focus on re-analyses with high vertical extension and relevant satellite data assimilation. Supporting model studies will help quantify the impact of extreme geomagnetic activity on atmospheric composition, temperature, and dynamics, and to provide an envelope for what could be found in re-analyses. The main objective is the quantitative estimation of these signatures, including their temporal and spatial statistical significance. A secondary objective is to provide guidelines for next-generation reanalysis development, in particular concerning assimilation and treatment of ozone.

The main question to be answered is: is there robust, statistically significant evidence of dynamical signatures from EPP or geomagnetic activity in the state-of-the-art re-analyses?

The main tasks will be:

1. to improve the methodology to extract and statistically assess dynamical signals due to solar EPP in the latest atmospheric reanalyses considering what is the most appropriate index to characterize EPP in this context (e.g. Ap, Dst, Ae or Kp indices, solar wind pressure);

2. to carry out supporting model studies to quantify the impact of extreme geomagnetic activity on atmospheric composition, temperatures, and dynamics, and to provide an envelope for what could be found in re-analyses. The interdisciplinary research activities will rely on Multi-decadal re-analyses using assimilated satellite and in-situ observations; wholeatmosphere chemistry-climate models (namely WACCM); satellite observations of ozone to benchmark re-analysis ozone (e.g., SBUV, MLS, SAGE, SABER, MIPAS, HALOE, POAM) and multi-satellite combined ozone datasets.

**2.Shen X. (China Earthquake Administration, CN), Hulot G. (IPGP, FR), and Zhang X.N (China Earthquake Administration, CN)**

**The Electromagnetic Data Validation and Scientific Application Research Based on CSES Satellite**

Last ISSI-BJ Session: October 21-25, 2019

Scientific Rationale: China Seismo-Electromagnetic Satellite (CSES, also named Zhangheng-1 or ZH-1), the first space-borne electromagnetic monitoring platform in China, has been launched successfully on February 2, 2018. There are eight scientific payloads installed onboard, including HPM and SCM for magnetic field observation, EFD for the electric field, LAP and PAP for in-situ plasma parameters, HEPP for high-energy particles, and TBB and GOR for electron density profiles below the satellite. Based on this satellite, the team proposed the investigation of the near-Earth space plasma dynamics and the electromagnetic environment by multi-parameter analysis from a variety of payloads. This study aims to construct the chain of lithosphere-atmosphere-ionosphere processes associated with major natural disasters: earthquakes, tsunamis, typhoons, and volcanoes.

The goals are 1. to validate the data quality of CSES by combing other international missions, including DEMETER during 2004-2010, and the still in-orbit Swarm constellation since Nov. 2013; 2. to monitor the near-space electromagnetic environment, studying their variations with relation to the plasma; 3. to analyze the space weather and other natural and artificial events to reveal the coupling mechanism of the magnetosphere-ionosphere-atmosphere; 4. to study the disturbances possibly related to strong earthquakes observed by CSES, and the coupling models such as electromagnetic wave propagation model, overlapped DC electric model will be improved further to coincide with the observations.

The team made of leading Chinese and international experts in different disciplines will provide a unique opportunity for knowledge fusion to make a breakthrough in space electromagnetic data validation and application research of CSES.

**3.Orosei R. (INAF, IT)**

**Searching for Subglacial Water on Mars with Orbiting Ground Penetrating Radars**

Upcoming Session: TBD

Scientific Rationale: MARSIS is a syntheticaperture, orbital-sounding radar carried by the European Space Agency spacecraft Mars Express searching for subsurface water and ice on Mars. Recently, MARSIS found anomalously bright subsurface reflections in the Southern polar cap. Quantitative analysis of the radar signals produced estimates of relative dielectric permittivity matching that of water-bearing materials (Orosei et al., 2018). But the search for subsurface water is far from being complete, MARSIS is approaching the end of its operative life, and SHARAD, a higher-frequency radar sounder also operating at Mars, cannot penetrate at the depth at which MARSIS detected liquid water. The only possibility to extend the search for subglacial water in the Martian poles lays in the Mars Global Remote Sensing Orbiter, the first Chinese mission to Mars.

This proposal aims at creating the capabilities needed to expand the analysis presented in Orosei et al. (2018) to the whole of the Martian polar caps, involving also the next radar sounder to Mars. Observing the same area with three different sensors will allow the combination of their different resolution and penetration capabilities to produce a more detailed mapping of the physical properties and the stratigraphy of the subsurface.

The goals of the team are to 1. discuss and compare the technical characteristics and the capabilities of all three radars to assess the potential for combined analysis of the data; 2. discuss the onboard and ground processing methods for the data of each instrument, sharing the relevant information to determine the best methods to develop potential cross-calibration and joint data analysis between the three instruments; 3. use real data and simulated radar observations by the three different instruments for a set of test cases for the search of subsurface water on Mars, testing different approaches to data analysis; 4. define a set of recommendations for an effective science strategy in the future search for liquid water beneath the Martian polar caps, with a focus on the Mars Global Remote Sensing Orbiter radar sounder.

The team is made of scientists from both the MARSIS and SHARAD teams in Europe and the Mars Global Remote Sensing Orbiter radar from China, working together with experts in the modeling and simulations of electromagnetic propagation.

**4.Li G. (University of Alabama in Huntsville, US) and Wang L. (PKU, CN)**

**Using Energetic Electron and Ion Observations to Investigate Solar Wind Structures and Infer Solar Wind Magnetic Field Configurations**

Upcoming Session: TBD

Scientific Rationale: Solar electron events are a common phenomenon observed in interplanetary space. A majority of these events are related to small flares and they have no fast coronal mass ejections (CMEs) associated with them. Recent observations from multiple spacecraft (e.g. STEREO-A/B, Wind, and ACE) showed that electrons and ions in many of these events can be observed over a longitudinal separation of > 90 degrees or larger. What causes these large separations?

To answer this question, the team proposed a comprehensive investigation that includes both observations and simulations with three main objectives. First, extending the FVDA analysis to STEREO-A and STEREO-B data, and search for events where simultaneous observations from multiple spacecraft exist. For these events, the resulting path lengths from the FVDA analysis will be compared. Secondly, modeling the transport of energetic

electrons and ions in the turbulent solar wind, with a particular focus on the effect of the meandering field line. Finally, performing MHD simulations to examine how preceding CMEs can affect the configuration of the solar wind magnetic field.

Made of experts in solar and heliospheric modeling, theory, observations, and instrumentation, the team's strength lays in its interdisciplinarity

**5.Pevtsov A. (National Solar Observatory, US)**

**Modeling Space Weather and Total Solar Irradiance over the Past Century**

Upcoming Session: TBD

Scientific Rationale: Observations of magnetic fields on the Sun are ingrained into modern modeling of solar outer atmosphere and solar wind, the conditions throughout the heliosphere, and space weather effects near Earth and around other planets. Unfortunately, the systematic direct magnetographic measurements began in the mid-1960s. This lack of magnetograph data for early solar cycles severely restricts the development of a comprehensive understanding of solar activity and its space weather effects in the past, and their prediction for the future.

With the goal of developing a clear physics-based understanding of long-term changes in the heliosphere, total solar irradiance, and space weather conditions near Earth, this project will employ the newly developed maps of magnetic field for modeling the space weather effect on Earth and solar total irradiance (TSI) and solar spectral irradiance (SSI) over the last century. The team will also use community-accepted models such as PFSS, WSA-Enlil, etc to model the amount of open flux from the Sun, the location of coronal holes, the electron density, temperature, and speed of solar wind in the heliosphere and at 1 AU. The results of the modeling will be compared and constrained with historical observations of geomagnetic activity, which date as early as the early 1840s. The applicability of the newly created pseudo-magnetogram dataset to reconstructing total solar irradiance for the period of the last 100 years will also be explored.

This project will be a collaboration of a team of scientists from China, Finland, Germany, Italy, Japan, Russia, South Korea, and the USA.

**6.Yao Z. (University of Liège, UK) and Shi Q. (Shandong University at Weihai, CN)**

**The Morphology of Aurora at Earth and Giant Planets: Characteristics and their Magnetospheric Implications**

Upcoming Session: TBD

Scientific Rationale: Over the last two decades, auroral measurements at Earth, Saturn, and Jupiter have become regularly available. Since late 2016, a wealth of observations of Jupiter's aurora from the NASA/Juno mission and the Hubble Space Telescope (HST) and other multi-waveband observatories (e.g., Chandra, XMM-Newton, IRTF) have provided a unique opportunity to understand the Jovian polar aurora. Similarly, NASA/Cassini's orbital configuration from late 2016 to the end (during the Cassini Grand Finale phase) offered the best opportunity to investigate Saturn's polar aurora. Benefiting from the unprecedented large dataset of aurora at giant planets, the team is committed to a detailed investigation including data analysis and modeling, which will compare auroral features at Earth and the giant planets over multiple temporal and spatial scales. The goal is to understand the fundamental driving mechanisms that generate similar features despite the uniqueness of each planet's system.

The team aims to perform a detailed investigation comparing auroral features at different planets across multiple temporal and spatial scales. Specifically, the research group plans to build a global view of auroral morphologies throughout the solar system and, on a systematic basis, provide a theoretical or numerical model to understand the similarities and differences of auroral morphologies at different planets. Three specific research topics are addressed: 1. comparing and contrasting aurora morphologies at Earth, Saturn and Jupiter; 2. determine and compare the physical processes that drive similar auroral morphologies at different planets; 3. modeling and theoretical investigations of the fundamental auroral features at Saturn and Jupiter.

The team is composed of experienced scientists from different countries, six working on planetary auroral sciences, five working on terrestrial auroral sciences, while the team leader Dr. Yao is an active researcher in both communities.

**7.Ward M. (Durham University, UK)**

**Active Galaxies in Crisis: A Statistical Study of Ultra-Violet Variability**

Upcoming Session: TBD

Scientific Rationale: Much progress has been made in our understanding of active galactic nuclei (AGN) in the 85 years, and mass accretion via a hot rotating disc onto a supermassive black hole is now the well-accepted picture. Mass accretion via a hot rotating disc onto a supermassive black hole is now the well-accepted picture. However, much is left to be explored. This has been highlighted by the increased use of the time domain as a new tool to investigate the inner regions of AGN that we cannot spatially resolve.

This team will focus on a particular aspect of time-domain astrophysics, namely the ultra-violet (henceforth, UV). This wavelength region is not accessible from the ground (except for the bluest u-band) due to atmospheric absorption. For low redshift AGN which often has the best quality data, this is the wavelength region dominated by the accretion disc, a key component in our understanding of the physics of AGN. The timescales of AGN UV variability are inconsistent with basic ideas of the source of the observed variations. In particular, viscosity changes within the disc occur far too slowly compared with observations ("The Quasar Viscosity Crisis", Lawrence, 2018).

Finally, the project aims to address the UV variability as a symptom of this crisis by quantifying the UV variability on timescales from weeks to decades, for a very large sample of AGN. It will be the first such study to exploit the huge UV databases that exist for observations from the ESA cornerstone mission XMM-Newton and the Neils Gehrels Swift Observatory (with Italian and UK involvement).

## Teams Selected in 2020

**1.Toshi N. (Boston University, US)**

**Multi-scale Magnetosphere-ionosphere-thermosphere Interaction**

Upcoming Session: TBD
Scientific Rationale: Localized structures in the Magnetosphere-Ionosphere-Thermosphere (M-I-T) system in space have major adverse impacts on radio communications and satellite operations. Although the existence of such structures has been known, efforts for understanding their quantitative properties and formation processes are severely limited. It is a scientific challenging issue because coupling processes across scales (multi-scale) have to be handled.

