

国际空间科学研究所—北京

# **ANNUAL REPORT 2019**

GISTDA BARTSA

Brainstorming Forum on
SCIENCE MISSIONS USING CUBESATS

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# **IMPRINT**

**ISSI-BJ** Annual Report

Address	No.1 Nanertiao, Zhongguancun, Haidian District, Beijing, China
	Postcode: 100190
	+86-10-62582811
	info@issibj.ac.cn
	www.issibj.ac.cn
Editor/ Graphic Design	Laura BALDIS
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# **COVER PAGE**

Bubbles composed of seven images (from the lower left to the upper right):

- 1. Dr. Pavel Bakala (Silesian University) giving an Understanding Science seminar on "Traveling to the Black Hole" on January 22, 2019.
- Group picture of the participants of the ISSI-BJ/APSCO Joint Forum on "Science Missions using CubeSats", held on June 3-8, 2019, in Si Racha, Chon Buri Province, Thailand.
- Cover of TAIKONG no. 14 on "Discover the Sky by Longest Wavelength with Small Satellite Constellation". Credit: NAOC.
- 4. Group picture of the participants of the ISSI-BJ Forum on "Exploration of Outer Heliosphere and Nearby Insterstellar

Medium" held on November 7-8, 2018.

- 5. The International Team working on "The electromagnetic data validation and scientific application research based on CSES satellite" at ISSI-BJ on October 21-25, 2019.
- Coronal Mass Ejection on ISSI-BJ Taikong 13 on "PRESTO: Predictability of the Variable Solar-Terrestrial Coupling - The SCOSTEP Scientific Program 2019-2024". Credit: ESA/NASA/Soho.
- 7. A representation of Magnetic Reconnection, the theme of the forum "Cross-scale Measurements of Space Plasmas to explore Magnetic Reconnection" held in September 2019.

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# MESSAGE FROM THE CHAIRMAN OF THE BOARD OF TRUSTEES



The year of 2019 has been a fruitful and successful one for ISSI-BJ. In fact, during the past twelve months ISSI-BJ improved its services to strengthen the international involvement and contribution to Chinese space science programs.

Following the progress of the Strategic Priority Program on Space Science (Phase-II), ISSI-BJ has organized one forum for the candidate missions under intensive study, and four forums for the mission concepts studies, covering a wide field of space science disciplines, from looking into the dark age by very long wavelength radio interferometry with small satellite constellations to the exploration of magnetic reconnection by cross-scale measurement of space plasma, the exploration of the outer heliosphere and nearby interstellar medium, as well as new concepts for research of the earth's atmosphere for global climate change by multi-frequency occultations. This series of forums has successfully planted seeds for the future of space science.

Furthermore, we continued and steadily developed our collaboration with our strategic partner, the Asia-Pacific Space Cooperation Organization (APSCO), and after our successful 2<sup>nd</sup> Space Science School held in 2018, in 2019, together with APSCO, we organized a very productive joint forum on 'Space Science Missions Using Cubesats'.

2019 was also an important year for the future of space science in China. The strategic planning of the 14<sup>th</sup> five-year-plan (2021-2025) and mid to long-term planning to 2035 were kicked off. Space science is intrinsically an international science. In order for the international community to explore and contribute more to the future Chinese space science programs and for the Chinese community to learn further

and coordinate with international programs, ISSI-BJ, together with NSSC, has co-organized the '2<sup>nd</sup> Strategic Forum on Space Science' and the forum on 'Science Objectives and Observation System for the International Meridian Circle'.

In 2019, ISSI-BJ was also on the right track to continue its excellent international team projects and workshops on space science. Moreover, we are planning additional activities to make the most out of the achievements and breakthrough progresses of Chinese space science missions, such as the Chang-E missions. ISSI-BJ is properly gearing up for the future of space science, aiming to enhance the international collaboration and the interaction between Chinese and international space science communities.

On the management side, I would like to express special thanks to Maurizio Falanga for his very generous enthusiasm and contribution in leading the development of ISSI-BJ under the challenging situation. I would also like to express my gratitude to Alvaro Giménez, who had initially agreed to temporarily fill the vacancy as Executive Director with short notice from September to the end of 2019.

Finally, I would like to thank the excellent staff of ISSI-BJ, Lijuan En, Anna Yang, and Laura Baldis, for their daily work, as well as Xiaolong Dong for his cooperative and efficient support helping the exective directors and making ISSI-BJ successful.

Ji Wu

Beijing, May 2020

# MESSAGE FROM THE EXECUTIVE DIRECTOR (AD INTERIM)



After I served as the first ISSI-BJ Executive Director from 2012 to 2016 and from 2017 to 2019 (ad interim), the time for me to leave office arrived at the end of 2019, as I aim to dedicate more time and efforts to ISSI in Bern. It has been an honor and pleasure

for me to be the first Executive Director of ISSI-BJ, a position which filled me with pride and enriched me greatly. Even though almost seven unforgettable and beautiful years in Beijing have now come to their end, I would not hesitate to define ISSI-BJ's activities as excellent, young, modern, dynamic, future-oriented, innovative, and of great interest to the international space communities.

From 2013 up to now, we have hosted five workshops — which led to the publication of the corresponding books — 23 forums, whose summaries have been released in the form of the forum-related TAIKONG magazine ('Outer space' in Chinese), a total of 38 international teams have been approved, and two very successful Space Science Schools have been organized by ISSI- BJ.

Furthermore, in the context of our outreach program, we have hosted 13 Understanding Science seminars for the general public. As expressed in an interview which is included in this Annual Report (p. 54), the quality of ISSI-BJ's activities and outputs has now reached a competitive level, and this is reflected in our events' popularity not only in Asia but worldwide. In fact, more than 50% of ISSI-BJ's visitors come from Western countries which show much interest in collaborating with China and Asian countries in general.

As the end of my 2<sup>nd</sup> term has come, I would like to

express my gratitude for the trust and support I have always received from the ISSI-BJ Board of Trustees, especially from its Chairmen, Prof. Ji Wu and Prof. Chi Wang, as well as from Prof. Georges Meylan (Chairman of the ISSI BoT), Prof. Tilman Spohn (ISSI Executive Director), and Prof Roger Bonnet (member of the ISSI-BJ BoT). I am also thankful to the ISSI-BJ advisory body, i.e. the joint ISSI/ISSI-BJ Science Committee and its Chairwoman, Prof. Louise Harra. My special thanks also go to the very productive and efficient ISSI-BJ staff — Xiaolong Dong (ISSI-BJ Administrative Director), Lijuan En (Assistant to the ED), Laura Baldis (PR and Editorial Manager) -, to the scientific team composed of Ivan Zimovets and Richard de Grijs, as well as to one former staff member of ISSI-BJ, Anna Yang, who with dedication, professionalism, and enthusiasm contributed to the success of ISSI-BJ.

To the newly appointed Executive Director I would like to extend my warmest wishes to ensure continuity and constantly improve the quality of ISSI-BJ's future services. Let's keep ISSI-BJ unique and let's do always aim at "the stars" to best serve all the space communities by facilitating informal scientific meetings.

On a personal note, I must confess that I will deeply miss all my friends at ISSI-BJ and in Beijing, Beijing and its excellent food, and everything that I was blessed to experience during these amazing and unforgettable years. Many thanks to all of you.

Maurizio Falanga

Beijing, May 2020



# **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.

### History

In October 2011, Professor Ji Wu, the Director General of the National Space Science Center of Chinese Academy of Sciences (NSSC, CAS, China), visited the International Space Science Institute (ISSI) in Switzerland. During his visit, he formulated the proposal to establish an International Space Science Institute in Beijing (ISSI-BJ).

In February 2012, Simon Aegeter, Chairman of ISSI's Board of Trustees (BoT), and Roger-Maurice Bonnet, Executive Director of ISSI, visited NSSC for further discussions. Both parties exchanged opinions and signed the Memorandum of Understanding which was approved by the ISSI's 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 of the 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 of the conviction that NSSC is an extremely trustworthy partner. Following this decision, ISSI and NSSC moved forward with the implementation plan to establish ISSI-BJ.

The inauguration ceremony of ISSI-BJ was held at the NSSC in Beijing on July 16, 2013. Professor Rafael Rodrigo, Executive Director of ISSI, and Professor Ji Wu, Chairman of the BoT of ISSI-

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 widespread spectrum of space science disciplines, including solar and space physics, planetary science, astrobiology, micro-gravity science, and earth observation. It complements the ISSI program with special emphasis on future scientific opportunities.

BJ and former Director-General of NSSC, jointly inaugurated the new institute located on the 3<sup>rd</sup> floor of the NSSC building. In 2013, the ISSI-BJ Board of Trustees elected Professor Maurizio Falanga from Switzerland to lead the Institute as its first Executive Director.

A brainstorming forum on the strategy of ISSI-BJ was held in November, 2014, and an international visiting assessment committee was established to evaluate the performance of ISSI-BJ. The assessment reports gave ISSI-BJ a very good feedback, supporting the very positive start of ISSI-BJ and acknowledging its already excellent reputation in the international science communities. Based on these evaluations, NSSC and ISSI agreed to continue their cooperation. The BoTs 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 Ji Wu, former Director-General of NSSC and Chairman of the ISSI-BJ BoT, and Professor Rosine Lallement, Representative and Vice Chair of the ISSI BoT, signed a new agreement, which sanctioned the continuation of the cooperation between the two parties. Following this three-year agreement, both sides once again renewed the collaboration in 2019.

# ISSI-BJ'S SCIENTIFIC PROGRAM

ISSI-BJ's mission is to serve the space science communities in multilateral and multidisciplinary activities. ISSI-BJ is open to support projects from any Asian or international scientists or institutes, encouraging researchers to work together in Beijing.

# Research Tools



The results of the Workshops are published as refereed papers in the Space Science Reviews issues and in parallel as volumes of the Space Science Series of ISSI (SSSI).



**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 magazine series constitutes the output of the Forums organized at ISSI-BJ. They report on the content of the Forums and reflect in a neutral way the discussions and advices gathered by 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 as scientific articles.



INTERNATIONAL TEAMS

**International Teams** follow a strict bottomup approach whereby in response to a specific call issued every year in January, scientists can propose projects corresponding to the topics broadly identified in the Call. The reviewing and ranking process is the responsibility of the Science Committee.

International Teams (IT) are composed of ca. five to 15 scientists from different institutions, nationalities, and expertise. They meet at ISSI-BJ for one or more weeks and they are active for 12-18 months. IT projects often involve data or modelling work. Their activities are managed and organised 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.



Workshop on "Oscillatory Processes in Solar and Stellar Coronae" in October 2019

### **Outreach and Training Tools**



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.



**ISSI-BJ Space School** is a biennial School on space sciences and space science missions for international students. The students are provided with the required scientific background relevant to producing a report.



**Understanding Science** is organized by the UK Royal Society of Chemistry, Beijing University of Chemical Technology, and ISSI-BJ. Its goal is to make the broader public aware of today's accomplishments in space science research through short scientific lectures in English (popularization talks), and to give an opportunity to talk with either international or Chinese scientists in a relaxed atmosphere.

### **Statistics**

In 2019, ISSI-BJ organized seven Forums, one Workshop, and two Understanding Science public seminars. In 2019, ISSI-BJ had 16 active international teams — three selected in 2017, six selected in 2018, and seven selected in 2019.

In the course of 2019, a total number of 312 international scientists participated in the scientific activities of ISSI-BJ.

Pie chart on the right: geographical distribution of the ISSI-BJ scientific activities participants



# 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/ ISS-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 **any time**.
- 2. Submit a **summary** of maximum **one page**, explaining the proposal **topic**, the **rationale** to organize the event at ISSI-BJ, and the **list of proposers**.
- 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.