The team proposes to quantify the role of multi-scale processes in the M-I-T system and to advance the community's understanding of how multi-scale structures form and evolve. We will determine occurrence conditions and properties of key quantities over multi-scales (energetic particles, flows, currents, plasma density, and neutral density, wind, and temperature) by taking advantage of the growing network of highresolution observations. Multi-scale numerical simulations will take the observed properties and examine reproducibility and physical mechanisms of the formation of meso/small-scale structures.

This investigation is timely because of the growing availability of high-resolution observation in space and on the ground, the growing capability of high-resolution numerical simulations, and the significant community interest as demonstrated in several recent conferences and workshops. We will form a team with a diverse and comprehensive set of expertise across our research domain throughout the M-I-T system, who otherwise will not have a chance to meet all in the same room for extensive discussion and effective collaboration.

The team will have two in-person meetings (one in Bern and another in Beijing) and two teleconferences, and the results will be disseminated through scientific journals and conferences.

**2.Leaman R. (Max-Planck Institute for Astronomy, DE); Zhu L. (Shanghai Astronomical Observatory, CN)**

**Population-Dynamical Archeology of Galaxies**

Upcoming Session: TBD
Scientific Rationale: Galaxies show a huge diversity of structure and stellar populations, reflecting a complex and unknown mixture of star formation episodes and hierarchical merging events in their past that are impossible to observe directly. Promising new methods to recover the distribution of stellar orbits within a galaxy can reveal its dynamical 'skeleton', which in turn sets the spatial distribution of its baryons. However, to reconstruct the assembly history of the galaxy, we must simultaneously infer ages for the recovered orbits of stars and star clusters. Age dating these stellar tracers provides a dynamical memory for the galaxy, as the orbits are imprinted by discrete events (galaxy mergers, starbursts) in the galaxy's history. We have begun the first steps towards this novel combination of stellar population and orbitbased dynamical modeling.

With the support of the ISSI team framework, we will apply this revolutionary tool to existing data available from the astronomical community. The dynamical records this method identifies will pinpoint the epoch of major mergers which grew a galaxy's bulge and halo, or timescales over which its disk(s) formed. These focused meetings are necessary, as a particularly diverse set of expertise (spectroscopic data analysis, chemical evolution, dynamical modeling, algorithm optimization, model validation via comparison with simulations) is required to solve this problem.

The timing of this funding proposal is crucial to exploit the wealth of space and ground-based imaging and wide-field spectroscopic data that are being released for thousands of galaxies— and for the first time, age-date the invisible past assembly history of galaxies.

**3.Li R. (National Astronomical Observatories of China, CN)**

**Strong Gravitational Lensing Studies with CSS-OS and EUCLID**

Upcoming Session: TBD
Scientific Rationale: Strong lensing systems provide a unique laboratory in which to study the fundamental physics of the Universe and the evolution of galaxies. Two next-generation space-based surveys, the Chinese Space Station Telescope survey (CSS-OS) and the ESA Euclid mission, will increase the number of known strong lenses by over two orders of magnitude, and survey them all with high-resolution imaging in near-UV to infrared wavelengths.

This international team includes experts in strong lensing from both missions to explore the potential scientific return of a joint analysis of the combined data.

Specifically, we will address the following key problems:

1) How to efficiently search for strong lens systems in Euclid + CSS-OS data

2) How to model the distribution of dark matter in strong lens systems with multi-color imaging

3) Optimum synergy between the two survey designs

**4.Brasseur G. (Max Planck Institute for Meteorology, DE); Granier C. (Laboratoire d'Aérologie, FR)**

**Use of Geostationary Satellites to Improve Air Quality Characterization and Forecasts**

Upcoming Session: TBD
Scientific Rationale: We propose to assemble an international team of experts in air quality studies, atmospheric chemistry modeling, and remote sensing to make the best use of the most recent and forthcoming high spatial and temporal resolution satellite instruments dedicated to atmospheric composition. Space observations of the chemical composition of the atmosphere are a primary source of information on the formation and fate of large-scale and regional air pollution. In the very recent period, there have been major advances in space observations of chemical species, with the launch of the Sentinel-4 satellite, which includes the TROPOMI instrument. This unique instrument observes several key air pollution species at a much higher spatial resolution than earlier instruments. Furthermore, in February 2020, a geostationary satellite, GEO-KOMPSAT-2, was successfully launched, which includes the GEMS spectrometer (Kim et al., 2020), the first geostationary instrument measuring air pollution from space. GEMS is the Asian element of a constellation of three geostationary satellites, which will include in a few years the Sentinel-4 European component and the TEMPO component for North America.

The objective of the proposed project is to gather a multi-disciplinary team of scientists, who will jointly investigate and develop novel approaches to make the best use of these high temporal and spatial resolution satellite observations to improve regional and local air quality monitoring and forecasts. The team will be composed of experts in space observation retrievals, in situ measurements, meteorological and chemical modeling, data assimilation and inverse modeling, and surface emissions. The two projected workshops, one in Beijing and one in Bern, will provide the opportunity for a detailed discussion on the different issues related to optimized use of the most recent and future high-resolution satellite datasets. The first meeting that will be organized in Beijing will give an excellent opportunity for Asian scientists to share the first results from the geostationary GEMS instrument focusing on Asian pollution, and to contribute in the future to the analysis of these space observations.

**5.Feng W. (IGG, CAS, CN)**

**Time-variable Gravity Field Modeling and Simulation from Present and Future Gravity Satellite Missions**

Upcoming Session: TBD
Scientific Rationale: The team proposes to assemble an international team 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. Besides, the numerical simulation for possible synergistic observing of gravity satellites from Europe and China will be investigated for retrieving mass changes with higher spatiotemporal resolutions and accuracy shortly.

The aim of the team members will join their efforts for gravity field modeling especially the added contribution from China to generate established combined time-variable models to be included in the Combination Service for Time-variable Gravity Field Solutions (COST-G) and to establish so improved reference models as it has been demonstrated by the EGSIEM (European Gravity Service for Improved Emergency Management) project of the European Community. Also, the simulation of constellation design for Chinese gravity satellites will be performed to pave the way to multi-pair gravity missions for improving our understanding of mass redistribution among different spheres of the Earth, i.e., hydrosphere, cryosphere, atmosphere, and lithosphere. The temporal mass variability in the Earth system observed by gravity satellites is crucial to understand climate change and anthropogenic activities, e.g., droughts and flooding, sea-level change, groundwater depletion, glacier melting, etc.

ISSI and ISSI-BJ will offer us ideal facilities to establish fruitful interactions and meetings between the members in creating a framework of regular and dedicated science rendezvous. The international team involved in the project unified for the first time in the field of satellite gravity inversion and simulation from leading Chinese experts, and scientists from Switzerland, Germany, France, and Austria. The meetings supported by ISSI/ ISSI-BJ will provide excellent opportunities for us to have concrete face-to-face discussions and build the foundation for further close international collaboration on satellite gravimetry.

**6.Bemporad A. (INAF, IT); Feng L. (PMO, CAS, CN)**

**Solar Eruptions: Preparing for the Next Generation Multi-Waveband Coronagraphs**

Upcoming Session: TBD

Scientific Rationale: Space- and ground-based coronagraphs, together with EUV space-based imagers, are the only instruments capable of providing observations of Coronal Mass Ejections (CMEs) from their early acceleration phases to interplanetary propagation. As the study of these phenomena is key for our understanding of how the Sun interacts with planets and modulates the whole Heliosphere, coronagraphs will be onboard the recently launched and upcoming solar missions, such as the ESA Solar Orbiter and PROBA-3 missions, the Chinese ASO-S mission, the Indian Aditya-L1 mission. These future coronagraphs will provide a new capability that was almost unexplored so far: the acquisition of coronagraphic images in multiple narrow-band spectral ranges, from visible light (VL) to ultraviolet (UV). Moreover, next space- (Aditya-L1/VELC) and ground-based coronagraphs (UCoMP, CorMAG) will acquire spectro-polarimetric observations to measure the weak coronal magnetic fields. The analysis of these innovative data will require the development and testing of new diagnostic techniques to determine not only the CME plasma densities (usually done from broad-band VL images), but also other parameters such as the electron temperature, line optical thickness, filling factors, and magnetic fields.

The goal of the proposed Team at ISSI-BJ is to investigate how the CME properties affect the expected emission in the future multi-waveband coronagraphic observations, to develop new diagnostic techniques to tackle the open science questions on CMEs. This will be done by building synthetic data based on existing MHD simulations, testing new diagnostics with synthetic data inversion, and applying the newly developed techniques to existing and future data.

**7.Bosco Habarulema J. (South African National Space Agency, South Africa); Qian W. ( National Center for Atmospheric Research, US)**

**Long Term Ionospheric Effects and Their Associated Modeling During Extreme Space Weather Events over the African Sector**

Upcoming Session: TBD

Scientific Rationale: The study of ionospheric dynamics and electrodynamics over the African region is complicated due to two main factors. The first one is largely logistical due to the scarcity of ground-based instrumentation dedicated to providing vital observations for utilization in different scientific investigations. The second challenge has to do with different Physics exhibited at different latitude regions given that the African sector comprises mid-latitudes in both northern and southern hemispheres as well as low/ equatorial regions. The first challenge prohibits the accurate handling of the second problem. As a result, the ionospheric behavior over the African sector is less understood and there remain several outstanding questions. Thus, the comprehensive understanding of different phenomena over the African sector is only based on the physical process performed only through a combination of measurements with existing sparsely located ground-based and satellite-based instruments. On the other hand, the demand for precise ionospheric correction for communication and navigation application in the region has grown up dramatically. However, to correct the impact of the ionosphere on the commination/navigation radio signals, understanding the physics behind each ionospheric phenomenon in the region is essential. This requires continuous observations of ionospheric parameters and their internal (due to lower thermosphere-ionosphere coupling) and external (due to solar wind–magnetosphereionosphere coupling) drivers, which become complex during both quiet and extreme space weather events. We propose to assemble a team of diverse expertise to look at different ground-based and satellite datasets and model simulations to perform analyses and interpretations of the longterm ionospheric effects during extreme space weather events over the African sector with a view of addressing issues related (but not limited) to:

1) What mainly controls the ionospheric dynamics in the African sector?

2) Is it the forcing from above (SWmagnetosphere-ionosphere coupling) or from below (lower thermosphere-ionosphere coupling such as the role of atmospheric gravity waves (AGWs), planetary waves, and tides)?

3) What is the relative contribution of the SWmagnetosphere-ionosphere coupling during disturbed conditions (over the existing background conditions) on a long-term scale?

To contribute to the above questions, a multiinstrumental approach is required. Therefore, the assembled team comprises the principal investigators (PIs) of different instrumentation deployed in the African continent. The instruments include magnetometers, Fabry Perrot Interferometers (FPIs), Global Navigation Satellite Systems (GNSS) receivers, very high frequency (VHF) radar, ionosondes, and Continuous Doppler Sounding Systems (CDSSs). The beauty of these different instruments is that they observe different parameters, and coordinating these measurements provides an excellent opportunity for the working team to understand the physical process that controls unique ionospheric dynamics and structure in the African sector during quiet and disturbed conditions. Considering the range of instruments and volume of scientific results from long-term observations, performed by individual PIs, require extended discussion time to coordinate and understand all the results, we propose to hold TWO one-week face-to-face team meetings at ISSI in Beijing, China. Provisionally, we propose to hold the meetings in the second half of 2021 and 2022. The step-by-step progress report of the team's effort will be presented at different international conferences, and the final paper(s) will be published in a peer-reviewed journal.