The results of the ISSI-BJ forums are available online as TAIKONG magazine issues at www.issibj.ac.cn/publications

# Discover the Sky by Longest Wavelength with Small Satellite Constellation

### January 23-25, 2019

Conveners: Xuelei Chen (NAOC, CAS, China), Ji Wu (NSSC, CAS, China), Jack Burns (Colorado University, USA), Joe Silk (JHU/IAP, USA/France), Leon Koopmans (Groningen University, The Netherlands), Hanna Rothkaehl (SRC, PAS, Poland), and Maurizio Falanga (ISSI-BJ, China).



Group picture of the forum participants

The aim of this ISSI-BJ Forum was to discuss the problems of low frequency radio observation, which is hampered on the ground by the ionosphere and man-made radio frequency interferences, and so far our knowledge about the sky in this part of the electromagnetic spectrum is very limited. The scientific problems related to this include the cosmic dark age and dawn, the Sun, planets and exoplanets, interstellar medium (ISM), galactic structure, radio galaxies, quasars, clusters, and intergalactic medium (IGM), among others.

During the Forum, the participants discussed various science problems related to the low frequency radio, such as the signature of cosmic dark age and dawn, the solar system, galactic and extragalactic sources, the propagation effects, and data analysis methods.

The Forum started with a short introduction to ISSI-BJ given by Maurizio Falanga (Executive

Director of ISSI-BJ), and an introduction to the CAS Strategic Priority Program on Space Science delivered by Chi Wang (Director General of the NSSC, CAS, China). Following that, the future low frequency space missions were discussed, such as SUNRISE and DSL Mission at Lunar Orbit. The rest of the first day as well as the beginning of the second day of the Forum were dedicated to the experts' presentations on various science cases related to the low frequency radio. During the rest of the second day, global spectrum experiments were introduced and discussed, followed by the talks on past and current space missions, such as CE-4 Longjiang, CE-4 NCLE, and CE-4 LFRS. The first half of the last day of the Forum was dedicated to the topic of the instruments and technology for space missions.

Finally, the participants had an open discussion on science and technology of the missions, international collaboration opportunities, as well as on the future work plan.

# ISSI-BJ/APSCO Space Science Missions using CubeSats

### June 3-8, 2019

Conveners: Maurizio Falanga (ISSI-BJ, China) and Mohammad Ebrahimi SEYEDABADI (APSCO, China).



Group picture of the forum participants

The main aim of this Forum was to identify suitable key sciences that can be developed for CubeSats science missions and answer the question about CubeSat feasibilities for space development countries. The goal was also to develop CubeSats space education system to establish cooperative programs not only for the purpose of training, but also with a view to prepare collaboration for scientific or application missions.

The Forum started with a short introduction to ISSI-BJ, APSCO, and to the Forum. Following that, the participants were introduced to the history of CubeSats, to the COSPAR Roadmap on Small Satellites for Space Science, as well as APSCO's current and future plans to use Cubesats as a tool for capacity-building and university cooperation. The second half of the day was devoted to the topic of using CubeSats for space sciences. After the talks given by international scientists, there was a special slot for the students' presentations and discussions.

The first day of the Forum ended with a social dinner which enabled the participants to enrich their social network and continue discussions in a less formal environment. In the second day of the Forum, scientists and researchers studied the CubeSats technology issues for science, which was also followed by the students' presentations and an open discussion of all the participants, as well as a summary of the Forum.

# Exploring Greenhouse Gases, Water, and Climate Changes by LEO-LEO Occultation

### July 24-26, 2019

Conveners: Gottfried Kirchengast (WEGC, University of Graz, AT), Daren Lv (IAP, CAS, CN), Yueqiang Sun (NSSC, CAS, CN), Quanlin Fan (NSSC, CAS, CN), Xin Wang (IAP, CAS, CN), Armin Loescher (ESA Future Missions & Instrument Division, NL), Stig Syndergaard (DMI Copenhagen, DK), Congliang Liu (NSSC, CAS, CN), and Maurizio Falanga (ISSI-BJ, CN).



Group picture of the forum participants

The forum aimed to investigate the role and contribution of the Essential Climate Variables (ECVs), such as the atmospheric thermodynamic state variables and greenhouse gases, to the research on atmospheric physics and global climate change.

Given the need to improve the existing groundbased and satellite observations, to successfully deliver atmosphere and climate benchmark data, and to reduce data ambiguity, the forum focused on three main subjects: the key scientific questions and responses of ECVs in relation to global change; the principles, algorithms, and payloads of microwave occultation-using centimeter and millimeter wave signals between low Earth orbit satellites (LEO-LEO microwave occultation, LMO) as well as of the LEO-LEO infrared-laser occultation (LIO); the Climate and Atmospheric Components Exploring Satellites (CACES) mission concept proposed to the Strategic Priority Research Program of Chinese Academy Science (SPRPCAS).

The forum's schedule, spread over two days,

neatly reflected the content focus, as its first day started with the introduction to the LEO-LEO occultation technique and the review of previous studies in Europe as well as in China, which were brilliantly provided by Prof. Kirchengast, Prof. Loescher, Prof. Sun, and Prof. Liu, followed by the insightful overview on the CACES mission as well as on the scientific challenges in greenhouse gases, water, and climate change studies.

As the second day started, a deeper understanding of the CACES mission concept design as well as of complementary missions and scientific international collaborations was achieved thanks to the insightful presentations given by Prof. Wickert and Prof. Cahohy, among others. It allowed conveners and participants to elaborate on a solid ground the discussion on the science goals of CACES, on data observing and gathering techniques. The discussion on the potential of international partnerships, which represented the concluding part of the forum and that preceded the evening's gathering organized by CACES team.

# Second Strategic Forum on Space Science

### September 4-5, 2019

Conveners: Ji Wu (NSSC, CAS, CN), Alvaro Giménez (CSIC, Spain/ISSI-BJ), Chi Wang (NSSC, CAS, CN), and Maurizio Falanga (ISSI-BJ, CN).



Group picture of the forum participants

Prominent researchers representing various space science discipline fields — space astronomy, solar physics, space physics, space and earth science, and planetary science — and engaged during two days, worked towards the encouraged discussion on space science frontiers and opportunities for the coming decade, selecting Beijing as a fertile ground for debates.

In fact, considering the increasing contribution of Chinese scientists to the space science research endeavored since 2011, the People's Republic of China currently represents a very inspiring environment for international researchers and for multi-cultural scientific research. Furthermore, in recent years China has launched several spacecraft missions, such as DAMPE, QUESS, HXMT, and many new ones are under development, for example EP, ASO-S, and SMILE.

The forum participants — 20 international scientists together with 15 Chinese national experts — were warmly welcomed at the Swan Lakeview Hotel on the evening preceding the forum, which was formally opened by Prof. Chi

Wang (NSSC, CAS) and Prof. Maurizio Falanga (ISSI-BJ Executive Director) in the morning of September 4, 2019. The first day featured a detailed account of the European (Prof. Hasinger, ESA), Japanese (Prof. Fujimoto, ISAS, JAXA), Russian (Prof. Zelenyi, IKI, RAS), and Chinese space science programs (Prof. Wang, NSSC, CAS), introduce by the presentation on the role of the National Academy of Sciences in the US space planning (Prof. Hartman, SSB, NAS). On the same day, the challenges in Space Astronomy and Fundamental Physics, Solar and Space Physics, as well as in Exoplanets were approached and elaborated over three sessions, all chaired by Prof. Giménez (CSIC, Spain/ISSI-BJ).

As the second day started, the debates' focus still concerned the challenges in the space science field, moving on to Planetary Science and Earth Space Sciences, which were then followed by comprehensive reports and summaries of the forum in order to identify the key scientific questions to be addressed in the following decade, thus sparking a round-table discussion.

# Cross-Scale Measurements of Space Plasmas to Explore Magnetic Reconnection

### September 5-6, 2019

Conveners: Walter Gonzalez (INPE, Brazilian Academy of Science, Brazil), Vytenis Vasyliunas (Max Planck Institute, Germany), Chi Wang (NSSC, CAS, CN), Lei Dai (NSSC, CAS, CN), Malcolm Dunlop (RAL and BUAA, UK and China), Philippe Escoubet (ESTEC, ESA), Vassilis Angelopoulos (UCLA, US), Giovanni Lapenta (KU Leuven, Belgium), Tai Phan (UC Berkeley, US), Larry Kepko (NADA/GSFC, US), Alessandro Retino (LPP, Ecole Polytechnique, France), Michael Hesse (University of Bergen, Norway), and Maurizio Falanga (ISSI-BJ, CN).



Group picture of the forum participants

Given the need of improved understanding of magnetic reconnection on the electron-kinetic, the ion-kinetic, and the Macro-scale, which are investigated respectively by the ESA's Cluster mission as well as the NASA-led THEMIS and Magnetospheric Multiscale missions (MMS), and further enriched by the recently observed first interplanetary shock, the forum strove to provide an overview on magnetic reconnection, on its cross-scale science as well as in the solarterrestrial connection to lay the groundwork for the debate on current spacecraft missions and international collaborations.

The forum participants were also given the chance to explore the Self-Adaptive Magnetic Reconnection Microscope Mission (SAMRM) formulated by the NSSC in 2016, which aims to make simultaneous and self-adaptive measurements of plasmas at electron-ion-macro scales with a fleet of 12+ CubeSats and one mother satellite. On the basis of this newly initiated Chinese mission as well as of all other space missions researching the fundamental questions on magnetic reconnection, the forum focused specifically on the macro-scales of reconnection,

which are deemed to represent the key point to define main magnetospheric plasmas and fields changes due to reconnection.

Spanning over two days, the forum started with an overview of magnetic reconnection and the Constellation missions (Cluster, PROSPERO, SAME, MagCon, MMS), moving then to the crossscale and multiple-scale science of reconnection, including cross-scale measurements, all presented by 15 competent scientists from leading institutions. As the second day began, the symposium on the cross-scale science of reconnection continued, bringing in turbulence, electron acceleration, waves, and MI-coupling as additional points of discussion in regard to reconnection and related to the space missions and their measurement approaches.

The two-days intense schedule was then concluded by the overall remarks on the Self-Adaptive Magnetic reconnection Explorer mission (SAME), on the questions posed and the ones answered, and on international cooperation opportunities.

# Science Objectives and Observation System for the International Meridian Circle

#### September 23-25, 2019

Conveners: Prof. William Liu (NSSC, CAS, China), Prof. Michel Blanc (IRAP, CNRS-Université Toulouse III, France), Prof. Eric Donovan (University of Calgary, Canada), Prof. John C. Foster (MIT Haystack Observatory, USA), Prof. Mark Lester (University of Leicester, UK), and Prof. Maurizio Falanga (ISSI-BJ)



Group picture of the forum participants

In the light of the great challenges posed to our planet and to humankind by our changing environment, the forum tackled the question of how energy from the sun and from the earth affects our planet by analyzing the issue from a very specific scientific angle, i.e. the function of the Upper and Middle Atmosphere and Ionosphere layers (IMUA) as a 'mirror' of these environmental jeopardies. As the effects of environmental threats are detectable on the IMUA, such screen represents an essential tool for the prediction, identification, and mitigation of possible natural disasters coming from above (Solar activity and Interplanetary Space) and from below (lower atmosphere, meteorology, climate change, and Solid Earth).

Therefore, two main results were set as forum goals, i.e. providing a science case for the creation of an internationally-coordinated Observation System of the IMUA at global level, and identifying the preliminary ground-based design of such system, called the "International Meridian Circle Project" (IMCP).