## Teams Selected in 2021

**1.Jamet C. (Univ. Littoral Côte d'Opale, Univ. Lille, FR); Dionisi D. (CNR – ISMAR, IT)**

**Toward a 3-D Observation of the Ocean Color: Benefit of Lidar Technique**

Upcoming Session: TBD

Scientific Rationale: Passive ocean color space-borne observations began in the late 1970s with the launch of the Coastal Zone Color Scanner space mission. An uninterrupted record of global ocean color data has been sustained since 1997. These passive observations have enabled a global view of the distribution of phytoplankton and marine primary productivity. However, these measurements are limited to clear sky, daylight, high Sun elevation angles, ice-free oceans and are exponentially weighted toward the ocean surface. Moreover, the processing of the ocean color images requires the knowledge of the atmospheric components (gases, air molecules and aerosols).

Lidar (Light Detection and Ranging) is a"laser radar" technique that has been used for a wide range of atmospheric and ocean applications. As an active remote sensing technique, it can overcome some of the above-mentioned limitations of passive observations. Despite several cases that demonstrated oceanic applications of ship-, air- and space-borne lidars, this tool has not received significant attention from the ocean color remote sensing community. Recently, it has regained interest from the ocean community as new studies used the lidar signal from the space-borne CALIOP/CALIPSO and ATLAS/Ice-Sat-2 instruments to estimate the ocean particulate backscatter and showed the feasibility of using both lidars to provide accurate estimates of the ocean color over the globe and in the polar regions (and over the water column for ATLAS). Thus, satellite lidars are a natural complement to passive ocean color radiometric remote sensing, operating under thin clouds, between holes in broken clouds, and in polar regions, providing vertical measurements both during day and night.

However, as those space-borne lidars are primarily dedicated to atmospheric and land measurements, several issues need to be considered for being able to optimally use them in oceanic applications. Among them, we propose to tackle the following issues: 1) Validation of CALIOP and ATLAS retrievals including intercomparison of the results obtained with both retrievals and 2) Analysis of the limitations of the current space-borne lidars. The outcomes of this International Team work will help to define a scientific roadmap for a future dedicated space-borne oceanic profiling lidar. Our work is to be concluded with peer-reviewed publications. We propose to have two 3/4-day meetings at ISSI and one 4-day meeting at ISSI-BJ.

**2.Krucker S. (University of Applied Sciences and Arts Northwestern Switzerland, CH); Jeffrey N. (Northumbria University, UK)**

**Measuring Solar Flare Hard X-ray Directivity using Stereoscopic Observations with Solar Orbiter/STIX and X-ray Instrumentation at Earth**

Upcoming Session: TBD

Scientific Rationale: The hard X-ray (HXR) imaging spectrometer STIX on board Solar Orbiter gives us the first opportunity to systematically perform stereoscopic X-ray observations of solar flares with a new X-ray fleet: ASO-S/HXI, Aditya-HEL1OS, GECAM, and potentially with PADRE, a CubeSat proposed for this task and carrying STIX cross-calibrated detectors. These observations will provide the first reliable measurements of HXR directivity, our link to the angular distribution of flare-accelerated electrons, and constrain the processes that can accelerate electrons in the corona and in other astrophysical objects. However, such observations must be compared with theory and state-of-the-art modelling taking into account various transport effects and realistic plasma conditions, all of which can change the properties of the measured HXR directivity. Further, measurements of HXR directivity with confidence intrinsically rely on the calibration accuracy of the independently developed detector systems of the different HXR telescopes. In our ISSI team, we propose to bring together experts of each of the different instruments with theorists. The goal of our meetings is to establish requirements on the calibration accuracy derived from simulations so we can distinguish between different theoretical models, and then work out a joint calibration approach of the different detectors to reach the required accuracy. Additionally, the first joint observations between STIX and instruments at Earth (Aditya-HEL1OS and GECAM solar data) will be available in 2021 so it is vital to bring our team together in 2022

**3.LU San (USTC, CN)**

**Interaction between Magnetic Reconnection and Turbulence: from the Sun to the Earth**

Upcoming Session: TBD

Scientific Rationale: Magnetic reconnection is an important process in space plasmas, which converts magnetic energy to particle acceleration and heating through topological changes in magnetic fields. It is therefore believed to be responsible for explosive phenomena in space, especially solar flares and geomagnetic storms/substorms. Turbulence shaped by linear/nonlinear waves and coherent structures on magnetohydrodynamic (MHD) and kinetic scales (frequencies) is a fundamental component of space plasma. It is natural to consider the interaction between these two important aspects of space plasma. Recent studies have shown that magnetic reconnection can produce waves and coherent structures to form turbulence. On the other hand, turbulence can provide and enhance dissipation to allow and accelerate magnetic reconnection. In addition, in plasmas that are already turbulent, magnetic reconnection can play a major role in the dissipation of turbulent energy. Recently, new observations have opened up new windows into turbulence and reconnection occurring in different heliospheric plasma contexts, from the Earth's environment (THEMIS, ARTEMIS, MMS) to the solar wind and inner heliosphere (Parker Solar Probe, Solar Orbiter, Bepi Colombo). Thus, it is timely to establish an ISSI-BJ team with a balanced mix of theoretical, simulation, and observational expertise to study the interaction between magnetic reconnection and turbulence. The team will focus on four important space plasma regimes, the solar corona, the solar wind, Earth's magnetosheath, and Earth's magnetosphere. The team aims to answer the following questions: What waves and coherent structures are produced by magnetic reconnection to form turbulence? (2) What are the effects of turbulence on the process of magnetic reconnection? (3) What is the role of magnetic reconnection in dissipation of turbulent energy in turbulent plasmas? To answer these questions, the team will perform MHD, Hall MHD, hybrid, particle-in-cell simulations, which will be guided by and compared with in-situ and optical observations from the Sun to the Earth.

**4.N. Pedatella (National Center for Atmospheric Research, US)**

**Data Assimilation in the Ionosphere and Thermosphere**

Upcoming Session: TBD

Scientific Rationale: Specification and forecasting of the Earth's ionosphere and thermosphere (IT) is of critical importance owing to its impact on, for example, navigation signals (e.g., GPS) and satellite orbital drag. Following the path of troposphere numerical weather prediction, the IT community has recently adopted data assimilation techniques in order to improve specification and forecast capabilities. In addition to operational space weather applications, data assimilation models are a valuable tool for addressing fundamental IT scientific questions. In particular, physics-based data assimilation models enable investigation of the predictability of the IT system, including the physical mechanisms controlling the predictability. By providing the best estimate of the IT state, data assimilation models further enable improved understanding of the processes driving IT variability, making them a valuable resource for the scientific community.

Data assimilation in the IT is a relatively recent endeavor, and the methodologies remain relatively immature with a variety of different approaches taken by different researchers. Furthermore, the capabilities of data assimilation models to investigate the predictability of the IT have yet to be fully exploited. We propose to bring together experts in data assimilation, numerical modeling, and observations in order to: (1) investigate the predictability of the IT, and (2) improve current IT data assimilation techniques. The predictability of the IT system has yet to be fully explored, making it an important, unresolved, scientific question. Aspects of the

IT predictability will be investigated through detailed event studies, enhancing scientific understanding of both IT predictability as well as the advantages and disadvantages of different data assimilation techniques. Through comparison of different data assimilation techniques, we will develop an in-depth understanding of the optimal approaches for IT data assimilation. The ISSI will additionally provide a forum for the development and exchange of IT specific data assimilation algorithms. It is critical for such a forum to take place now given the recent availability of abundant new IT observations from the COSMIC-2, GOLD, and ICON missions.

**5.Zuccarello F. (University of Catania, IT) LUO Bingxian (NSSC, CAS, CN)**

**Step forward in Solar Flare and Coronal Mass Ejection (CME) Forecasting**

Upcoming Session: TBD

Scientific Rationale: The genesis of solar flares and coronal mass ejections (CMEs) in solar active regions (ARs) is still not well understood, despite the capital importance of these eruptive events in various aspects of the Sun-Earth connection. A central pursuit of contemporary solar and space physics is to protect our technologically-dependent society that can find itself at considerable risk from impulsive radiation flux and relativistic charged particles streaming from the Sun. The occurrence rate of the most energetic eruptions traversing the entire Solar System follow the 11-year solar cycle, although outliers in terms of both timing and size are known to exist; e.g., the Carrington-event. At the peak of the cycle, several hazardous high-intensity flares and very fast CMEs may occur, even multiple times each month. Major flares and CMEs associate with complex sunspot groups. Indeed, the sources of the most intensive solar eruptions are mixed-polarity ARs; their complexity, reflected in their morphological properties, plays a decisive role. A key question of contemporary Space Weather (SW) research is how to optimize flare and CME forecasts. To date, there are no unique markers known to reliably indicate whether an AR will erupt within a certain time window and how strong the eruption will be. With this coordinated research proposal, we wish to make a step forward by assembling a remarkably international team consisting of i) members with complementary expertise on SW research underpinned by strong track records and ii) additional early-stage researchers who have just embarked on flare, CME and overall SW forecasting.

**6.LI Bo (Shandong University Weiha, CN); Nakariakov V. (University of Warwick, UK)**

**Magnetohydrodynamic Wavetrains as a Tool for Probing the Solar Corona**

Upcoming Session: TBD

Scientific Rationale: Magnetohydrodynamic (MHD) wave-caused perturbations abound in the highly structured solar corona, with their measurements key to the flourishing field of coronal seismology. However, these perturbations are seldom as ideal as canonically theorized. Rather, they tend to appear as isolated or intermittent sequences of wavetrains (WTs), here broadly taken to refer to wave motions localized in time and space with or without envelope modulation. While already heavily involved in the establishment of coronal seismology, WTs have been shown to be ubiquitous only in the past decade. This stride was made possible largely due to the availability of cutting-edge instruments with ever-increasing temporal and spatial resolution. WTs are now known to be associated with a diverse set of eruptive activities, ranging from microflares to miniature jets to fully-fledged flares and coronal mass ejections (CMEs). Likewise, WTs have been identified in post-flare loops, quiescent active region loops, polar plumes, as well as the flanks and wakes of CMEs. On the theoretical side, WTs are known to encode a rich set of information not only on their exciters and host media, but also on the processes that shape their hosts. Nonetheless, available studies on WTs remain to be conducted largely on an individual basis by disparate groups with their own focuses/emphases. The objective of this project is therefore to assemble an ISSI-BJ team of top-notch observers, theorists, and numerical experts to examine WTs in a synergistic way such that the diagnostic potential of WTs can be exploited to a much fuller extent than before. Specifically, as a team we will

• Transfer the knowledge pool from individual groups across the team and eventually to the community, thereby enhancing the detection and quantification of WTs.

• Categorize the diverse WTs in terms of morphology, kinematics, and energetics as well as their exciters and hosting structures.

• Develop seismic tools to invert the measurements of WTs for the physical conditions in both closed and open portions of the solar corona. In addition to their key discoveries, the team members will ensure the success of this project by their extensive experience with advanced MHD codes (e.g., AMRVAC1, PLUTO, FLASH, LareXd), novel tools for data analysis, as well as multi-passband instruments deployed both on ground (e.g., LOFAR, MUSER, NoRH, RATAN-600) and in space (e.g., SDO, STEREO, RHESSI). The outcome of the project will better connect the in situ measurements by Parker Solar Probe to the corona. Likewise, the developed techniques will find applications to the data that will soon be routinely released by Solar Orbiter, and in particular by its METIS instrument which specifically addresses "plasma density fluctuations, turbulence, and waves"

# FUTURE ACTIVITIES

## FORUMS

### The Lunar Scientific Station

**TBD**

*Conveners: Wang Chi (NSSC, CAS, China); Yu Dengyun (CAST, China).*

In recent years, China has doubled its efforts to achieve significant scientific results in the exploration of the moon and its features in the context of its Lunar Exploration Program (CLEP), which led to the Chang'e-4 landing on the far side of the moon in December 2018.