To this end, the forum was organized into three major thematic sessions — Science Cases, Observation System, Modeling and Data Analysis/Assimilation Tools — spanning over three days. During the first section, the presenters touched multiple topics, such as "Solar and interplanetary processes" (Prof. Gopalswamy, USA), "Magnetosphere processes" (Prof. Gonzalez, Brazil), and "Troposphere/ stratosphere weather system" (Prof. Lu, China). The completion of this initial session chaired by Prof. Lester (UK) prompted all scientists to reflect and discuss on the above mentioned "Chinese Meridian Project" System (Prof. Xu, China) as well as on the observations of the magnetosphere (Prof. Donovan, Canada), the middle/upper atmosphere (Prof. Bounhir, Morocco), as well as on the solar and interplanetary monitoring (Prof. Yan, China), among others.

With the beginning of the second day, the thematics of the session on the Modeling and Data Analysis/Assimilation tools were approached, going into the details of "MIT (Magnetosphere-Ionosphere-Thermosphere) coupling" (Prof. Zou, USA), "ITM (Ionosphere-Thermosphere-Mesosphere) coupling" by Prof. Lei (China) and "Plasmasphere Modeling" by Prof. Pierrard (Belgium). This phase opened the general discussion and summary of the forum which took place in the morning of September 25, when participants also addressed the preparation of the Second IMCP-led Forum on the Space Segment.

# **Exploration of Outer Heliosphere and Nearby** Interstellar Medium

#### November 7-8, 2019

Conveners: Prof. Wang Chi (NSSC, CAS, China), Prof. Ralph L. McNutt Jr. (Johns Hopkins University, USA), Prof. Robert Wimmer-Schweingruber (University of Kiel, Germany), Prof. John D. Richardson (MIT, USA), Prof. Li Hui (NSSC, CAS, China), and Prof. Maurizio Falanga (ISSI-BJ, China).



Group picture of the forum participants

Symbolically marking the one-year anniversary of NASA-led Voyager 2 mission since it first entered the interstellar space on November 5, 2018, the forum represents one of the most relevant activities held at ISSI-BJ in 2019 thanks to the groundbreaking studies thoroughly discussed during the two-day meeting.

The talks aimed identify some to kev problems related to some still uncharted territories such as heliosphere, the interstellar medium, our solar system, as well as their interactions. "The forum underlined the

"

Interstellar Express (IE). Following the 2014 Scientific Pioneer Program of Space Science of the Chinese Academy of Sciences (CAS) as well as the 2018 Xiangshan scientific conference, key questions related to such interstellar undertaking were tackled.

The mission, whose probes are meant to move

The Voyager spacecrafts are doing an amazing job, making the first observations of the heliosphere's boundaries and interstellar medium, but they are nearing the end of their lifetimes. The forum started planning to send a spacecraft to true, undisturbed interstellar space.

Prof. John D. Richardson, MIT, USA

in two opposite directions - towards the "nose" of the heliosphere as well as towards its "tail" - is ought to be launched in 2025 and its significance also lies in its potential for the understanding of the interactions between the hot, low-density plasma of the solar wind and the cool, higher-density plasma of the interstellar space. As highlighted by Prof. Wimmer-Schweingruber, "the mission

exciting science that is waiting for us "out there" in the interstellar space, but also what is yet to be discovered on our way to the edges of our home in the galaxy" commented Prof. Wimmer-Schweingruber (Germany).

Scientists were also faced with the complexity of a new interstellar mission proposal, i.e. the would be of great scientific interest to the broad international community as it reaches beyond traditional heliophysics to plasma physics, astrophysics, and fundamental physics".

After a preliminary introduction to the forum and its goals, researchers were first confronted with the latest results yielded from the investigations on the outer heliosphere and the interstellar medium. These included presentations on the magnetic field as well as galactic cosmic rays in the outer heliosheath, and on the heliospheric shield.

As the second day started, the interstellar mission became the pivot of the discussions, its scientific objectives were examined and payload suggestions were brought forward, such as ENA imager(s), plasma- and magnetic field instruments, and L-y spectometer, among

others. Last but not least, the far-reaching and well-promising approach of this mission has attracted the interest of the international scientific community, leaving the call for worldwide collaboration still open.

This forum represents our first attempt to organize an international gathering to meet with American, Russian, and European experts, and it is by no means a good start for the future of the IE mission. There is no doubt that in future, China will continuously cooperate with other space powers towards the success of this interstellar mission.

Prof. Guo Xiaocheng, NSSC, CAS, China

The exploration of the outer heliosphere and the interstellar space is an ambitious goal which arises from the innate tendency of mankind towards innovation. Our Chinese colleagues are actively participating and contributing to this mission with knowledge and wisdom and thanks to ISSI-BJ, the groundwork for international collaboration could be laid. I am looking forward to reaching a deeper understanding of the 'heliospheric mysteries' and to a brighter future for space exploration.

Prof. Li Hui, NSSC, CAS, China

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The event was featured in the Bulletin of the Chinese Academy of Sciences (CAS): "Interstellar Express: A possible successor to Voyagers", November 11, 2019.

# WORKSHOP

# Oscillatory Processes in Solar and Stellar Coronae

#### October 14-18, 2019

Conveners: Dr. Ivan Zimovets (Space Research Institute, RAS, Russia/ISSI-BJ, China), Prof. Valery Nakariakov (University of Warwick, UK), Prof. Dipankar Banerjee (Indian Institute for Astrophysics, India), Prof. Bo Li (Shandong University, China), Prof. Tongjiang Wang (NASA-Goddard Space Flight Center, USA), and Prof. Maurizio Falanga (ISSI-BJ).



Group picture of the forum participants

As the year 2019 marked the 50<sup>th</sup> anniversary of the first detection of oscillatory processes in the solar corona as a quasi-periodic pulsation (QPP) of an X-ray and radio emission produced by a solar flare, during the last decades the international scientific community has gathered and analyzed a vast array of data on this topic.

The results of such observations, obtained with the current spaceborne and groundbased observational instruments (in particular, SDO/AIA, Hinode/EIS, STEREO/ EUVI, NoRH and IRIS), now constitute the basis for future investigations by means of the upcoming state-of-the-art solar instruments (Solar Orbiter, DKIST etc.).

As a result, in order to give the gist of the current state of research, to examine its problematics, as well as to identify future theoretical and observations-based questions on solar and stellar oscillatory phenomena, almost 50 scientists from 11 different countries met and debated on various topics, including the seismology of coronal plasma structures, novel data analysis techniques, and non-linear effects.

This event made it possible for me to finally meet some of my colleagues in person and to considerably benefit from the interactions and the discussions held with all the participants.

Prof. Bo Li, Shandong University, China

A special priority was given to the study of the complementarity of multi-instrumental and multiwavelength observations, the development and benchmarking of modern data analysis tools, the creation and use of a link between analytical theory, numerical modeling, and the interpretation of observations, as well as of the solar-stellar analogy following the TESS space mission.

Despite being fraught with thematic complexity:

Thanks to the excellent organization ensured by ISSI-BJ, we could fully immerse ourselves in our studies and numerous prominent international colleagues were given the chance to make their precious contribution to the workshop.

Dr. Ivan Zimovets, IKI, RAS, Russia

The workshop was inaugurated by Prof. Dong (ISSI-BJ, China) and Prof. Nakariakov (University of Warwick, UK) on October 14, and given the wide range of topics addressed, the presentations were organized in seven different chapters introduced during the first morning. These included: novel techniques in coronal seismology data analysis (led by Prof. Anfinogentov, Institute of Solar-Terrestrial Physics, RAS, Siberian Branch, Russia); kink oscillations and waves in the corona (led by Prof. Nakariakov, University of Warwick, UK); slow waves in coronal loops (led by Prof. Wang); MHD waves in open coronal structures (led by Prof. Banerjee); quasi-periodic pulsations in solar and stellar flares (led by Dr. Zimovets); Sausage oscillations and waves in the corona (led by Prof. Bo Li); coronal heating by MHD waves (led by Prof. van Doorsselaere, Catholic University of Leuven, Belgium).

The well-thought distribution and diversification of topics outlined by the conveners allowed for in-depth observations on many different research foci, which will therefore provide the international community with valuable interdisciplinary data.



Prof. Fabio Reale, University of Palermo, Italy

firmly believe that the results of this workshop will enable us all to make significant steps forward towards a better understanding of various phenomena of coronal physics and it will serve as a reference point to the international scientific community active in the solar physics field.

Prof. Srivastava, Indian Institute of Technology, India.

Thanks to the effective platform provided by ISSI-BJ to gather experts and young scientists active in the field, we could lay the groundwork for the upcoming publication of the workshop's reflections and results.

Prof. Tongjiang Wang, NASA-Goddard Space Flight Center, USA

# **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 invite 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 2017 🥯

### 1. Heger A. (AU) & Lugaro M. (HU)

# Radioactive Nuclei in the Cosmos and in the Solar System

Last Session: November 4-8, 2019

Scientific Rationale: The presence of today extinct radioactivities can be inferred from the analysis of primitive meteoritic inclusions and presolar grains, the former telling us about the formation history of the Solar System, the latter about chemical evolution of the Galaxy, and nucleosynthesis mostly in low-mass stars and supernovae. Key examples of such nuclei include 26 Al, 6 0 Fe, and 2 44 Pu. Our goal is to exploit these nuclei and the information that they carry by combining the most current sophisticated experimental, observational, theoretical, and numerical modelling investigations. We will undertake a unique and complete effort to understand the production of these radionuclei in stars and supernovae, their distribution and history in the Galaxy, and how they ended up in the Solar System.

Our team includes experts on gamma-ray observations, accelerator mass spectrometry,

nuclear experiment and theory, and modelling of stars, supernovae, and galactic chemical evolution. We will take advantage of new nuclear research facilities in China (e.g., JUNA), Europe (FAIR) and USA (FRIB) to obtain nuclear data and we will identify uncertainties in key reaction channels that need to be constrained by future experiments, helping to define the future research program. This becomes particularly powerful in combination with data from current and future international and Chinese gamma-ray observatories through which theory and models can be tested.

Our key target is to exploit radioactive nuclei to constrain stellar evolution and nucleosynthesis, the production and propagation of such nuclei, and the timescales of Galactic history and of the origin and history of the matter in our Solar System.

### 2. Zimovets I. (RU/CN) & Ning Z. (CN)

# Pulsations in solar flares: matching observations and models

### Last Session: October 16-20, 2017

Scientific Rationale: Our Team will focus on comprehensive analysis of solar flare spaceand ground-based observations and advanced modeling to deepen current knowledge about non-stationary processes of flare energy release manifested as pulsations of flare electromagnetic emission.

The Team is composed of international experts in the relevant areas of solar physics and is aiming to: 1. develop more rigorous criteria of quasi-periodicity for solar flare light curves; 2. utilize new methods of analysis of nonlinear and non-stationary datasets; 3. develop an advanced classification of different types of pulsations in solar flares; 4. perform detailed multi-wavelength spatially-resolved analysis of the sources of pulsations in the large sample of solar flares using modern observational datasets (RHESSI, Fermi, SDO, IRIS, Lomonosov, Vernov, Spectr-R, NoRH/NoRP, SSRT, etc.); 5. assess adequacy and improve the existent flare models; 6. evaluate the possible role of pulsations in solar-terrestrial connections; 7. develop a strategy of exploration of pulsations in solar and stellar flares with spaceand ground-based instruments in the coming years.

### 3. Zhang H. (US) & Zong Q. (CN)

# Dayside Transient Phenomena and Their Impact on the Magnetosphere-Ionosphere

Last ISSI-BJ Session: May 20-24, 2019

<u>Scientific Rationale</u>: We propose a team that will employ both observations and simulations to investigate dayside transient phenomena at the magnetopause and bow shock and their impact on the magnetosphere and ionosphere.

Dayside transients are frequently observed upstream from the bow shock (e.g., Hot Flow Anomalies, foreshock cavities, and foreshock bubbles) and at the magnetopause (e.g., flux transfer events and surface waves). They play a significant role in the mass, energy and momentum transport from the solar wind into the magnetosphere and impact the whole magnetosphere-ionosphere system. Foreshock transient phenomena, associated with variations in the solar wind dynamic pressure, deform the magnetopause, which in turn generates fieldaligned currents (FACs) connected to the auroral ionosphere. Solar wind pressure variations along with transient phenomena at the dayside magnetopause are also believed to be sources of magnetospheric ULF waves, some of which can play an important role in the dynamics of Earth's radiation belts.

The goal of our team is to provide a fundamental physical understanding of dayside transient phenomena and their impact on the magnetosphere-ionosphere system. Specifically, we will focus on the following key unanswered questions: 1. What are the physical differences and relationships among hot flow anomalies, foreshock cavities, and foreshock bubbles upstream from the bow shock? 2. What are the spatial and temporal variations of the magnetic reconnection at the magnetopause? 3. How do the magnetosphere and ionosphere respond to dayside transient phenomena?



1. Donatella Romano (IT) & Zhi-Yu Zhang (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.

With this proposal, we aim at building up an international team whose members have all the necessary expertise to (i) reduce significantly the uncertainties present in abundance measurements, (ii) extend the measurements to different types of galaxies, from dwarfs to ellipticals, at both high and low redshifts, (iii) improve –or develop from scratch– the theoretical tools that are necessary for a full exploitation and interpretation of the data.

Our team is composed of ten scientists from five European countries and from China. It includes experts in numerical simulations, semi-analytical models of galaxy formation in a cosmological context, state-of-the-art hydrodynamical simulations, stellar evolution and nucleosynthesis, chemical evolution, IGIMF theory, as well as experts in ISM physics, molecular line observations and data analysis.

### 2. Zuhui Fan (CN)

### Weak Gravitational Lensing Studies from Space Missions

Last Session: November 4-8, 2019

<u>Scientific</u> <u>Rationale</u>: 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 of the CSS-OS.

The studies 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. Jeremie Lasue (FR) & Roger Wiens (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. We plan to propose one meeting in each ISSI location (Beijing and Bern) for maximum benefit to the international nature of the team. Of course, all team members are committed to attending the meetings in both locations.

### 4. Li J.(CN)

### Understanding and unifying the gamma rays emitting scenarios in high mass and low mass X-ray binaries

### Last 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 gamma ray emission observed from HMXBs and LMXBs are found to be different.

With this project we plan to enlarge the sample of sources and to 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 unifications between the different classes.

### 5. Mironova I. (RU)

### Relativistic electron precipitation and its atmospheric effect

### Last Session: October 14-18, 2019

<u>Scientific Rationale</u>: The main goal of our Team project is obtaining progress in understanding of precipitating of electrons of relativistic energies (especially more 1 MeV) into the Earth 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 modelling atmospheric and climate effects of energetic particle precipitation. Measurements and modelling of relativistic electron precipitation into the Earth atmosphere as well as its atmospheric and climate applications, it is a multi-disciplinary problem that requires collaboration of specialists looking at this problem from different points of view.

One of the outputs of the Team project is



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. J.-C. Vial (France) and P. F. Chen (China)

# The eruption of solar filaments and the associated mass and energy transport

Last 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.



### 1. Yvan Orsolini (NO) & S He (NO)

# Dynamical signatures of energetic particle precipitation in atmospheric re-analyses

### New 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 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, with the aim to determine the mechanisms at work. It will gather complementary expertises in magnetohydrodynamics, plasma diagnostic, radiative transfer...

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 H $\alpha$  Telescope and Indian Aditya L1 missions.

activity on atmospheric composition, temperature and dynamics, and to provide an envelope for what could be found in re-analyses. A 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 a 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:

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

ii) 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. Xuhui Shen (CN), Gauthier Hulot (FR)

### & Xuemin ZHang (CN)

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

Last 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 Feb. 2, 2018. There are eight scientific payloads installed onboard, including HPM and SCM for magnetic field observation, EFD for 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. On the basis of this satellite, the team proposes an investigation of the near-Earth space plasma dynamics and electromagnetic environment by multi-parameter analysis from variety of payloads. This study aims to construct the chain of lithosphere-atmosphereionosphere 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 anayze 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 of the leading Chinese and International experts in different disciplines will provide a unique opportunity for knowledge fusion to make a breakthrough in the space electromagnetic data validation and application research of CSES.

### 3. Orosei (IT)

### Searching For Subglacial Water On Mars With Orbiting Ground Penetrating Radars

### New 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 ond 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 on board 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 modelling and simulations of electromagnetic propagation

### 4. Gang Li (US)

& Linghua Wang (CN)

### Using Energetic Electron And Ion Observations To Investigate Solar Wind Structures And Infer Solar Wind Magnetic Field Configurations

New Session: TBD

Scientific Rationale: Solar electron events are common phenomenon observed in interplanetary

space. A majority of these events is 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 proposes a comprehensive investigation which 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. Besides electrons, 3He ions will a. Secondly, modelling the transport of energetic electrons and ions in a turbulent solar wind, with a particular focus on the effect of meandering field line. Finally, performing MHD simulations to examine how preceding CMEs can affect the configu-ration of solar wind magnetic field.

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

### 5. Alexei Pevtsov (US)

### Modeling Space Weather And Total Solar Irradiance Over The Past Century

#### New 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 had only begun around mid-1960th. This lack of magnetograph data for early solar cycles severely restricts developing a comprehensive understanding of solar activity and its space weather effects in the past, and their prediction for the future.

With the goal of developing a clear physicsbased understanding of long-term changes in 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 back as the early 1840s. The applicability of newly created pseudo-magnetogram dataset to reconstructing total solar irradiance for the period of 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 USA.

### 6. Yao (UK) & Shi (CN)

### The morphology of aurora at Earth and giant planets: characteristics and their magnetospheric implications

### New 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 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) provided us with 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 leaderDr. Yao is an active researcher on both communities.

### 7. Ward (UK)

### Active Galaxies In Crisis: A Statistical Study Of Ultra-Violet Variability

#### New Session: TBD

<u>Scientific Rationale</u>: 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 super-massive black hole is now the well accepted picture. However, all is not well with

important aspects of our understanding. This has been highlighted by the increasing use of the time domain as a new tool to investigate the inner regions of AGN that we cannot spatially resolve.

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 bluest u-band) due to atmospheric absorption. For low redshift AGN which often have the best quality data, this is the wavelength region dominated by the accretion disc, a key component in our understanding of the physics of AGN. The timescales of 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 exists for observations from the ESA cornerstone mission XMM-Newton and the Neils Gehrels Swift Observatory (with Italian and UK involvement).



The International Team on "Understanding and unifying the gamma rays emitting scenarios in high mass and low mass X-ray binaries" at ISSI-BJ in March 2019.

# **PUBLIC OUTREACH**

### UNDERSTANDING SCIENCE SEMINARS

# Traveling to the Black Hole

### Pavel Bakala

### January 22, 2019

On January 22, 2019, ISSI-BJ organized an Understanding Science seminar on "Traveling to the Black Hole". The talk was held by Dr. Pavel Bakala, a theoretical physicist of the Silesian University in Opava, Czech Republic, whose research is focused on the field of numerical relativity, advanced methods of relativistic raytracing and visualization in the vicinity of black holes and neutron stars. The seminar was held at Bunny Drop Café & Bar in Haidian District, Beijing.

Dr. Bakala started the seminar by introducing the general relativity theory and the history behind its development. Einstein's theory of gravitation implies the existence of black holes which were the main focus of the talk. Dr. Bakala presented the computer modeling of the sky view for the observers located in very close vicinity of black holes. As he explained, the curved spacetime near the event horizon of black holes works has an extreme gravitational lens with highly surprising and completely non-intuitive properties which are absolutely different from the common optics in the weak gravitational field of the Earth known



Dr. Bakala during his lecture.



Dr. Bakala during his lecture.

from our everyday experience. Virtual observers travelling near a black hole could see the sky with radiating bodies in bizarre and entirely different shapes and colors as opposed to the view of the sky undistorted by the strong gravity. They could also observe an infinite number of multiple relativistic images, the Einstein rings deformed by the rotation of the black hole, black hole shadows, and the color effects caused by strong gravity and the motion of the observer.

In this fascinating seminar, Dr. Bakala presented the visualization of the sky for an observer at rest relative to a black hole, for an observer on a very low orbit around the black hole, and for an observer falling freely towards the event horizon. The talk brought together not only scientists, but also people from all backgrounds, fascinated by the topic of mysterious black holes.

# Life in the Universe

### Alvaro Giménez

### December 5, 2019

On Thursday, December 5, 2019, Prof. Alvaro Giménez, the current Director General of the Foundation of Spanish National Research Council (CSIC, Spain), gave a lecture on "Life in the Universe" at TusStar Coffee in Haidian District, Beijing. As part of the Understanding Science seminar series jointly organized by the International Space Science Institute–Beijing (ISSI-BJ), the UK Royal Society of Chemistry (RSC), and Beijing University of Chemical Technology, the event aimed to attract non-experts to reflect on space science-related questions with the help of an experienced scientist.

The interest in the mysteries of our galaxy, of the interstellar space, and of our universe spans across time and space. Given the many still unsolved questions and enigmas concerning our cosmos, it is no surprise that researchers spare no effort to conduct deeper investigations on our universe and its laws. Considering the climate changes that are affecting our ecosystem and the future of our planet, the fascination towards space science-related topics has grown, leading not only to increased research but also to copious artistic productions and imaginative suppositions regarding other forms of life and the future of humankind in the universe.



Prof. Giménez (CSIC, Spain) on the major stars close to the Earth



Prof. Alvaro Giménez (CSIC, Spain) giving a seminar on Life in the Universe

scientific (il)legitimacy of Despite the these conjectures, they all aim to quench thirst knowledge our for concerning some our universe and for answering popular yet essential questions, such as:

- What is life?
- Did life emerge by necessity or by chance?
- How will humankind evolve, and where?
- How will our planet and the solar system evolve?
- Are we alone?

To address these questions, Prof. Giménez introduced the audience, ranging from senior scientists to students, professionals, and nonexperts, to the origins of the universe and in particular, of life in the cosmos, which is commonly traced back to over 3,500 million years ago. After

> defining life as a self-sustaining chemical system capable of Darwinian evolution, Prof. Giménez explored the three main ingredients that represent the essential factors for life to arise, i.e. organic compounds, liquid water, and a source of energy.

> Hitherto the Earth represents the only planet in the solar system which can present liquid water on its surface, but are these the only necessary factors for life to emerge or did life appear merely by chance? In order to analyze this interrogative and challenge such

theory some forms of life that survive and exist in extreme conditions — harsh temperatures, pressure, pH — were mentioned, such as the organisms discovered in the Río Tinto, Spain, 'Red River' in English, and in the Gunhuver hot springs, Iceland, or the ecosystem found 2.8 km underground in the Mponeng Gold Mine near Johannesburg, South Africa.