Such an achievement represented the peak of the Chang'e missions promoted by the country, whose four satellites CE-1, CE-2, CE-3, and CE-4, focused on the circling (CE-1 and CE-2), landing (CE-3 and CE-4), and returning (CE5) before 2020. As the first three phases are now concluded, the new phase four, spanning over 15 years (2020-2035), will concentrate its efforts on the primary unmanned research station.

The scientific objectives to be achieved by the 2020-2035 missions will include the distribution, contents, and origin of water on the moon; the deep composition and structure of the moon; the age of the South Pole Aitken basin; the near-moon space environment of the South Pole. Furthermore, the experiments to be performed will investigate and include resource utilization during in situ experiments (water, He, lunar soil, etc.), the Earth-moon VLBI testing, and ecosystem science experiments.

The exploration will be articulated in three different missions, with the overall goals of producing a highly accurate survey on the moon, its regional geology, collect samples to conduct laboratory studies, and provide longterm lunar observations:

Mission 1: Lunar surface exploration and geological survey on landing site (Orbiter, Lander, Rover, Flying robot, Relay satellites);

Mission 2: Collecting samples and return them to Earth for analysis (Ascender, Lander, Returner, Orbiter);

Mission 3: Lunar surface observations and scientific application experiments (Lander, Rover, Flying robot).

In order to summarize and analyze the yielded results and think thoroughly of the phase 4 of CLEP, which will prioritize international collaboration, several leading international scientists in moon science will gather at ISSI and ISSI-BJ. The first forum session will be held at ISSI, while the second part will be hosted by ISSI-BJ, and its overall objectives include: the selection of landing site for scientific research station; the optimization of scientific objectives; the possibility of international cooperation (including payload, scientific research, etc.).

The results of the forum sessions will be published in the ISSI-BJ Taikong magazine series, the forums' output which is available online and understandable to non-experts.

China's Chang'e-4 - Credits: NSSC, CAS, China

### Detecting "Missing" Baryons in the Universe

**TBD**

*Conveners: Cui Wei (Tsinghua University, China); Joel Bregman (University of Michigan, USA); Fang Taotao (Xiamen University, China); Jan-Willem den Herder (SRON, The Netherlands); Dan McCammon (University of Wisconsin-Madison, USA); Kazuhisa Mitsuda (ISAS/JAXA, Japan); Noriko Yamasaki (ISAS/JAXA, Japan); Yuan Feng (Shanghai Astronomical Observatory, China); Maurizio Falanga (ISSI, Switzerland).*

The goal of this ISSI-BJ forum is to discuss the problems of missing baryons on scales of galaxies and large-scale structures and to make plans for X-ray missions that are dedicated to solving these problems. The missing baryons are deemed to constitute a major component of the circumgalactic medium (CGM) and intergalactic medium (IGM), but they are difficult to observe due to the limitations of the current instrumentation, and thus, they represent a key obstacle to our understanding of the galaxy evolution. During this activity, the forum participants will discuss the results yielded from cosmological hydrodynamical simulations on the properties of the hot CGM and IGM, the observational evidence for their existence, and the implications on galaxy evolution. Moreover, it will be discussed how to fill the observational gap of directly detecting the missing baryons and thus measuring their properties and distributions.

Since they are postulated to exist in the form of low-density, hot CGM/IGM, and to radiate mainly in soft X-rays, the discussions will center on effective X-ray means. To this end, a number of proposed mission concepts will be presented. Consensus will be sought on an optimal strategy to collectively push for a high-resolution X-ray spectroscopic mission and to sustain the momentum over the long run. Besides the subject of missing baryons, the participants will also discuss some important scientific issues related to the topic that can benefit from high-resolution X-ray spectroscopic observations, including diffuse X-ray background, supernova remnants, and cluster outskirts, as well as techniques of modeling the high-resolution X-ray spectra obtained.

The results will be published in the ISSI-BJ Taikong magazine series.

Objectives

The meeting will be divided into five main sessions, including:
1. Census of cosmic baryons
2. Theoretical understanding of missing baryons
3. Recent observations of WHIM and implications
4. High resolution X-ray spectroscopic observations and modeling
5. Synergies and collaborations

Missing Baryons - Credits: Illustris Collaboration

## Performing High-Quality Science in Astronomy on Space Stations

**TBD**

*Conveners: Matthias Sperl (DLR, Germany), Athena Coustenis (The Observatoire de Paris-PSL, France), Dominique Langevin (Université Paris-Saclay, France), Lev Zelenyi (IKI, Russia) (TBC),Jianfu Zhao (IMCAS, China).*

On May 28, 2018, the United Nations and China jointly release the United Nations/ China Cooperation on the Utilization of the China Space Station First Announcement of Opportunity. The cooperation provides scientists from around the world with the chance to conduct their experiments aboard the China Space Station. They received over 40 applications from 27 countries, and a few related to Space Sciences, such as

• Forecasting Solar Energy Particle Events;

• Spectroscopic Investigation of Nebular Gas;
• POLAR-2: Gamma-Ray Burst Polarimetry.

• This ISSI-BJ Forum will bring together a set of international scientists with some interests in the application of space stations space experiments' relevant disciplines with a selection of experienced system developers to discuss existing, planned, and future experiments on e.g., CSS or ISS.

• With participants from several countries, including China, Europe, Russia, Japanese, USA, and India, the Forum will identify the key characteristics for suitable experiments on space stations, it will undertake an outline examination of the feasibility of a range of "mission" concepts, and it will characterize barriers that limit the scientific impact of these measurement platforms.

• While technical and engineering topics are outside ISSI-BJ activities, the Forum tool appears ideally suited to enable a broad discussion on this thematic. The two-day forum will focus on the following key topics:

• Identify suitable Space Stations payloads in a variety of fields and discuss their feasibility and/or science results that have already been achieved;

• Identify barriers — both technical and otherwise — that limit the scientific impact of the Space Station platforms;

• Identify the limitations of the Space Stations as a platform of scientific investigation.

The Chinese Space Station - Credits: CMSEO

## For a Fundamental Improvement of the Lunar Crater Chronology

**TBD**

*Conveners: Zhiyong Xiao (Sun Yat-sen University), Stephanie C. Werner, (University of Oslo), Stuart J. Robbins (Southwest Research Institute, Boulder),Caleb I. Fassett (NASA's Goddard Space Flight Center), Carolyn van der Bogert (University of Münster), Greg Michael (Freie Universität Berlin).*

Statistics of impact craters is the dominating technique used to estimate relative and absolute model ages of exterrestrial bodies. This technique is built on the premise of known production rates of different-sized craters, which is largely supported by isotopic ages of sampled returned by the Apollo and Luna missions and observations of crater size-frequency distributions at the sampling regions. Prediction of impact flux based on orbital dynamics is a relatively independent approach, which also needs to be calibrated against observations by previous lunar explorations.

The first order reliability of crater statistics in estimating relative and absolute model ages has been well verified in many tests. However, debates and concerns about the accuracy of this technique exist pervasively. For examples, the provenance of samples returned by Apollo and Luna samples, even those thought to be related with Copernican-aged terrains, contains certain ambiguity, and we frequently see different interpretations about the source region/event; populations of impactors in the inner solar system might have been different at different planetary bodies, and/or at different geological times for a given planetary body; connections between observed crater populations and postulated impactor populations might not be straightforward due to difficulties caused by target properties, secondaries, and inadequate knowledge of impact cratering mechanics.

We are in the beginning of another golden age of lunar exploration. Our knowledge about lunar science has been substantially improved thanks to the many new missions performed in the first decade of the 21st century. The past five years have witnessed grand progress of the Chinese lunar exploration program, the ambitious plan of the Artemies Program, and numerous new powers determining to arrive the Moon. It can be imagined that more samples from a broader region of the Moon that have much clearer geological contexts, such as those returned by the Chang'E-5 mission, would become available in the coming few years. Therefore, lunar crater chronology would be fundamentally improved in the coming decade.

The aims of this ISSI-BJ forum are to discuss 1) the key scientific questions existed in the lunar impact history and crater chronology; 2) the scientific objectives and sampling requirements of future lunar explorations. Leading scholars from all fields related with the impact history of the Moon and terrestrial planets (e.g., planetary geology, sample analyses, orbital dynamics, etc.) are invited to this forum.

## Space Resources Forum

*Conveners: Angel Abbud-Madrid (Colorado School of Mines, USA), Chris Welch (International Space University, USA), Meng Su (University of Hong Kong, China), Anhuai Lu (Peking University, China), Kefei Zhang (China University of Mining and Technology/RMIT University, China), Yang Gao (University of Surrey, UK), Amara Graps (Baltics in Space,EU).*

The purpose of the workshop is to share and exchange thoughts and progress between Chinese and international experts on space resources.

The exploration and utilization of space resources is an interdisciplinary subject, including planetary science, astronomy, aerospace technology, mining technology, machine learning, etc. The progress in this area is fast recently due to the commercial activities around the world. There were several international conferences in previous recent years focusing on space resources.

The Chinese aerospace community has not participated in the discussion of space resources with international professionals very much. On the other hand, the community has accumulated a lot of related technologies to explore space resources.

The forum will have 4 sessions:
-Science and Technology
-Education and Jobs
-Market and Capital
-Laws and Policy
The participants include scientists, engineers, lawyers, investors, government officials, etc.

It will be great with ISSI's organization to attract more professionals to join the workshop.

## Exploration of the Local Interstellar Medium Intruding in the Heliosphere

*Conveners: Qiugang Zong (Peking University, China) , Stas Barabash (Swedish Institute of Space Physics, Sweden), Michael Blanc (Institute of Astrophysics and Planetary Science (IRAP), France), Huaiyu He (IGGCAS , China), Merav Opher (Boston University, USA), Jiansen He (Peking University, China), Hui Li (NSSC,CAS, China).*

The forum plans to invite internationally renowned scientists and engineers to focus on the local interstellar medium invading the heliosphere especially in the enrichment region caused by the focusing effect of solar gravity. The forum will conduct in-depth and extensive debate in the form of special topics, refine relevant cutting-edge scientific issues and list suggestions on relevant exploration targets. The experts participating in this forum will also discuss the subsystem design required by the exploration plan (including orbit and launch, satellite platform design, load configuration, measurement and control data transmission, scientific application, etc.), analyze the key technical breakthrough and early scientific preparation required for exploration, and look forward to the expected breakthrough progress and its scientific significance.

Our solar system locates in a spiral arm called the Orion Spur, 27,000 light-years from the center of the Milky Way. Many newborn stars have been observed in the interstellar medium of the nebulae inside and outside our galaxy. The solar system evloved from an ordinary but special planetary nebula that harbors our blue star and advanced life. What is the local interstellar medium around our solar system? It is an intriguing and critical topic. There are four relevant scientific questions:

(1) How does the local interstellar medium affect our heliosphere? The extrinsic interstellar medium and the intrinsic solar wind determine the size, the structure, and the dynamics of our heliosphere. It is impossible to determine the outer boundary conditions of the heliospheric system, and thus the state of the heliospheric system in which we live, without understanding the condition of the local interstellar medium.

(2) What is the past, present, and future of the Sun and the heliosphere in the local interstellar medium? Although revolving around the galactic center together, the local interstellar medium and the solar system have a relative motion. Such relative motion means that the neutral components in the local interstellar medium have a relative motion concerning the solar system. The neutral components can intrude into the heliosphere without being blocked by the interplanetary electromagnetic field. The intrusive local interstellar medium could be detected in-situ and provides a basis for understanding the history and predicting and future of the solar system in the local interstellar medium.

(3) What is the effect of the local interstellar medium on the origin and evolution of the solar system? For exploring the origin and evolution of the solar system, it is crucial to understand and compare the composition of the solar system nebulae with that of the local interstellar medium around the solar system. What are the similarities and differences between the current local interstellar medium and the speculated original nebula in which the solar system (planetary) nebula is located? It is one of the critical frontier scientific questions.

(4) What are the detectable components of the intruding local interstellar medium in the solar-gravity-affected enrichment region (between 2 and 3 au) and the scientific significance of the detection? Can we accurately detect the neutral gas, dust, and energy neutral atoms from the local interstellar medium in the heliosphere? What are the significances of these precise measurements for revealing the properties of the local interstellar medium and its interactions with the heliosphere?

At this stage, it is at the right time to apply for this forum. Previous space science

missions (e.g., Ulysses, IBEX, Voyager-1&2) have laid a solid foundation for detecting and understanding the local interstellar medium. The project (IMAP) has also been established, which is a more in-depth exploration of the heliosphere and interstellar medium in the vicinity of Earth space, planned to be launched in 2024. However, there is no dedicated mission aiming to explore the enriched region of the intrusive local interstellar medium. On the other hand, the international countries/regions (including China, the United States, and Europe) are actively demonstrating the arrival mission at the heliosphere's edge and even in the interstellar medium. It is no doubt that detecting the intrusive local interstellar medium inside the heliosphere is an essential complement to the arrival detection of the solar plasma system's edge.

This project is interdisciplinary. It requires background knowledge and participants from different disciplines such as space physics, planetary science, astronomy, geology, space science and engineering, space exploration et cetera.

ISSI-BJ is an internationally recognized public space science institution. The primary task of ISSI-BJ is to promote a deeper scientific and technical understanding of both the future space missions and the scientific results of current and past missions through multidisciplinary research. The ISSI-BJ program covers a broad range of space science disciplines, including solar and space physics, planetary science, astrobiology et cetera. Both ISSI-BJ and ISSI place particular emphasis on the exploration and pursuit of future space science missions. Suppose we can obtain the recognition of ISSI-BJ and hold relevant forums on its platform. In that case, it will play a positive role in attracting international scientists' participation, ensuring the quality of the organization and convening of the forum, and promoting the impact of the results of the forum. Therefore, ISSI-BJ has significant value-added brand benefits for the forum project.

It is anticipated that the forum will reach a consensus on the relevant scientific problems and objectives through the organization and convening of the forum. The forum will also provide constructive suggestions for carrying out the relevant exploration missions and research programs in the future. Finally, the forum will sort out and summarize the results of the forum, forming a report with clear objectives, rich content, reasonable structure, progressive levels, and clear conclusions. The report will be submitted to the TAIKONG journal. The subsequent research results based on the forum will also be published in other domestic and international academic journals.



## WORKSHOPS

### Joint ISSI/ISSI-BJ Workshop "A New Moon in the New Century"

***TBD***

***Conveners:*** *Wing-Huen Ip (ISSI-BJ, China), Doris Breuer (DLR, Germany), Fa Wenzhe (PKU, China), Jessica Flahaut (Univ. Orlean, France), Mihali Horanyi (U. Colorado, Boulder, USA), Brad Jolliff (U. Washington, St. Louis, USA), Noriyuki Namiki (NAOJ, Japan), Clive Neal (U. Notre Dame, USA), Yang LIU (NSSC, CAS, China), Zhongcheng Ling (Shandong University, China), Mark Wieczorek (OCA, France).*

In the past twenty years, several exploration missions aimed at researching the moon, including the Chinese Chang'E (CE) 1-5 satellites, the Indian Chandrayaan 1-2, Japan's Kaguya (Selene), ESA's SMART mission, and the US' Lunar Reconnaissance Orbiter (LRO).

| Name | Nation | Launch | Type |
|---|---|---|---|
| Chang'e 2 | China | 10/1/2010 | Orbiter |
| ARTEMIS | USA | 2010 | Orbiters |
| Gravity Recovery and Interior Laboratory (GRAIL) | USA | 9/10/2011 | Orbiters |
| Lunar Atmosphere and Dust Environment Explorer (LADEE) | USA | 9/7/2013 | Orbiter |
| Chang'e 3 | China | 12/6/2013 | Lander |
| Yutu | China | 12/6/2013 | Rover |
| Chang'e 5-Test Vehicle | China | 10/23/2014 | Flyby |
| Queqiao | China | 5/20/2018 | Orbiter |
| Chang'e 4 and Yutu 2 | China | 12/7/2018 | Lander, Rover |
| Beresheet | Israel | 2/22/2019 | Lander |
| Chandrayaan-2 | India | 7/22/2019 | Orbiter |
| Chang'e 5 | China | 11/23/2020 | Sample Return |

The workshop, therefore, aims to summarize the scientific achievements and progresses accomplished in the past decades, specifically targeting the aforementioned missions.

The workshop reflections and results will be released as peer-reviewed articles and published in Springer's Space Science Reviews and subsequently, as a hard-copy edition of the ISSI-BJ Space Science Series (SSSI).

## ISSI-BJ Workshop "Exploring the Jovian satellite system: from formation to habitability"

**TBD**

*Conveners: Michel Blanc (IRAP, CNRS-CNES-Univ. Toulouse, France), Scott Bolton (SwRI), Tomoki Kimura (Tokyo University of Science), Li Lei (NSSC, CAS, China), Kathleen Mandt (JHU-APL, USA), Christophe Sotin (JPL, Caltech & LPG, Univ. Nantes, France), Sun Daoyuan (University of Science and Technology of China, China), Tim Van Hoolst (ROB, Belgium).*

The Jupiter system is the most massive secondary system in the Solar System. Its formation and early evolution had a profound influence on the sculpting of the architecture of the solar system and on the delivery or water and other chemical species to the inner planets. Its satellite system offers a broad diversity of objects whose inventory and characterization is still incomplete. Despite eight years of intensive exploration by NASA's Galileo mission, the formation scenarios, geology, geochemistry, geophysics and potential habitability of the four Galilean satellites continue to challenge our understanding. These "big questions" have motivated a "new wave" of space missions to the Jupiter system which are currently flying (Juno) or in development (JUICE, Europa Clipper, LUCY). This workshop will review the way these missions will address these questions and will help identify the science case for new mission initiatives, particularly in China where a mission aiming at assembling the puzzle of the scenario of the formation of the Jupiter system is currently under study, and in the U.S. where a mission focusing on Io, IVO, is currently considered.

The workshop will aim to:

1. Explore the Jovian satellite system, including all moons and small bodies (Galilean satellites, inner regular satellites, irregular satellites and Jovian Trojans) and review our current understanding of their formation, evolution, workings, and of the possible emergence of habitable moons among them;

2. Review the way these key questions will be partly addressed by space missions to the Jupiter system currently in flight (Juno) and in development (JUICE, Europa Clipper, LUCY), and identify the science base for new mission initiatives, particularly in China and the U.S., that will further address these open questions.

3. Provide a high-level reference book for the scientists who prepare these missions and will analyze their observations in the coming two decades.

The resulting SSSI book could be structured in five main parts subdivided into more specialized chapters, each one taking the form of a peer-reviewed article for Space Science Reviews:

1. Exploring the diversity of the Jovian satellite system

2. Origin and early evolution of the Jovian satellites

3. Geophysics and geochemistry of the Galilean satellites

4. Coupling processes in the Jupiter system and implications for habitability

5. Planned missions and future initiatives: science return and scientific synergies



## Cross-calibration of laser-induced breakdown spectroscopy(LIBS) instruments for planetary explorations: 1 week Mars data workshop

**TBD**

***Conveners:*** *Jérémie Lasue (Institute of Research in Astrophysics and Planetology, France); Roger Wiens (Los Alamos National Laboratory, USA); Sylvestre Maurice (Institute of Research in Astrophysics and Planetology, France); Rong Shu (Shanghai Institute of Technical Physics, China); Yuichiro Cho (Tokyo University, Japan); Javier Laserna (Universita de Malaga, Spain).*

Laser-induced Breakdown Spectroscopy (LIBS) is an active analytical technique that makes use of a pulsed laser to ablate material of interest at a distance. The atoms in the high temperature plasma emit at specific wavelengths from the UV to near-IR and the light can be analyzed by spectrometry to determine the composition of the target. Since 2012, LIBS has been successfully used for exploring the geology of Mars at Gale Crater with the Mars Science Laboratory rover's ChemCam instrument.

LIBS can be used to analyze single regolith mineral particles and larger rocks, giving major and minor elements compositions. Moreover, LIBS is sensitive to volatile elements (H, C, Na, etc.) that are of intrinsic interest to understand key planetary processes, like water alteration. The generated shock wave can also ablate dust covering rocks to allow further analysis by other instruments on the mission platform (rover, lander). In order to quantify the elemental composition of various targets, well suited on-board calibration targets need to be designed and large laboratory samples analyses are required for calibration, with ChemCam's calibration database containing more than 400 standards.

The year 2022 will be an ideal time for the three rover teams to start comparing their in-situ results and calibration procedures and discuss with other international specialists of LIBS.

The goals of the workshop will be fourfold:

1. Assess the potential for combined analysis of the data by sharing and discussing the technical details of each instrument design.

2. Discuss the calibration procedures of each instrument and share the relevant tools (databases, software, calibration targets, etc.) to develop potential cross calibration between the three active Mars instruments.

3. Develop and share the tools necessary to interpret the analyses as an international effort.

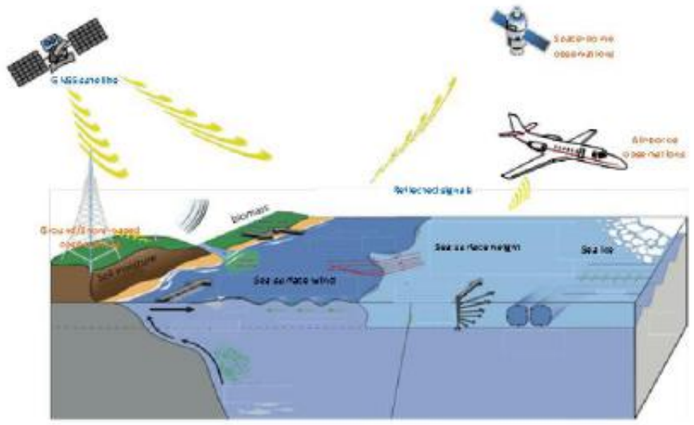
4. Define a set of recommendations and foster further technological developments to facilitate the use of LIBS for future planetary missions.

## NRSCC-ESA GNSS Reflectometry Joint Workgroup Annual Workshop

**October, 2022 (DATE TBD)**

*CONVENERS: Jiancheng Shi (NSSC, CN), Dongkai Yang (BUAA, CN), Jens Wickert (GFZ, GER), Manuel Martin-Neira, (ESTEC, NED).*

Global Navigation Satellite System Reflectometry (GNSS-R) utilizes the GNSS signals reflected by Earth surface to observe geophysical parameters. This technique has attracted rising attention in the past three decades due to its low-cost but exceptional temporal-spatial sampling capacity over Earth surface, and has shown great potential in ocean and land surface parameter remote sensing, such as sea surface wind, sea surface height, sea ice thickness, soil moisture, biomass and snow thickness.