Similarly, even though the surface of Mars does not appear to provide a fertile ground for life to appear, the discussion on life on Mars is ongoing both in scientific and non-scientific circles. In fact, four billion years ago Mars presented some conditions which could have made life possible, and this leads to the unavoidable necessity to explore what lays beneath its crust.

As the talk went deeper into the topic of life in the universe, the debate also moved further from the earth and outside of our solar system, as Prof. Giménez introduced Exoplanets, i.e. planets outside of the Solar System, which possess completely different characteristics from the ones visible in our system.

Given the 4120 exoplanets currently known as well as the soon to-be-concluded interstellar

mission of the Voyager 2 probe, the interest in the interstellar space and the related missions has peaked, bringing us closer to some compelling questions on life in the universe, such as if there is life on other planets outside of the Solar System and under which conditions it can arise. As illustrated by Prof. Giménez, we are aware that around 20-50 exoplanets are potentially habitable (only 0.5/1% of the total number), but we still grope in the dark regarding the existence of habitable planets — with water on the surface — or already inhabitable ones, i.e. with a biosphere.

Following the Fermi Paradox, which outlines the apparent contradiction between the lack of evidence for extraterrestrial civilizations elsewhere in the Milky Way galaxy and various high estimates for their probability, the talk was concluded with some suggested theories on the existence of life on other planets, ranging from other forms of life's lack of interest in communicating with us to the extreme difficulty for them to reach the Earth.

As the lecture was concluded, several questions of different kinds were brought up and exhaustively answered by Prof. Giménez.



Prof. Giménez (CSIC, Spain) on Exoplanets

### EVENTS

### Introduction to ISSI-BJ and Scientific Seminar on Neutron Stars at Peking University

### January 19, 2019

Prof Maurizio Falanga was invited by Prof. Renxin Xu & Prof. Zhaosheng Li's Astronomy & Astrophysics Group to Peking University

ISSI-BJ Executive Director Prof. Maurizio Falanga went to Peking University to give the students an introduction on the scope, goals, activities, and the research opportunities available at ISSI-BJ, highlighting the essential function of international collaboration for the development of Space Science studies. Moreover, Prof. Falanga also held a scientific seminar on determining masses and radii of neutron stars. The meeting was followed by a Q&A session led by Prof. Falanga.

Introduction to CAST and open discussions for future collaboration and joint activities at Qianxuesen Laboratory of Space Technology, CAST

### January 25, 2019

Participants: Yao Wei (Qian Xuesen Laboratory of Space Technology, CAST, China); Zhang Xiaojing (Qian Xuesen Laboratory of Space Technology, CAST, China); Zhao Shaofan (Qian Xuesen Laboratory of Space Technology, CAST, China); Yu Zhitong (Qian Xuesen Laboratory of Space Technology, CAST, China); Gao Lei (Qian Xuesen Laboratory of Space Technology, CAST, China); Meng Ying (Qian Xuesen Laboratory of Space Technology, CAST, China); Zhou Hui (CAST, China); Maurizio Falanga (ISSI-BJ)

On January 24, 2019, Prof. Falanga went to visit the CAST Qian Xuesen Laboratory. Founded in December 2011, it is an innovative "special zone" of China Aerospace Science and Technology Group Co., Ltd. dedicated to becoming an



Prof. Falanga at the CAST Exhibition Center.

internationally influential first-class space science and space technology laboratory. It works together with domestic and foreign scientific research institutions to carry out strategic demonstration, mission definition, application basis, key technologies and load instruments in different areas, including the innovation workstation of the Central Military Commission. the innovation center of the Bureau of Science and Technology, major national projects in the future, and space science missions. The meeting started at 14:00 with an Introduction to the Laboratory, given by Mr.Lei Gao, its Director, followed by Prof. Falanga's presentation of ISSI-BJ's mission and tools. After a common understanding of the two institution, they had a friendly and open discussion and exchanged ideas for future collaboration. Prof. Falanga also had the pleasure to visit the impressive exhibition center of CAST.

## NSSC/ISSI Agreement Renewal Ceremony

### June 11, 2019

Prof. Ji Wu (ISSI-BJ, China); Prof. George Meylan (ISSI, Switzerland); Prof. Maurizio Falanga (ISSI-BJ, China)

On June 11, 2019, Prof. George Meylan (ISSI, Switzerland), Prof. Ji Wu (ISSI-BJ, China), and Prof. Maurizio Falanga (ISSI-BJ, China), met at the International Space Science Institute (ISSI) in Bern, Switzerland, to sign the agreement renewal between ISSI and the National Space Science Center of the Chinese Academy of Sciences (NSSC, CAS).

The agreement sanctioned the beginning of a new three-year chapter of collaboration between NSSC and ISSI to mutually support and promote the activities organized at ISSI-BJ and foster an international environment of knowledge sharing and fruitful cooperation in space science.



From the left: Prof. Maurizio Falanga (ISSI-BJ, China); Prof. George Meylan (ISSI, Switzerland); Prof. Ji Wu (ISSI-BJ, China)

# **2020 ACTIVITIES**

Please note that given the COVID-19 pandemic, the ISSI-BJ 2020 Events Schedule could be considerably affected.

# FORUMS Joint ISSI/ISSI-BJ Forum "The Lunar Scientific Station"

### Fall/Winter 2020

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

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, prior to 2020 focused on the circling (CE-1 and CE-2), landing (CE-3 and CE-4), and returning (CE-5). 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 environmental of South Pole. Furthemore, the experiments to be performed will investigate and include resource utilization during in-situ experiments (water, He, lunar soil etc.), the Earthmoon 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 sample to conduct laboratory studies, and provide long-term 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 the phase 4 of CLEP, which will prioritize international collaboration, several leading international scientists in moon science will gather at ISSI and ISSI-BJ in the year 2020. The first forum session will be held at ISSI in May/June 2020, while the second part will be hosted by ISSI-BJ at the end of the year 2020, 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 made available online and understandable to nonexperts.

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

# FORUM "Detecting "Missing" Baryons in the Universe"

### October 14-16, 2020

Conveners: Wei Cui (Tsinghua University, China); Joel Bregman (University of Michigan, USA); Taotao Fang (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); Feng Yuan (Shanghai Astronomical Observatory, China); Maurizio Falanga (ISSI-BJ, China).



Missing Baryons - Credits: Illustris Collaboration

The goals of this ISSI-BJ forum are 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

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International Space Science Institute - Beijing



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

### Fall/Winter 2020

#### Conveners: Maurizio Falanga (ISSI-BJ, China), TBD

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 opportunity to conduct their own experiments aboard to the China Space Station. They received more than 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 interests in the application of space stations space experiments relevant disciplines with a selection of experienced system developers to discuss existing, planned and possible 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 the scope of ISSI-BJ activities, the Forum tool appears ideally suited to enabling a broad discussion of this topic. The discussion during the two-day Forum will focus on the following main 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 science impact of the Space Station platforms.
- Characterize limitations of the Space Stations as a platform of science investigations



The Chinese Space Station - Credits: CMSEO

# WORKSHOPS

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

### Fall/Winter, 2020

Conveners: Chi Wang (NSSC, CAS, China); Yongliao Zou (NSSC, CAS, China), TBD

In the past twenty years, several exploration missions aimed at researching the moon, including the Chinese Chang'E (CE) 1-4 satellites, the Indian Chandrayaan-1, Japan's Kaguya (Selene), ESA's SMART mission and the US' Lunar Reconnaissance Orbiter (LRO).

Prior to the current year 2020, the China's Lunar Exploration Program (CLEP) has focused and researched the circlying (CE-1 and CE-2), landing (CE-3 and CE-4), and returning (CE-5) of its mission's satellites. If the CE-1, CE-2, and CE-3 - launched between 2007 and 2013 satellites have helped scientists yield important data on the microwave brighteness temperature map, the chemical and mineral composition of the lunar surface, the near-moon environment, the Toutatis asteroid, and the volcanic history of the Imbrium Basin among others, the Chang'e-4 has accomplished a milestone achievement in December 2018 as it landed on the far side of the moon, opening a new set of perspectives and opportunities in moon science.

The Japanese SELENE mission (2007-2009) is a lunar orbiter that includes a main orbiter and two small satellites, and the main orbiter will be at a distance of 100 from the moon, flying on a circular track of several kilometers. It aimed at exploring the origin, the formation and evolution of the moon, its space environment, as well as at observing the outer space.

On the other hand, the Indian Chandrayaan-1, launched in 2008, focused instead on the radiation measurement of the space between the earth and the moon, the high-resolution geological maps, mineral maps, and topographic maps of the moon. Finally, the mission encompassed also explorations on the hypothesized existence of water at the lunar south pole.

The workshop therefore aims at providing a summary and review of 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 the Springer's Space Science Reviews and subsequently, as a hardcopy edition of the ISSI-BJ Space Science Series (SSSI).



Full Moon in Beijing - Credits: Xinhua/Chen Duo

# WORKING GROUPS

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



Planet Mars - Credits: NASA/ESA

### October 3-7, 2020

Conveners: Vlada Stamenković, NASA Jet Propulsion Laboratory, USA; Barbara Sherwood Lollar, CIFAR Earth 4D Program & University of Toronto, Canada; Wenzhe Fa, Institute of Remote Sensing & GIS, Peking University, China; Cara Magnabosco, Geobiology, ETH Zurich, Switzerland.

One of the main 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. The first steps on the path to exploring the potential for life in the Martian subsurface are currently in process with InSight and ExoMars 2020, but to date, there has been no focused effort to address the question of modernday 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.

ISSI-BJ represents in this sense an invaluable platform due to three main reasons: (1) the Chinese 2020 Mars mission will have payloads that will explore the subsurface, (2) the Deep Carbon Observatory that so far led Deep Life exploration on a global scale has reformed itself within the new International Center for Deep Life Investigation (IC-DLI) in Shanghai, China, becoming a new global center for subsurface life exploration; (3) any mission that focuses on extant life in the Martian subsurface in the next two decades will likely need to be an international mission due to its complexity.

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 in order to formulate mission concepts, from small space craft 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 obtain the measurements? How can we sound 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 2020 Analysis and Investigation of Scientific Moon Data

### September 14-23, 2020

Conveners: Ebrahimi Seyedabadi (APSCO) and Maurizio Falanga (ISSI-BJ, China)



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 on Space Sciences 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 means of 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 on the Moon's surface. The only lunar seismic data had been obtained during 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 in order 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 in 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 1-2 tutors experienced in the related field. Each group will have its own 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 the 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 in order to facilitate the communication between students, teachers, tutors, and organizers. The school will be concluded with the presentations of the groups' results to receive feedbacks 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 multi-disciplinary way; it will encourage creativity and provide the contacts for the participants to develop a professional network. In fact, international collaboration will also be an 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 in order to have access to all necessary experimental data, models, and literature through the Internet. Tutors will provide and/or indicate the data and models on-site.

#### Location & Local arrangement

Macau University of Science and Technology (MUST), Macau, China.

#### Application

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



# PUBLICATIONS

# TAIKONG MAGAZINE



### Study Space Weather Effects: From the Earth to the Ground



Authors: All ISSI-BJ/APSCO Space Science School Participants

Editor: Anna Yang (ISSI-BJ, China)

On October 10-19, 2019, the 2<sup>nd</sup> ISSI-BJ and APSCO Space Science School with EISCAT on Study Space Weather Effects: From the Sun to the Ground was held at the Sanya Institute of Remote Sensing (RADI) in Sanya, Hainan Province, China.