The NRSCC-ESA GNSS-R joint workgroup was established in 2012 under the framework of the space science and technology cooperation agreement between MOST and ESA, aiming at cooperatively exploring GNSS-R applications to provide scientific methods and data for human concerned issues such as global climate change. Since then, workgroup has conducted all-round cooperation in this field under the joint leadership of NRSCC and ESA, including academic investigation, joint experiments, data sharing and talent exchange aspects, involving extreme weather, climate change and water cycle issues. By the end of 2021, 10 more workshops, 7 joint experiments, and 11 person times of talent exchange have been carried out; 12 experimental stations have been established; 20 more co-publications have been reported.

The annual workshop is one of the most important communication mechanisms of the workgroup. This will be the 11th NRSCC-ESA GNSS-R joint workgroup annual workshop, and the major objectives are as follows: 1) Report the research progresses of both sides in 2022, including but not limited to the basic theories, key technologies, experiment activities and innovative applications; 2) Summarize the work of 2022 and make the annual plan for 2023.

Following this workshop, a contributed book will be published. It will provide a scientific description towards the GNSS-R methods and applications developed by the joint workgroup in the past decade.



## WORKING GROUPS

## ISSI/ISSI-BJ Working Group "Extant subsurface Life on Mars? Science, Tools and Missions Together"

**TBD**

*Conveners: Vlada Stamenković (NASA Jet Propulsion Laboratory, USA), John Mustard (Brown University, USA), Barbara Sherwood Lollar ( University of Toronto, CA), Jesse Tarnas (Brown University, USA), Ana Plesa (DLR, Germany).*

One of the key drivers for planetary exploration has been the search for signs of life beyond our planet. Mars, in particular, has been a target for planetary missions, orbital and landed, but it has been assessed that the Martian surface is currently inhospitable to life as we know it.

There are first indications that the subsurface could be hiding liquid water and/or life, though, as highlighted also by the US National Academy of Sciences report on the Astrobiology Strategy for Exploration of life in the Universe and the International Center for Deep Life Investigation in Shanghai, China. There has been no focused effort to address the question of modern-day subsurface habitability and extant life in the Martian subsurface, from science to implementation.

Therefore, this joint ISSI and ISSI-BJ Working Group aims to bring together a 14-researcher international, multi- and interdisciplinary team composed of geobiologists, astrobiologists, geochemists, geophysicists, geologists, spectroscopists, instrument developers, and programmatic leaders, to study the science, the tools, and the missions that would enable to search for signs of extant subsurface life on Mars.

The first part of the Beijing meeting will target the technological capabilities needed to explore the Martian subsurface habitability and life. Its second session would unite the scientific results yielded and the technological input to plan mission concepts, from small spacecraft applications to larger missions on an international platform.

The three major objectives of the proposed Working Group that will meet in Beijing are:

Where are we going to look and for what kind of life? Where and how much liquid water exists today? Where are cells shielded? Where, how much, and what kind of food is there?

What are the tools & limitations to get the measurements? How can we measure the subsurface? How can we sample the subsurface?

Unite the results from A+B to define the trade space of exploration: Shallow vs deep life exploration; Modern habitability vs extant life; International mission scenarios.

Following the meetings, a book of the ISSI Scientific Report Series will be published, which would provide the first credible, scientific approach towards the science and exploration of extant life/modern-day subsurface habitability on Mars.

## SPACE SCIENCE SCHOOL

### ISSI-BJ/APSCO Space Science School 2023 Analysis and Investigation of Scientific Moon Data

**TBD**

*Conveners: Mohammad Ebrahimi Seyedabadi (APSCO, CN), Ip Wing-Huen (ISSI-BJ, CN).*

This is the third joint Space Science School organized by the Asia-Pacific Space Cooperation Organization (APSCO) and the International Space Science Institute in Beijing (ISSI-BJ), which since 2016 intend to promote a biennial School for Space Science for Master's and Ph.D. students as well as post-doctoral and early career scientists or engineers.

This school will provide the participants with in-depth knowledge on the science of the moon, from its evolution history to its geology, by lunar data. The focus will be put on the evolution history of the moon, of its crust and craters, its internal structure and field geology, as well as the moon's nearby environment and sample return. Gravity and seismology are the two most important geophysical methods to study the interior structure of both the Earth and the Moon. Lunar gravity study has been conducted mainly with orbital observation, and the latest GRAIL data in 2012 revealed the global gravity field and structure. Comparing with lunar gravity study, lunar seismology study relies on in situ observation of the Moon's surface. The only lunar seismic data have been obtained from 1969 to 1977 with the Apollo seismic stations. Therefore, lunar seismology works with old data and new methods.

With this project, we do not only aim to provide an international platform for students and experts to exchange knowledge, ideas, and know-how to advance space science studies but also to build a valuable social net between participants as well as between teachers and participants to facilitate future collaboration in the field.

The School will teach students how to approach the study on many aspects of Moon science, including data analysis, theoretical questions, and engineering-oriented topics. Students will be divided into groups and sub-groups according to the five topics identified, i.e. surface and evolution history of the moon; field geology of the moon; internal structure; near-moon environment; sample return analysis.

Each group will include ca. 10-12 students managed by one or two tutors with extensive experience in the related field. Each group will have its topic and agenda using actual observations as well as computer models, and their reports will constitute the school's output that will be published after school. The different teams will be supported and guided by expert tutors. At the end of each day, all participants will have a joint dinner to facilitate the communication between students, teachers, tutors, and organizers. The school will be concluded with the presentations of the groups' results to receive feedback from the other groups, the teachers, and the tutors.

Furthermore, the School aims to create an international environment to approach questions in an open and multidisciplinary way; it will encourage creativity and provide the contacts for the participants to develop a professional network. International collaboration will also be a key topic addressed by this school. We welcome applications to select 60 science and engineering experts, students, and enthusiasts.

Participants are required to select the working group they wish to join in the registration form. The working language is English. Students need to bring their laptops to have access to all necessary experimental data, models, and literature through the Internet. Tutors will provide and/or show the data and models on site.

**Preliminary Arrangement**

Thailand

**Application**

More info and registration soon online at www.issibj.ac.cn.



### China-ESA Advanced Mars School

**TBD**

*Conveners: Colin WILSON (ESA/ESTEC, Netherlands), Yang LIU (NSSC, China), Ana PLESA (DLR, Germany), Jun CUI (SYSU, China), Jingnan GUO (USTC, China), Louisa PRESTON (UCL/MSSL, U.K.).*

The Advanced Mars School is jointly organized by the International Space Science Institute - Beijing (ISSI-BJ), National Space Science Center, Chinese Academy of Sciences (NSSC, CAS) with the European Space Agency (ESA).

Inspired by the scientific investigations conducted by an ever-growing fleet of missions, the Mars School aims to provide a broad overview of Martian planetary science, from its interior and surface to its atmosphere and interactions with space. Lectures will cover theoretical background & modelling to observation techniques & datasets, as well as the search for past or present life. The week will also include breakout discussions, social excursions, a poster session and potentially also a hands-on session with Mars mission data.

The following is a preliminary list of lecture topics (subject to change): Interior structure & evolution, Volcanism & tectonism, Mineralogy and climate evolution, Aqueous surface processes, Geomorphology / landscape evolution, Atmospheric dynamics

Atmospheric chemistry, Upper atmosphere / thermosphere, Aeronomy (airglows, aurorae etc), Space weather & radiation environment, Magnetosphere / solar wind interaction & escape, Habitability and the search for life on Mars, Chinese Mars missions – science investigations, European Mars missions – science investigations.

Lecturers and participants will be drawn both from Chinese and European Mars science communities; a full list of lectures and speakers will be announced later in 2022.

The Mars School will take place over in 15-19 May 2023 in Huairou Campus of National Space Science Center, Beijing.

## 10 YEARS ANNIVERSARY

ISSI-BJ was founded in 2013 based on a cooperative agreement between ISSI and NSSC. The same tools have been used to organize high-quality scientific meetings and attract leading scientists to exchange ideas and cooperate on scientific problems of common interest. To celebrate its 10th Anniversary, a one-day symposium plus a series of forums and workshops are being planned for 2023.

# INTERVIEW

## Interview with Prof. Lindy Elkins-Tanton

*Lindy Elkins-Tanton is the Principal Investigator of the NASA Psyche mission, Arizona State University Vice President and Co-chair of the Interplanetary Initiative at ASU, and co-founder of Beagle Learning, a tech company training and measuring collaborative problem-solving and critical thinking.*

*Her research and efforts are focused on a positive human space exploration future, the effective leadership of teams, and education for the future of society. She has led four field expeditions in Siberia. She served on the Planetary Decadal Survey Mars panel, and the Mars 2020 Rover Science Definition Team, and now serves on the Europa Clipper Standing Review Board.*

*In 2010 she was awarded the Explorers Club Lowell Thomas prize. Asteroid (8252) Elkins-Tanton is named for her. In 2013 she was named the Astor Fellow at Oxford University. She is a fellow of the American Geophysical Union, and of the American Mineralogical Society, and in 2018 she was elected to the American Academy of Arts & Sciences.*

*In January 2020, she was awarded The Arthur L. Day Prize and Lectureship, by the National Academy of Sciences, for her lasting contributions to the study of the physics of Earth, and for illuminating the early evolution of rocky planets and planetesimals.*

*In 2021, she was elected to the National Academy of Sciences. Elkins-Tanton received her B.S., M.S., and Ph.D. from MIT. Together we are working toward a positive space exploration future, and toward creating a generation of problem-solvers.*

Interview:

**1. Thank you so much for making time to answer our questions. We are sure that your experience and vision in science will be very inspiring to many young students and researchers. To begin at the beginning, can you tell us when the first time that you decided to be a scientist?**

All my life I have been interested in, well, everything…playing the flute, art, botany, entomology, riding horses, working with dogs. Going into college I decided to work in science but I still did not know which science. So unlike many scientists, I was not set unwavering on my path at an early age.

**2. How did you enter the field of planetary science - and you must be very happy with making the choice?**

As an undergraduate I studied geology and wanted to be a field geologist, but I had serious knee problems and could not do the requisite hiking and climbing. After a master's in geochemistry I left academia for eight years and worked in business, and then taught math at a college for two years before deciding to come back for my PhD. In my PhD I started applying knowledge of terrestrial igneous rocks and volcanic processes to lunar problems, and from there, studied magma oceans, Mars, Venus, Mercury, and finally planetesimals. So I kind of slid into planetary science. Still, I had no aspiration to propose a flight mission; that came from an email from some scientists at Jet Propulsion Laboratory who wanted us to propose something to test a hypothesis in a paper we'd written. So rather by chance I started working on a mission.

**3. Have you participated in the activities of ISSI in Bern or in ISSI-BJ? For ISSI-BJ, what do you particularly like to see to happen in the context of international cooperation.**

Yes, I have participated in some ISSI Bern activities, including a conference and writing for a publication. I would love to see scientists forging strong personal bonds of work and collegiality, to help ease the tensions on the political front, and remind us that we are all humans together, endeavoring to understand our universe.

**4. You are running this amazing space mission to asteroid Psyche which will be launched in August next year. What are the main scientific questions to be answered by this ambitious project?**

The Psyche mission is named for its target, the asteroid (16) Psyche. (16) Psyche is one of the largest asteroids and its spectra, density, and radar characteristics indicate its surface is fine-grained metal, and its bulk composition is 30 – 60% metal. The mission has five science objectives:

Objective A: Determine whether the asteroid (16) Psyche is a core, or if it is unmelted material.

Objective B: Determine the relative ages of Psyche's surface regions.

Objective C: Determine the global abundances, in portions of Psyche's surface that appear to be a metal phase, of light elements S, K, and Si.

Objective D: Determine whether Psyche was formed under more oxidizing or more reducing conditions than Earth's core.

Objective E: Characterize Psyche's topography.

Of these, the first is the most important. We think, based on all available data at the moment, that the asteroid is largely made of metal. So the question becomes, how was this metal concentrated in the asteroid? Perhaps it is part of the core of a differentiated planetesimal.

**5. We are most impressed by the many things happening at the Arizona State University of which you are Vice President. Among them, the Interplanetary Initiative with you as the Managing Director stands out. Can you tell us a little bit about it?**

We envision an interplanetary future built upon cooperative and inclusive new structures, systems and perspectives. In Interplanetary, we are working on new organizational structures and processes that bring together all disciplines to work toward such a future.

We have developed a new way to put together interdisciplinary research teams focused on big questions rather than focused on hero leaders, and we find they have a high effectiveness and a high quality of work experience for the participants. We are working on connecting private sector, government, and university personnel in these projects. So far, our 25 pilot teams built this way have brought in a 7.5 times return on our seed money in external grants and contracts.

We also offer a cutting-edge new undergraduate degree, Technological Leadership, that offers a bachelor of science in three years. Here were are training process: How to be part of a team, how to identify and takes steps toward solving unsolved problems, how to give and receive feedback, and how to be a curious and effective human. These transferable skills are not usually taught in colleges.

The Interplanetary Initiative Lab is a flight hardware build, test, and fly facility designed for projects in partnership with outside

organizations. We have a team of dedicated students to help staff new projects.

In all, we have a staff of about 15 people, 50 undergraduate majors, and hundreds of pilot team members and outside partners.

**6. Would Interplanetary Initiative welcome international partnership since it is such an attractive idea? If so, what should one do to join?**

We welcome all kinds of partnerships. We have several organized around specific projects, some of them pilot projects and some initiated by the partner organization. In general we like to co-create new projects with partners, since we are dedicated to creating inclusive, interdisciplinary teams. Contact through our website or via email is welcome!

**7. It is very difficult to understand how you can do so many things at the same time. I am sure that you will be thinking about what to do after the Psyche mission. But please think about visiting ISSI-BJ in person and you are always welcome.**

Thank you so very much for your patience and understanding! I'm so honored to have spoken in your series, and I would really love to visit in person one day. It would just have to be after Psyche launch! Many many thanks from me to you and your whole team.



## Interview with Prof. Jiancheng Shi

*Dr. Jiancheng Shi is a senior research scientist at National Space Science Center (NSSC), Chinese Academy of Sciences (CAS), Beijing, China. He received the B.A. degree from the University of Lanzhou, Lanzhou, China, and the M.A. and Ph.D. degrees in geography from the University of California, Santa Barbara (UCSB), CA, USA, in 1982, 1987, and 1991, respectively.*

*He then joined the Institute for Computational Earth System Sciences at UCSB as a Research Professor. During 2010-2020, he took a position as the director and senior research scientist with the State Key Laboratory of Remote Sensing Science, jointly sponsored by Institute of Remote Sensing and Digital Earth, CAS and Beijing Normal University, Beijing, China. He is currently working as a senior research scientist at NSSC.*

*Dr. Shi has a long career in remote sensing of Earth energy and water cycle of the earth system. His research interests mainly include 1) remote sensing theory and techniques, 2) remote sensing of cryosphere components, water cycle components, and radiation energy balance, 3) development of new satellite missions, 4) synergy of remote sensing observations and Earth process models for hydrology and climatic change. He has published more than 500 papers with nearly 12000 citations.*

*Dr. Jiancheng Shi is the Fellow of IEEE, Fellow of SPIE and the Fellow of the Electromagnetics Academy. He is the Chair of Community on Earth Science from Space under China National Space Science Society since 2017, Co-Chair of Community on Remote Sensing and GIS under China Cryosphere Society since 2016, and Chair of Community on Polar Science under International Digital Earth Society since 2019. He is the associate editor of Remote Sensing of Environment since 2018, and the associate editor of SCIENCE CHINA-Earth Sciences since 2003.*

Interview:

**1. Thanks for accepting to be interviewed amid your very busy schedule. Can you tell us how big is your research group at NSSC, and what are your main projects?**

A: I transferred to NSSC in July, 2020. The current group has 2 researchers and 3-5 assistant researchers coming soon. I have a project from NSSC to establish an Earth Science from Space Division, a project on satellite consolidation for water cycle system observation supported by CAS and a project for Satellite Observations and Modeling of Energy and Water Cycle in Tibet supported by MOST at my old institute.

**2. We know that China has a large space program for Earth Observations. How do you divide the major disciplines and what are the main satellite missions? Would you like to expand the program further and how?**

A: There are 3 major disciplines: Meteorological satellite series, Oceanic satellite series, and Land resource satellite series. Each one has many satellites. They are mainly driven by application purpose. I would like to have more science driven satellite. We are trying through international collaborations.

**3. Is climate change or rather climate crisis a major concern for you?**

**What to do then?**

A: Climatic change has resulted in the intensified weather and hydrological disasters and has a great impact on sustainability of human society. We should put more affords to enhance our earth observation capabilities and synergies between satellite observations and Earth system modeling.

**4. How important is international cooperation for your field since we share the same planet with everyone on the Earth and in the future generations?**

A: To understand Earth system and the consequences due to climatic change, international cooperation is very important since it impacts everyone and every country on Earth. No single country can solve this challenge. We should put more affords to develop international cooperation!

**5. As Discipline Scientist on Earth Observations, how do you plan to improve and strengthen ISSI-BJ's role in promoting peaceful cooperation in space science and technology, especially in the area of geosciences?**

A: Currently, we are promoting a global water cycle mission and a program to establish a global water cycle observatory. Both will collaborate with international scientists, research groups, and agencies. In addition, we have also started the concept and initiative studies of EO on Earth radiation and biochemical cycle for their system observatories.

**6. Is terraforming of Mars possible? Yes or no.**

A: Yes.

**7. Can you say a few words of wisdom to encourage our young people to study space science and serve humankind?**

A: Space science is an interesting carrier. You will have fun and knowing better on the planet where you live.



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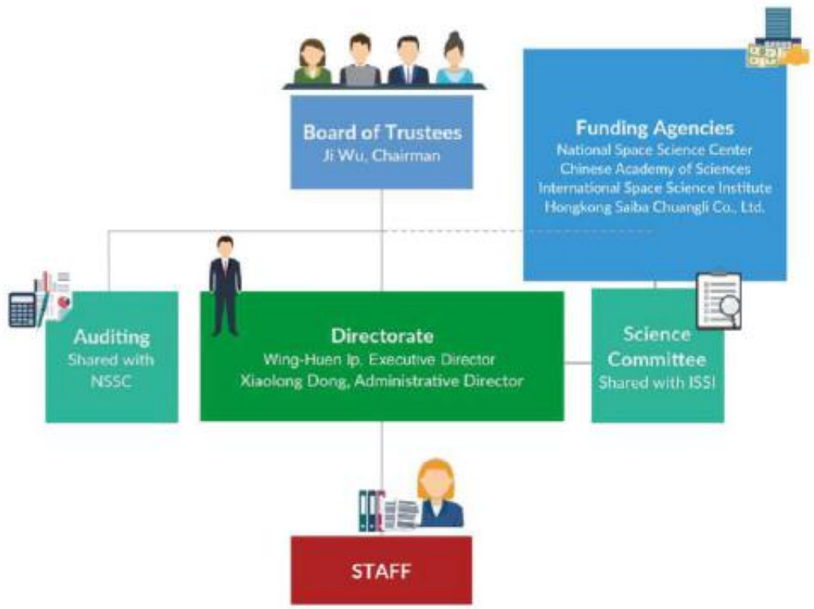
# ORGANIZATION STRUCTURE

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## Directorate

The Directorate is in charge of the scientific, operational, and administrative management of the Institute. It interacts with the Funding Agencies, the Board of Trustees, and the Science Committee.

Until the end of 2019, the Directorate consisted of the Executive Director, Prof. Maurizio Falanga, and the Administrative Director, Prof. Xiaolong Dong. Prof. Wing-Huen Ip is the ISSI-BJ's Executive Director since June 2020.

## Science Committee

The Science Committee is shared with ISSI and is made up of internationally known scientists active in the field covered by ISSI-BJ and ISSI.

Chaired by Louise Harra, 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 International Team proposals in response to the annual call.

Science Committee members serve a threeyear term with a possible extension of one year.

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# DISCIPLINE SCIENTISTS

## Jie JIANG

Jie JIANG is a professor and Ph.D. advisor at Beihang University, Beijing, China. In 2007, she received her Ph.D. in Astrophysics from the National Astronomic Observatories of the Chinese Academy of Sciences. Her research focuses on the physical forecast and generation mechanism of the solar magnetic cycle, its long-term changes, and effects on the heliospheric magnetic field, as well as stellar magnetic activities. She is currently a co-leader of a pillar of the SCOSTEP/PRESTO program and co-chair of the Solar Orbiter working group on Solar Dynamo and Cycle.

## Takehiko Satoh

Takehiko Satoh is a professor at the Department of Solar System Sciences, Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA). After receiving his Ph.D. from the Science University of Tokyo in 1992, he started his study of Jupiter's infrared auroras, magnetospheric, and atmospheric activities. His research interests also cover Mars and Venus and their atmospheres, in particular. Since 2001, he is involved in Japan's Venus orbiter mission, Akatsuki. He is the PI of the IR2 near-infrared camera and, since 2016, the mission's Project Scientist. He is also a senior member of the Council of Asia Oceania Geosciences Society (AOGS), currently filling the role of Assistant Secretary-General.

## Jiancheng SHI

Jiancheng SHI (Fellow, IEEE) received the B.S in Hydrological Geology and Geological Engineering from the University of Lanzhou, China, in 1982, and his M.S. and Ph.D. degrees in Geography from the University of California at Santa Barbara (UCSB), CA, USA, in 1987 and 1991, respectively. He subsequently joined the Institute for Computational Earth System Sciences, UCSB, as a Research Professor. He has worked as a PI for more than ten research projects for NASA, five projects for ESA, and four projects for JAXA. In 2010, he became the Director and a Senior Research Scientist at the State Key Laboratory of Remote Sensing Science, sponsored by the Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, and Beijing Normal University, Beijing, China. He is currently the PI of the Water Cycle Observation Mission (WCOM). He has authored or coauthored more than 200 articles in journals and conferences. His current research interests include microwave remote sensing of water cycle-related components and data assimilation. Dr. Shi is a fellow of the Electromagnetics Academy and the Society of Photo-Optical Instrumentation Engineers (SPIE).

## Maurizio Falanga

Dr. Maurizio Falanga received his degree in Theoretical Physics and Astronomy at the University of Basel, Switzerland. Afterward, he obtained his Ph.D. degree in Astrophysics from the University of Rome "La Sapienza". After his Ph.D., he held various Post-doc positions, e.g., CEA-Saclay, Service d'Astrophysique (High Energy Division), Paris. His research interest is mostly focused on accretion and emission in neutron stars, white dwarfs, and black holes. He is also involved in the Einstein Probe mission led by CAS. Since 2009, he is the Science Program Manager at the International Space Science Institute (ISSI) in Bern, Switzerland, and starting from August 2021, he is a Director at ISSI in Bern and a Professor at the University of Bern.