The School provided the young space researchers and engineers with the opportunity to gain the indepth knowledge of the science of Space Weather, observational methods, and its relevance to applications from the Sun to the ground. They were divided into four working groups, depending on their expertise and preferences: Sun/Heliosphere, Impact and Magnetospherelonosphere-Thermosphere Coupling, Ionosphere/EISCAT Incoherent Scatter Radars, and Effects on Satellites and Groundbased Infrastructures.

Students actively contributed to the School not only with questions and constructive comments after the lectures, but also with an intensive, week-long group work resulting in presentations and reports. During the students' presentations sessions, young scientists had the chance to present their research results and receive invaluable comments and advices from experts in the field. The final report including the reports written by all the working groups is published jointly with APSCO and EISCAT in this TAIKONG ISSI-BJ magazine.

### No. 13, June 2019

PRESTO: Predictability of the Variable Solar-Terrestrial Coupling: The SCOSTEP Scientific Program (2019-2024)



Authors: Nat Gopalswamy (SCOSTEP Bureau / NASA GSFC, USA), Ioannis A. Daglis (NSP Committee Chair/National and Kapodistrian University of Athens, Greece)

Editor: Anna Yang (ISSI-BJ, China)

On November 14-16, 2019, the Forum "Variability and Predictability of Solar-Terrestrial Coupling: the Next Scientific Program of SCOSTEP" was held at ISSI-BJ.

The Scientific Committee on Solar-Terrestrial Physics (SCOSTEP) was established in 1966 as an interdisciplinary body of ICSU, the International Council for Science. SCOSTEP is tasked with running long-term scientific program in Solar Terrestrial Physics, a topic closely aligned with several disciplines of the International Space Science Institute (ISSI).

The formal interaction between ISSI and SCOSTEP started in 2012 and the successful SCOSTEP scientific program VarSITI (Variability of the Sun and Its Terrestrial Impact) (2014-2018) was defined during the ISSI forum in May 2013 in Bern. As a result, a following forum was organized in two parts: the first one was conducted at ISSI-BJ in order to facilitate scientists from the Asia region to participate in the deliberations; the second one is the Forum at ISSI that finalized the next scientific program known as PRESTO (Predictability of the Variable Solar Terrestrial Coupling).

In this Taikong, the results of the discussions and debates held during the first ISSI-BJ Forum are summarized and presented by Prof. Gopalswamy (USA) and Prof. Daglis (Greece).

### No. 14, July 2019

### Discover the Sky by Longest Wavelength with Small Satellite Constellation



Authors: Xuelei Chen (NAO, CAS, China), Ji Wu (NSSC, CAS, China), Jack Burns (Colorado, USA), Joe Silk (Johns Hopkins University/Institut Astrophysique de Paris, USA/ France), Leon Koopmans (Groningen University, The Netherlands), Hanna Rothkaehl (Space Research Center, Polish Academy of Sciences, Poland), Maurizio Falanga (ISSI-BJ, China), Stuart Bale (UC, Berkeley, USA), Albert-Jan Boonstra (Groningen University, The Netherlands), Baptiste Cecconi (Observatoire de Paris, France), Cynthia Chang (University of KwaZulu-Natal, South Africa), Linjie Chen (NAO, CAS, China), Li Deng (NSSC, CAS, China) Heino Falcke (Radboud University, The Netherlands) ,Quanlin Fan (NSSC, CAS, China), Guangyou Fang (Institute Of Electronics, CAS, China) Anastasia Fialkov (Harvard-Smithsonian Center for Astrophysics, Cambridge, UK), Leonid Gurvits (European Research Infrastructure Consortium (JIVE), The Netherlands), Yicai Ji (Institute Of Electronics, CAS, China) Justin Kasper (University of Michigan, USA), Kejia Li (PKU, China), Yi Mao (Tsinghua University, China), Ben Mckinley (Curtin University, Australia), Raul Monsalve (McGill University, Canada), Ue-Li Pen (Canadian Institute for Theoretical Astrophysics, Canada), Jeff Peterson (Carnegie Mellon University, USA), Jinsong Ping (NAO, CAS, China), Ravi Subrahmanyan (Raman Research Institute, India), Harish Vedantham (Netherlands Institute for Radio Astronomy, The Netherlands), Chi Wang (NSSC, CAS, China), Marc Klein (Wolt Radboud University, The Netherlands), Fengquan Wu (NAO, CAS, China), Yidong Xu (NAO, CAS, China), Jingye Yan (NSSC, CAS, China), Bin Yue (NAO, CAS, China)

Editor: Anna Yang (ISSI-BJ, China)

On January 23-25, 2019, the Forum "Discover the Sky by Longest Wavelengths with Small Satellite Constellation" was held at ISSI-BJ.

Over the last century, astronomical observations have expanded from the optical to the radio, infrared, ultraviolet, X-ray and gammaray bands of the electromagnetic spectrum, and further supplemented by non-electromagnetic observations such as the cosmic ray, neutrino, and gravitational waves. These new observational domains brought many unexpected discoveries, which greatly changed our view of the Universe, and gave deep insight on the fundamental laws of Nature. However, at the longest wavelengths of the electromagnetic spectrum, our view is still incomplete.

The Forum reviewed the current understanding on various science subjects related to the low frequency radio window, previous and ongoing observations, recent progress, and key science problems to be solved. It then discussed concepts and technologies related to space-

> based low frequency radio observation and data processing. In particular, it focused on a possible future lunar orbit array mission of Discovering Sky at the Longest wavelengths (DSL). The proposed array is made up of satellites flying in linear formation, making both interferometric and single antenna observations on the orbit behind the Moon, shielded from the Earthoriginated radio frequency interferences. This mission concept is under intensive study by the Chinese Academy of Sciences (CAS) in collaboration with national and international partners.

### No. 15, December 2019

### Exploring Greenhouse Gases, Water, and Climate Changes by LEO-LEO Occultation



Authors: Liu Congliang (NSSC, CAS, China), Gottfried Kirchengast (WEGC, University of Graz, Austria), Sun Yueqiang (NSSC, CAS, China), Wang Xin (IAP, CAS, China), Lv Daren (IAP, CAS, China), Bai Weihua (NSSC, CAS, China), Du Qifei (NSSC, CAS, China), Armin Löscher (ESA Future Missions & Instruments Division, The Netherlands), Stig Syndergaard (DMI, Denmark), Tian Longfei (IAM, CAS, China), Zhang Zhihua (IAP, CAS, China)

Editor: Laura Baldis (ISSI-BJ, China)

On July 24-26, 2019, the Forum "Exploring Greenhouse Gases, Water, and Climate Changes by LEO-LEO Occultation" was held at ISSI-BJ.

Given the need of improvements in existing ground-based and satellite observations to successfully deliver atmosphere and climate benchmark data and to reduce data ambiguity, the Forum discussions focused on three main subjects: The key scientific questions and responses of ECVs in relation to global change; the principles, algorithms and payloads of microwave occultation-using centimeter and millimeter wave signals between low Earth orbit satellites (LEO-LEO microwave occultation, LMO) as well as of the LEO-LEO infrared-laser occultation (LIO); the Climate and Atmospheric Composition Exploring Satellites (CACES) mission concept proposed to the Strategic Priority Research Program of Chinese Academy Science (SPRPCAS).

This TAIKONG magazine presents an overview of the LEO-LEO technique and its status and then focuses on the CACES mission with its scientific objectives, mission concept, payloads design and the major outcome from this forum.

# **ISSI-BJ** in the ISSI Space Science Series

### Astronomical Distance Determination in the Space Age Volume 66, 2019 Editors: R. de Grijs, M. Falanga



D Springer

Originally published in Space Science Reviews in the Topical Collection "Astronomical Distance Determination in the Space Age"

Knowing the distance of an astrophysical object is key to understanding its formation and evolution. Without an accurate distance, we do not know how bright it is, how large it is, or even when it existed. This volume highlights the tremendous amount of recent and continuing research into a myriad of exciting and promising aspects of accurately pinning down the cosmic distance scale, where possible focused on space-based contributions.

These papers go one step further, putting the many recent results and new developments into the broader context of the physics driving cosmic distance determination. Thus, the volume will benefit researchers spanning a wide range of expertise, including theorists, observers, and modelers working on a large variety of spatial scales. International Space Science Institute - Beijing

# STAFF PUBLICATIONS

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# **INTERVIEWS**

### Interview with Rumi Nakamura



Prof. Rumi Nakamura is a space plasma scientist at the Space Research Institute of the Austrian Academy of Sciences in Graz, Austria. After receiving her master's and PhD degrees from the University of Tokyo, she focused her research on space plasma physics based on data analysis from satellites and ground-based measurements, as well as solar-terrestrial interactions, including the terrestrial magnetosphere. After joining the Goddard Space Flight Center (USA), she moved to Europe to work at the Max Planck Institute for Extraterrestrial Physics as a Senior Scientist, and since 2001 she's a leader of the Space Research Institute at the Austrian Academy of Sciences.

# When and how did you first learn about ISSI-BJ and its program?

I first learned about ISSI-BJ during one Science Committee meeting held at ISSI in Bern, as ISSI's scientific program was being outlined and the establishment of ISSI-BJ was being discussed.

# 2. How were you involved in ISSI-BJ's activities and how was it relevant for your own research focus?

After the inauguration of ISSI-BJ, I took part in some of the meetings to draft its annual scientific agenda, i.e. its forums, workshops, working groups etc. This year I was involved in two ISSI-BJ forums, where future space missions and research on space science – including my research area – were addressed. Being at these two forums was an exciting opportunity, as it allowed me to meet with scientists coming from different backgrounds, with agency representatives, as well as with scientists from my field, with whom I could expound on more focused research topics, such as fundamental plasma processes and possible future missions in space plasma physics.

# 3. What do you think is special about ISSI-BJ and how do you see its future development?

Despite my little experience as a scientist at ISSI-BJ as well as in the Science Committee meetings, I think that ISSI-BJ international forums on future space missions are guite a unique experience. First of all, the location represents a very special platform where scientists from all over the world can gather and work together on various research topics. Since we need more space missions, this is a very important factor and the best way to launch new missions is to involve international experts and establish crossnational collaborations between researchers and agencies. Thus, ISSI-BJ constitutes a precious meeting point to make interactions and communication smoother and international collaboration possible.

4. You have worked in several different countries, including Japan, USA, Europe. How relevant is international collaboration in science and how have cooperation opportunities changed throughout the years?

International collaboration is essential in space scInternational collaboration is essential in

space science. In all the Earth's magnetospheric mission I have been involved in so far, they were all either a multi-agency/country mission or a mission led by one agency but with some key instrument contributions from foreign countries. As scientists' needs are evolving toward better quality of observational studies – higher temporal and spatial resolution as well as larger coverage in space – the next-generation missions will require a larger number of spacecraft at dedicated locations in space with customized instruments. For the purpose of realizing such missions, international collaboration is fundamental not only for scientists but also for agencies.

# 5. Is there any place you particularly enjoy visiting in Beijing?

Unfortunately, since both my two visits in Beijing were rather short, I haven't had the chance to properly visit the city. But so far, I enjoyed very much an afternoon walk in the Forbidden City and a nice dinner at Bajiadayuan restaurant close to the Summer Palace, a very pleasant old Beijing neighborhood.

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### Interview with Nat Gopalswamy



Dr. Natchimuthuk Gopalswamy is a staff scientist at the Heliophysics Division of NASA's Goddard Space Flight Center, Greenbelt, Maryland, where he also holds the position of Astrophysicist in the Solar Physics Laboratory. He received his PhD from the Indian Institute of Science, Bangalore (1982) and did his postdoctoral training at the University of Maryland, College Park (1985). His research focuses on solar and solar terrestrial physics using data from various large radio telescopes and space missions. His research interest includes coronal mass ejections and their impact on Earth and on the heliosphere in the form of

magnetic storms and particle radiation. He is a Fellow of the American Geophysical Union and a recipient of Doctor Honoris Causa from the Bulgarian Academy of Sciences.

# 1. When and how did you first learn about ISSI-BJ and its program?

I heard about ISSI-BJ about six years ago, when it was announced in one of ISSI Newsletters.

# 2. How were you involved in ISSI-BJ's activities and how was it relevant for your own research focus?

I was one of the conveners of the ISSI Forum on the next scientific program of SCOSTEP (Scientific Committee on Solar Terrestrial Physics). The Forum was held in two parts, one at ISSI-BJ in November 2018 and the other at ISSI in February 2019. This activity culminated in the establishment of the PRESTO program (Predictability of the Variable Solar Terrestrial Coupling) as the next scientific program of SCOSTEP. The deliberations of the Forum were published in the ISSI-BJ Taikong No. 13 (June 2019). My second activity at ISSI-BJ was the participation in the Forum related to the International Meridian Circle Project [September 23-25, 2019]. This Forum was devoted to developing a compelling science case for a

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global observation system that will monitor our planet's upper and middle atmosphere and ionospheric layers. I was invited to this forum as an expert in solar and interplanetary processes that affect these layers. I also contributed to the material to be published In an upcoming Taikong issue.

# 3. What do you think is special about ISSI-BJ and how do you see its future development?

The ISSI-BJ encourages a broader participation of the international science community in solving outstanding problems in space science. ISSI-BJ promotes the efficient utilization of resources augmenting and enhancing the mission of ISSI, e.g., by reducing travel costs.

4. You have worked in several different countries, including Japan, USA, Europe. How relevant is international collaboration in science and how have cooperation opportunities changed throughout the years?

Modern problems and the tools to solve them involve huge resources that a single nation cannot afford. International cooperation has become a necessity. From my personal experience, I realized that international collaboration results in efficient problem solving and resource utilization. From my leadership activities in SCOSTEP and the International Space Weather Initiative (ISWI), I learned that global cooperation in space science is critical in making rapid progress on problems like space weather that affect the entire human society. The contribution of ISSI and ISSI-BJ on global cooperation has been exemplary.

# 5. Is there any place you particularly enjoy visiting in Beijing?

In addition to a trip to the Great Wall, I always enjoyed taking a stroll on the Wangfujing street.



Wangfujing Street in Beijing - Credits: Expedia

### Interview with ISSI-BJ International Team

The meeting of the International Team working on "Chemical abundances in the ISM: the litmus test of stellar IMF variations in galaxies across cosmic time" was held at ISSI-BJ from November 11 to November 15, 2019.



On this occasion, the two team leaders - Dr. Donatella Romano (INAF, Astrophysics and Space Science Observatory of Bologna, IT) and Prof. Zhang Zhiyu (formally Institute for Astronomy, University of Edinburgh, UK; currently School of Astronomy and Space Science, Nanjing University, China), together with their team members, answered some questions on their project as well as their experience at ISSI-BJ.

Where the interlocutor is not specified, the answer reflects the view of the whole team.

### How did you first learn about ISSI-BJ and about its International Teams program? And is it your first time at ISSI-BJ?

Dr. Donatella Romano: It is my first time at ISSI-BJ, but not the first one using ISSI tools, as I had already taken part in some other activities at ISSI Bern both as a team member as well as team leader\*. During these experiences at ISSI and thanks to Prof. Maurizio Falanga (ISSI-BJ Executive Director) and other members of ISSI Bern, I got the chance to learn about the establishment of a partner institute in Beijing as well as about the opportunity of applying for a joint International Team in Bern and in Beijing. As time went by, we thought of expanding our research team and look for new collaboration opportunities. Since many of my colleagues were Chinese, while Prof. Zhang's ones were mainly European, the ISSI/ISSI-BJ joint International Team program seemed the best solution for us. In fact, this would have allowed all our team members - both the European as well as our Chinese colleagues - to attend at least one meeting on either side of the world — Bern or Beijing.

Prof. Zhiyu Zhang: Apart from Prof. Chao [Prof. Chao Liu, National Astronomical Observatories, Beijing, China], who visited ISSI-BJ a couple of years ago, it is the first time here for most of us and I must admit we are gladly surprised by the organization and the facilities provided here at ISSI-BJ, similarly to ISSI Bern.

Can you briefly introduce your team, your research proposal and how you reached the conclusion that using ISSI-BJ tools would have helped you make progress in your work?



Our team members come from six different countries, including China, Italy, Greece, Czech Republic, Germany, and UK, and we are a colourful group not only in terms of nationalities but also in terms of study focus. As a matter of fact, we combine different expertise, ranging from stellar evolution to chemical evolution, molecular gas, and star formation. As interdisciplinarity is one of the key characteristics of ISSI-BJ International Teams and as a multidisciplinary approach is essential for the positive development of our research, we decided to include several fields of astronomy to better understand how our universe and our galaxy evolve. We use chemical abundances in molecular gas to discuss how stars are formed, how they are distributed and how they develop, the Stellar Initial Mass Function (IMF). Therefore, we need to join efforts from different areas to make significant improvements, and we must admit it is working guite well as we had a lot of inspiring ideas. Furthermore, thanks to ISSI-BJ facilities and support, we canconcentrate on our scientific agenda and this is invaluable.

# How is your research of considerable relevance for the scientific community?

We are achieving very important results as we are trying to find new tools to determine indirectly the Stellar Initial Mass Function (IMF). This is measured locally from star counts, it cannot be assessed directly in high red-shift galaxies though and therefore, we rely on some indicators, i.e. chemical abundances in galaxies. We need to combine different expertise because we need scientists able to observe all these elements. In fact, it is already not easy to derive the chemical abundances for the indicators from the observation we have of high red-shift galaxies, and then, we need to interpret what we yield from observations. Thus, we have experts in different fields, such as computing semianalytical models in full cosmological framework and detailed chemical evolution models, among others. We are trying to put together all pieces and we actually already have a good number of papers in favour of the variable IMF theory. We got some cool results.

# What are the main challenges you are currently facing in your research?

The main challenge we are currently facing is the proper understanding of some systematic effects that could affect our comparison of models and observations. This is something that makes us feel uncomfortable because it seems to us we still don't have a sound grasp of it. We are aware of the fact that the problem is complex and therefore, these interdisciplinary, face-toface brainstorming sessions are really helping us find some missing pieces in our research. Nonetheless, we still have to make a clearer outline of these "disturbances".

### Is there a specific highlight or some finding that stands out or a breakthrough of some kind which happened during your stay at ISSI-BJ?

Honestly, it is still hard to tell. Thanks to the fact that we have many different experts in our team, we have several creative ideas every day; nonetheless, it takes time to analyze and elaborate them thoroughly; we need time to determine if they are worth being developed further and how. There can be no 'sudden enlightenment' without a careful examination of each idea and its potential.

How would you describe the scientific landscape in China? And could you identify some major differences in the scientific approach among your multicultural team members?

Dr. Romano: It is actually not only my first time at ISSI-BJ, but overall my first time in China, and that makes it quite difficult for me to answer this question. I believe that in order to get familiar with the Chinese scientific community, I should spend more time here [in China]. Nonetheless, as our team somehow represents a multicultural "micro-cosmos", until now we have noticed no major difference in our scientific approach, there is a strong chemistry between our team members and this is of great importance.

### What advice would you give to early career

# scientists looking to pursue a career like yours?

Prof. Zhang: In my personal experience, my first advice is to publish more scientific articles since it is not very easy to find a job if you haven't released many studies. I am not a very active publisher myself; nonetheless, I think my relatively few contributions had a strong impact on the scientific community and this helped my career considerably. It is difficult for early career scientist though, and more attention should be paid to publishing. However, at the same time you should try to avoid low-quality, shallow articles.

Dr. Romano: I agree. I think nowadays, the pressure to publish scientific articles is pushing

down quality, and as a referee, I sometimes receive very disappointing papers. I think this publishing race is the cause of such poor submissions: Scientists feel an immense pressure to publish and that, of course, is affecting quality. So, my advice to early career scientists is to dedicate more time to each paper, be detailoriented - always double-check - and avoid short, shallow papers. Last but not least, another advice is to speak your mind, be open, do not be shy, and share your ideas. No idea is a stupid idea.

Prof. Zhang: Indeed. Very often, the most important scientific achievements derive from so-called "stupid ideas". Dare to ask and share your views.

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# Can you briefly introduce your experience at ISSI-BJ?

I am very proud and honored to be the founding Executive Director of ISSI-BJ. It was a great pleasure for me to work in Beijing and to implement my vision to promote the growth of the institute. Even more importantly, it was essential for me to be able to listen to the 'voice' of the

Prof. Maurizio Falanga took up duty as ISSI-BJ Executive Director in 2012, right after the establishment of the institute. Since then, he has served a four-year term from 2012 to 2016 and then from 2017 to 2019 (ad interim). Since he has left office at the end of 2019, we have seized the opportunity to ask him some questions about his experience working at ISSI-BJ.

> diverse international scientific communities. I think that neutrality represents an essential factor that helps us adapt to the heterogeneous scientific environment and efficiently carry out a broad variety of science activities. Another significant part of this job is the intercultural environment I was exposed to, as ISSI-BJ staff is very international. I spent around 30% of my yearly working time in Beijing and as the Executive director, I had to possess the ability to encourage and reward the staff when required. Furthermore, since ISSI-BJ is an international institute with a limited staff, I think that the distance between the personnel and the

# Interview with Maurizio Falanga



Director should be reduced. This implies that on one side, the Executive Director should have the authority to make decisions, on the other side, she/he should be capable to humbly listen to her/ his hard-working staff.

# How has ISSI-BJ changed since its inauguration until now?

Since the inauguration ceremony of ISSI-BJ back in 2012 rapid progress has been made. Until now, we have hosted five workshops leading to the publications of the corresponding books, 20 forums whose summary is released in the forumrelated magazine called TAIKONG ('Outer space' in Chinese), a total of 38 international teams have been approved, and two very successful Space Science Schools have taken place. Furthermore, in the context of our outreach program, we have hosted 13 Understanding Science seminars for the general public. The quality of ISSI-BJ's activities and outputs is competitive, and that is reflected in our events' popularity in Asia, but not only. At ISSI-BJ we are oriented towards an international audience - more than 50% of our visitors are coming from Western countries and therefore, we focus on arranging our events accordingly. Hitherto the relatively young age of our institute paired with its success did not prompt us to implement major changes in the way ISSI-BJ operates; nonetheless, we keep striving towards its continuous improvement, which is also increasing the visibility of our institute.

# How does ISSI-BJ differentiate itself in the international scientific landscape?

ISSI-BJ is an institute of excellence aiming to serve the different space science communities as an international and multi-disciplinary platform. One of its strengths is we try not merely to make decisions but rather to give recommendations. This helps us maintain ISSI-BJ's neutrality as well as our ability to bring together prominent scientists coming from various institutions, like NASA, ESA, JAXA, and different countries, for example, Russia, China, India to talk about science and future missions concepts. ISSI-BJ is open to all space science disciplines as well as nationalities as long as it is 'science first' and it maintains 'excellent quality.'

# What is ISSI-BJ's achievement you are most proud of?

ISSI-BJ is successfully employing the same tools as ISSI in Bern; however, I've introduced the forum-related output — TAIKONG magazine as well as the Space Science School in Beijing. Our outreach program — Understanding Science and scientific seminars — is also well established. In addition, I am honored to say that ISSI-BJ is currently able to connect with high-level agencies and scientists to promote innovative scientific activities in Beijing. Therefore, I am very proud of the numerous goals achieved since 2012 and that stand out when visiting our webpage at www. issibj.ac.cn or consulting our ISSI-BJ Annual Reports.