## Ekkehard Kührt

Dr. Ekkehard Kührt obtained his Ph.D. degree in Physics at the Humboldt-University Berlin, Germany. He held postdoc positions at the East-German Institute of Cosmic Research, at the Max-Planck Institute of Aeronomy in Lindau, and the Southwest Research Institute in San Antonio, Texas. From 1997 to 2020 he was the Head of the Asteroids & Comets Department at the Institute of Planetary Research of German Aerospace Center (DLR) in Berlin. Today he is engaged at the DLR Institute of Optical Sensor Systems and as a Senior Researcher at the China Academy of Space Technology (CAST). His main research topics are planetary physics, formation and evolution of solar systems, asteroids and comets, infrared radiometry, and environmental applications of space missions. Dr. Kührt has been involved in numerous space projects as the Russian Phobos and VEGA missions, the ESA missions Rosetta, BepiColombo, Comet Interceptor and HERA, the NASA Deep Impact mission, the JAXA Hayabusa-2, and MMX missions. As DLR project leader "Rosetta Instruments" he was responsible for all scientific contributions of DLR to this ESA cornerstone mission. As first or co-author, Dr. Kührt has published over 250 peer-reviewed papers in journals to planetary sciences. He was honored with the "Humboldt-Award" of HumboldtUniversity, the "Research Award for young scientists" of Leopoldina-Academy, the "Innovation Award" and the "Otto-Lilienthal-Award" of DLR with a research stay at ISSI Bern, the "Space Technology–Hall of Fame Award" of US Space Foundation and the "Award for Public Engagement with Planetary Science" of Europlanet. In 2019 he was a successful applicant for PIFI (President's International Fellowship Initiative) of the Chinese Academy of Sciences (CAS).



# SCIENCE COMMITTEE

The Science Committee is shared with ISSI Headquarters.

It is made up of internationally renowned scientists. Their duties include the evaluation of the scientific team proposals from the Annual Call.

**MEMBERS OF THE SCIENCE COMMITTEE:**

**Chair:** Louise Harra, PMOD World Radiation Center, Davos, Switzerland
**Secretary:** Mark Sargent, International Space Science Institute, Bern, Switzerland

Elena Amato, INAF, Osservatorio Astrofisico di Arcetri, Firenze, Italy

Svetlana Berdyugina, Leibniz Inst. für Sonnenphysik, Freiburg, Germany

Roberto Bruno, IAPS, INAF, Rome, Italy

Peng-Fei Chen, Nanjing University, China

Frédéric Courbin, EPFL, Observatoire de Sauverny, Versoix, Switzerland

Xiaolong Dong, International Space Science Institute Beijing, Beijing, China (ex officio)

Lisa R. Gaddis, Lunar and Planetary Institute, Houston, TX, USA (ex officio LPI/NASA)

Vladislav Izmodenov, IKI, Russian Academy of Sciences, Moscow, Russia (ex officio RAS)

Emmanuelle J. Javaux, Université de Liège, Belgium

Catherine L. Johnson, University of British Columbia, Vancouver, Canada

Karl-Ludwig Klein, Observatoire de Paris, LESIA, Meudon, France

Benjamin Koetz, ESA ESRIN, Frascati, Italy (ex officio ESA)

Philippa J. Mason, Imperial College London, United Kingdom

Mark McCaughrean, ESTEC ESA, Noordwijk, The Netherlands (ex officio ESA)
Céline Péroux, ESO (European Southern Observatory), Garching, Germany

Kanako Seki, University of Tokyo, Japan

Giovanna Tinetti, UCL, Dept. Astrophysics & Astronomy, Didcot, United Kingdom

Karina von Schuckmann, Mercator Océan, Ramonville Saint-Agne, France

Endawoke Yizengaw, Aerospace Corporation, Los Angeles, CA, USA

# SPONSORS AND PARTNERS

INTERNATIONAL SPACE SCIENCE INSTITUTE

International Space Science Institute

Chinese Academy of Sciences (CAS)

National Space Science Center (CAS)

European Space Agency

Space Research Institute (IKI) of the Russian Academy of Sciences

Asia-Pacific Space Cooperation Association

# FINANCIAL OVERVIEW

In the 2021 fiscal year, from 1 January, 2021 to 31 December of 2021, ISSI-BJ was operated with the total revenue of 916,582.43 RMB and the total expenses were 538,919.09 RMB, besides the direct support of 252,215.83 RMB from the National Space Science Center (NSSC), thus, the surplus is 125,447.51 RMB.

The funding includes: direct financial support of 350,000.00 RMB from the Bureau of International Cooperation of Chinese Academy of Sciences (CAS) as international organization project for ISSI-BJ activities; project fund of 314,366.60 RMB from the Strategic Priority Program on Space Science supported by the Bureau of Major Research and Development Programs of CAS for activities; and the direct support of 252,215.83 RMB from the National Space Science Center (NSSC) for expenses on premises facilities and a very small part of salary. The NSSC in-kind support, including the use of premises, financial management, IT support and support for administrative director, is not included in the statistics.

The expenses include: expenses on the salary of 2 staff members; other daily operating and maintaining expenses. The expenses of premises use, administrative expenses, salary of administrative director for ISSI-BJ activities, which are in-kind support from NSSC, are not included.

**Total Revenues in RMB for 2021 Fiscal Year (1 January, 2021 – 31 December, 2021)**

| Funding Sources | Amount |
|---|---|
| Bureau of International Cooperation, CAS | 350,000.00 |
| Strategic Priority Program on Space Science supported by Bureau of Major R & D Projects, CAS | 314,366.60 |
| NSSC Direct Support | 252,215.83 |
| Total | 916,582.43 |


**Operating Expenses in RMB for 2021 Fiscal Year (1 January, 2021 – 31 December, 2021)**

| Expenses | Amount |
|---|---|
| Local Transportations | 3,107.10 |
| Design, Publications, Printing, Post, Telecommunication | 169,309.25 |
| Salary1 | 347,343.74 |
| Travel | 13,172.00 |
| Premises | 5,987.00 |
| Total | 538,919.09 |
| Rent and Utilities Bills | 252,215.83 |
| Total | 791,134.92 |

Remarks:
1Salary includes the salaries for 2 staffs (salary for administrative director is not included)

# FACILITIES

ISSI-BJ office is located in the Building A at the Zhongguancun campus of the National Space Science Center, Chinese Academy of Sciences (NSSC, CAS).

The new 205 m2 ISSI-BJ facilities include one small meeting room (suitable for up to 12 participants) with a coffee break area, as well as a library with all ISSI-BJ and ISSI publications, and one big meeting room (suitable for up to 36 participants).

The three attached office rooms, equipped with laptops, fast internet connection, printer and paper shredder, offer space for the ISSI-BJ staff members, as well as for the visiting scientists.

*ISSI-BJ main office space with a small meeting room and office rooms attached*

Furthermore, ISSI-BJ shares its conference facilities with the National Space Science Center of the Chinese Academy of Sciences. The facilities are composed of six seminar rooms (20-30 participants each), two lecture halls (up to 100 participants each), and one multimedia conference hall (30 participants). All rooms are equipped with overhead projectors for large screen presentations and high speed wireless network connection

*Saturn Hall meeting room*

*Coffee break area*

*Small library*

# INTERNATIONAL SPACE SCIENCE INSTITUTE IN BERN

## About ISSI

The International Space Science Institute (ISSI) was created by space pioneer Professor Johannes Geiss in Bern (Switzerland) in 1995. Since then, the institute offers scientists from all around the world a platform to work together. On average, ISSI is now hosting around 950 scientists per year in its activities, in the framework of International Teams, Workshops, Working Groups, or Forums. ISSI is using all these tools to address, in a strict scientific framework, controversial issues and to promote a science program related directly to the most pressing issues raised by space and Earth science missions.

## Activities in 2021

As in the preceding year, ISSI's science program continued to be impacted by the pandemic in 2021. Eight International Team meetings could be held in person at ISSI between September and early December 2021. A significantly larger number of remote meetings took place, with Teams and Working Groups using the new suite of internet tools – provided by ISSI – for online meetings and collaborations. A total of 143 visitors came to ISSI in person in 2021, and a larger number joined ISSI events as online participants to remote or hybrid events.

## Workshops

In 2021, ISSI organized the followings Workshops in a hybrid mode:

- Global Change in Africa: Role of Space Observations (11–15 January 2021)
- Venus: Evolution Through Time (13–17 September 2021)

The Heliosphere in the Local Interstellar Medium (8–12 November 2021)

## Game Changers Online Seminars

ISSI has continued its series of online seminar talks in 2021 that have become known as the Game Changer Seminars with participants from all over the world. In early 2021 there was a line of talks on Earth observation missions and mission families including oceanography missions and missions to map the gravity and magnetic fields of the Earth. This series was followed by a line of talks on "Ideas and findings about the Solar System, the Universe and our Terrestrial Environment", alternating between astro- and solar physics, planetary science, climate science and fundamental physics. The Game Changer seminar talks were recorded and are part of ISSI's digital online library and available at www.issibern.ch/publications/game-changers-seminars/ where upcoming talks are being advertised.

## International Teams

Twenty-five new International Teams, three of which are organized jointly with ISSI-Beijing, have been selected for implementation from the proposals received in response to the 2021 Call for International Teams. Details can be found here: https://www.issibern.ch/program/teams/


Official Workshop Picture of the remote Workshop on "Global Change in Africa: Role of Space Observations"

## Working Groups

Two Working Groups started their project in 2021:

·Extant subsurface Life on Mars? Science, Tools & Missions Together
·Towards a Universal Tracers Portal in Astrobiology

## Forums

Two Forums were organized in 2021:
·Tipping Points in the Earth's Climate (26–29 January 2021)
·Ground and Space Astronomy: Challenges and Synergies (8–9 November 2021)

## Publications

The following volumes of the Space Sciences Series of ISSI, that resulted from ISSI Workshops, were published:

SSSI Volume 78:"Auroral Physics"edited by D.J. Knudsen, J.E. Borovsky, T. Karlsson, R. Kataoka, N. Partamies (Eds.), ISBN 978-94-024-2121-7, 2021

SSSI Volume 79: "The Tidal Disruption of Stars by Massive Black Holes" edited by P. Jonker, I. Arcavi, E.S. Phinney, E.M. Rossi, N.C. Stone, S. van Velzen (Eds.), ISBN 978-94-024-2145-3, 2021

SSSI Volume 80: "Reading Terrestrial Planet Evolution in Isotopes and Element

Measurements" edited by H. Lammer, B. Marty, A. Zerkle, M. Blanc, H. O'Neill, T. Kleine (Eds.), ISBN 978-94-024-2093-7, 2021

SSSI Volume 81: "Understanding the Diversity of Planetary Atmospheres" edited by F. Forget, O. Korablev, J. Venturini, T. Imamura, H. Lammer, M. Blanc (Eds.), ISBN 978-94-024-2125-5, 2021

SSSI Volume 82: "Geohazards and Risks Studied from Earth Observations" edited by T. Lopez , A. Cazenvae, M. Mandea, J. Benveniste (Eds.), ISBN 978-3-030-87988-4, 2021

Results of the Working Group was published in the Scientific Report Volume 17 (open access):

"Ionospheric Multi-Spacecraft Analysis Tools – Approaches for Deriving Ionospehric Parameters" edited by M.W. Dunlop and H. Lühr, ISBN: 978-3-030-26731-5, 2020

Furthermore, the International Teams publish over 200 peer-reviewed papers per year. The details can be found in the Annual Report: www.issibern.ch/publications/annual-reports.

## Operation

Three statutory bodies interact regularly in matters of strategy, operation, finance or public relations: The Board of Trustees, the ISSI Directorate and the Science Committee. The latter gives also scientific advice to ISSI-BJ. The ISSI Directorate consists of Tilman Spohn (Executive Director), Maurizio Falanga (University of Bern, Switzerland) and Michael Rast and is in charge of the scientific, operational and administrative management of the institute. The complete ISSI staff (scientists and administration) counts 15 members. More detailed information about the Institute, its program, as well as its publications can be found on the web page www.issibern.ch.