# What is/are the greatest challenge ISSI-BJ will have to face in the future?

With no doubt, we are positively carrying out our mandate at ISSI-BJ. The institute fulfills a unique and critical role as an inclusive neutral hub bringing together various agencies and individuals involved in space science studies. We do put special emphasis on the Asia-Pacific region but we are also well-connected with the global network of science experts. Regrettably, ISSI-BJ is severely under-resourced though, especially in view of the enormous potential of the Chinese space science research projects and the growing importance of international cooperation in space science. I think that this is a compelling case of an ambitious strategic plan that could help ISSI-BJ expand on a large scale over the next few years.

### If you had to describe the activities held at ISSI-BJ in just one or two sentences, how would you summarize them?

Just excellent. Some key words to describe ISSI-BJ would be: young, modern, dynamic,

future-oriented, innovative, and of great interest to the international space communities.

# How have international scientific cooperation models changed throughout these years, especially in regard to Chinese international scientific relations?

The Chinese Academy of Sciences (CAS) is following an 'open door policy' in regard to international scientific collaboration and following this principle, ISSI-BJ is an open door to reveal to the world what China is accomplishing in the space science field. In my view, a big country has to contribute to a sounder understanding of outer space to bequeath a legacy for later generations. Asia is investing a significant amount of money in space science; however, cost-sharing as well as the exchange of scientific knowledge and technological expertise represent some fundamental elements to advance rapidly in space science studies without repeating past mistakes. As a result, China is more and more open to international collaboration and similarly. ISSI-BJ is equally willing to support projects from any Chinese or international scientists or institutes. This is the reason why we are seeking researchers coming from all over the world to work together in Beijing.

### Would you describe your position as the one of a 'stateless ambassador for international scientific relations'?

No, I do not see myself as an ambassador but a humble supporter of space science communities. As I have an extensive network of scientific personalities that help me better promote scientific activities to serve the needs of many space science disciplines, I am entrusted with the responsibility and authority to invite them to ISSI-BJ. It comes without saying that such a mission takes a lot of my time which I thus cannot dedicate to my own research. In fact, I am a scientist too.

### How do you envision the future of ISSI-BJ?

In order to answer this question, I would like to use the statement issued by the Visiting Committee which reviews ISSI-BJ work every three years:

"In conclusion, we feel that there is a strong case for an ambitious strategic plan. This plan must however jealously defend the neutrality and independence of ISSI-BJ, which is a core value as well as the international standing and coherence of the ISSI 'brand.'"

# **ORGANIZATIONAL STRUCTURE**



# **Board of Trustees**

The Board of Trustees supervises the work accomplished at the Institute, exerts financial control and appoints the Directors. It consists of representatives of the Founder and of the funding agencies. The Board of Trustees is presided over by Ji Wu.

### 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.

The Directorate consists of Executive Director (Maurizio Falanga) and Administrative Director (Xiaolong Dong).

## 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 Mioara Mandea, 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 three year term with a possible extension of one year.

# **BOARD OF TRUSTEES & STAFF**

# **Board of Trustees**

**Chair**: WU Ji, Director-General, NSSC, CAS, China **Secretary**: Xiaoyu Li, NSSC, CAS, China

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# Staff



Maurizio Falanga,

Executive Director



Xiaolong Dong,

Administrative Director



Lijuan En,

Assistant to ED



Laura Baldis,

PR &

Editorial Manager



Richard de Grijs, Discipline Scientist

# SCIENCE COMMITTEE



# Members of the Science Committee:

**Chair:** Louise Harra, PMOD WRC, Davos, Switzerland **Secretary:** Maurizio Falanga, ISSI, Bern, Switzerland; ISSI-BJ, China

- Roberto Bruno, IAPS, INAF, Rome, Italy
- Corinne Charbonnel, Department of Astronomy, University of Geneva, Switzerland
- Pen-Fei Chen, Nanjing University, China
- Xiaolong Dong, International Space Science Institute Beijing, China (ex officio)
- Lyndsay Fletcher, University of Glasgow, Scotland
- Stein Haaland, University of Bergen, Norway
- Kevin Heng, Center for Space and Habitability, University of Bern, Switzerland
- Timothy Horbury, Imperial College, London, UK
- Vladislav Izmodenov, IKI, Russian Academy of Sciences, Moscow, Russia (ex officio RAS)
- Arvind Parmar, ESTEC ESA, Noordwijk, The Netherlands (ex officio ESA)

- Francesca Primas, ESO, Munich, Germany
- Michael Rast, ESA ESRIN, Frascati, Italy (ex officio ESA)
- Heike Rauer, DLR Institute of Planetary Research, Berlin, Germany
- Nathan Schwadron, University of New Hampshire, Durham, USA
- Kanako Seki, University of Tokyo, Japan
- Sami Solanki, MPI for Solar System Research, Göttingen, Germany
- Christophe Sotin, NASA Jet Propulsion Laboratory (JPL/Caltech), Pasadena, USA
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Asia-Pacific Space Cooperation Association



Tohoku Forum for Creativity, Tohoky University

# FINANCIAL OVERVIEW

In the 2019 fiscal year, from 1 January, 2019 to 31 December of 2019, ISSI-BJ was operated with the total revenue of 2,441.622.42 RMB and the total expenses were 2,437,963.20 RMB. The surplus is 3,659.22 RMB, which is used to patch up the overspend of previous year.

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 1,800,000.00 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 291,622.42 RMB from the National Space Science Center (NSSC) for expenses on premises, facilities, half salary of one staff member and the international traveling of the administrative director for ISSI/ISSI- BJ activities. 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 scientific activities (including seven forums, seven international teams meetings, one workshop), the salary of executive director and two staff members; travelling expenses of executive director and staff members; other daily operating and maintaining expenses. The expenses of premises use, administrative expenses, salary of administrative director and support of student assistant for ISSI-BJ activities, which are in-kind support from NSSC, are not included.

### Total Revenues in RMB for 2019 Fiscal Year (1 January, 2019 – 31 December, 2019)

Funding Sources	Amount
Bureau of International Cooperation,	350,000.00
CAS	
Bureau of Major R & D Projects, CAS	1,800,000.00
NSSC Direct Support	291,622.42
Total	2,441,622.42

Expenses	Amount
Scientific Activities	742,637.27
Local Transportation	19,903.00
Design, Publications, Printing, Post,	196,918.64
Telecommunication	
Salary	907,158.11
Traveling	155,203.42
Premises	191,531.95
Other Reception Expenses	224,610.81
Total	2,437,963.2





<sup>&</sup>lt;sup>1</sup> Scientific activities expenses include one workshop, seven international team meetings, and seven forums;

<sup>&</sup>lt;sup>2</sup> Salary includes the salaries for the executive director and the staff members (salary for administrative director is not included);

<sup>&</sup>lt;sup>3</sup> Traveling expenses include international and domestic traveling of the executive director and staff members.

# 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 m<sup>2</sup> 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



Saturn Hall meeting room



Coffee break area



Small library

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.

# INTERNATIONAL SPACE SCIENCE INSTITUTE IN BERN



# About ISSI

The International Space Science Institute (ISSI) was created by Space Pioneer Professor Johannes Geiss in 1995. Since then, the institute offers scientists from all around the world a forum 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.

### International Teams

In total, 67 Team meetings took place in 2019. On average, the teams publish over 200 peer-reviewed papers per year.

Thirty-two new International Teams, four of which are organized jointly with ISSI-Beijing, started their projects in the twenty-fifth ISSI business year (July 2019 to June 2020).

# Workshops

In the reported period ISSI organized two Workshops with the following topics:

- Star Formation (May 20-24, 2019)
- Natural and Man-Made Hazards Monitoring

by the Sentinel and Other Earth Observation Missions (April 15-18, 2019).

Workshops activities lead to a topical collection in Spaces Science Reviews or an issue in Surveys in Geophysics and are reprinted as a volume in the Space Science Series of ISSI (SSSI) published by Springer.

### Forums

Three Forums took place at ISSI in 2019.

- ISSI-Europlanet FORUM #2: "Solar System/ Exoplanet Science Synergies" (February 19-20, 2019)
- Next scientific Solar-Terrestrial Program (SCOSTEP) (February 25-27, 2019)
- The Impact of Big Data in Astronomy (July

4-5, 2019)

# **Publications**

Six volumes of the Space Sciences Series of ISSI, that resulted from the correspondent ISSI Workshops, were published in the course of 2019:

Volume 64: "The Delivery of Water to Protoplanets, Planets and Satellites" edited by A. Morbidelli, M. Blanc, Y. Alibert, L. Elkins-Tanton, P. Estrada, K. Hamano, H. Lammer, S. Raymond, M. Schönbächler, ISBN 978-94-024-1627-5, previously published online as a Topical Collection in the Space Science Reviews.

Volume 67: "The Scientific Foundation of Space Weather", edited by D. Baker, A. Balogh, T. Gom-



bosi, H.E.J. Koskinen, A. Veronig, R. von Steiger, ISBN 978-94-024-1587-2, previously published online as a Topical Collection in the Space Science Reviews.

Volume 68: "Supernovae" edited by A. Bykov, R. Chevalier, J. Raymond, F. Thielemann, M. Falanga, R. von Steiger, ISBN 978-94-024-1580-3, previously published online as a Topical Collection in the Space Science Reviews.

Volume 70: "Exploring the Earth System with Imaging Spectroscopy" edited by S. Förster, L. Guanter, T. Lopez, J. Moreno, M. Rast, M. Schaepman, ISBN 978-3-030-24909-0, published online in Surveys in Geophysics, Volume 40, Issue 3, May 2019.

Volume 71: "Forest Properties and Carbon Cycle Studies from Earth Observations" edited by K. Scipal, A. Cazenave, T. Lopez, ISBN 978-3-030-32838-2, published online in Surveys of Geophysics, Volume 40, Issue 4, July 2019.

Volume 72: "Clusters of Galaxies: Physics and Cosmology" edited by A. Bykov, J. Kaastra, M. Brüggen, M. Markevitch, M. Falanga, F.B.S. Paerels, ISBN 978-94-024-1733-3, previously published online as a Topical Collection in the Space Science Reviews.

Furthermore, one Scientific Report appeared in November 2019:

Volume 17: "Ionospheric Multi-Spacecraft Analysis Tools" edited by M.W. Dunlop, H. Lühr, ISBN 978-3-030-26731-5, Results of an ISSI Working Group, this book is published open access under a CC BY 4.0 license.

### 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. Since June 2019, Louise Harra is the new chair of the Science Committee. The ISSI Directorate consists of Tilman Spohn (Executive Director), Rudolf von Steiger (University of Bern, Switzerland), Anny Cazenave (CNES, Toulouse, France) and Joachim Wambsganss (Heidelberg University, Germany) and is in charge of the scientific, operational and administrative management of the institute. The complete ISSI staff (scientists and administration) counts 16 members.

The European Space Agency (ESA), the Swiss Confederation, the Swiss Academy of Sciences (SCNAT) provide the financial resources for IS-SI's operation. The University of Bern contributes through a grant to a Director and in-kind facilities. The Institute of Space and Astronautical Science (Japan Aerospace Exploration Agency, JAXA, Japan) is supporting ISSI with an annual financial contribution.

More detailed information about the Institute, its present and near term program, as well as its publications can be found on the web page www.issibern.ch.



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# **ISSI-BJ TOOLS**

January Annual Call

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