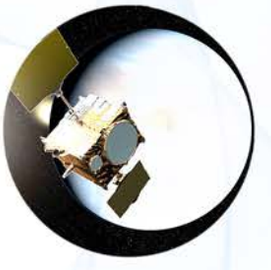
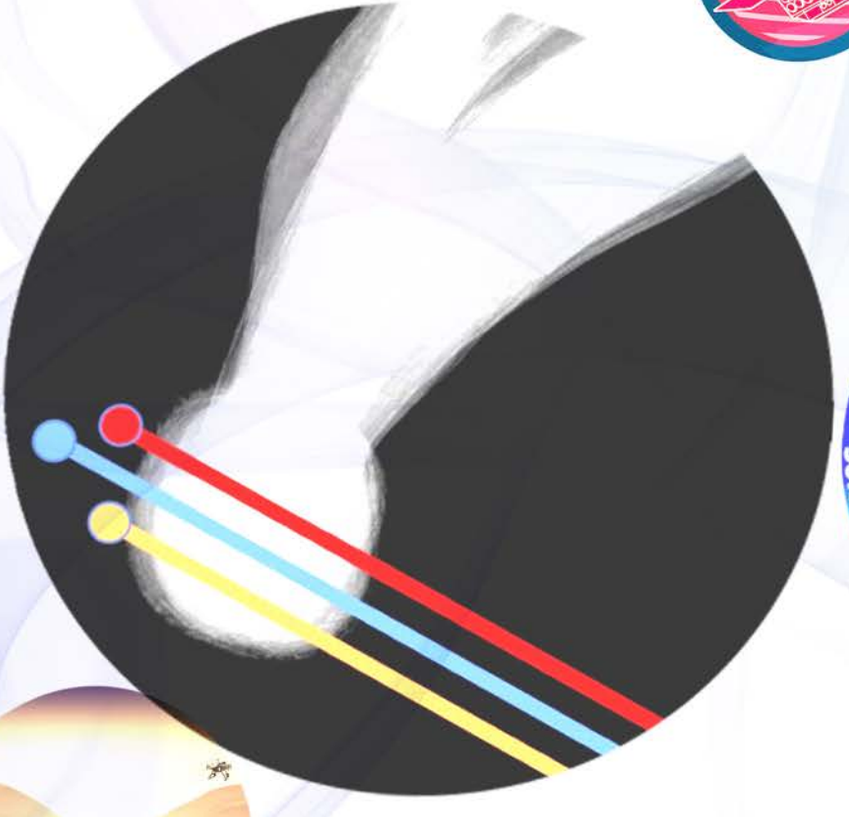
INTERNATIONAL SPACE SCIENCE INSTITUTE - BEIJING

国际空间科学研究所—北京





ANNUAL REPORT 2020

IMPRINT

ISSI-BJ Annual Report

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COVER PAGE

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

1. The Solar Orbiter Mission of the European Space Agency (ESA). Credit: ESA
2. The JUICE Mission of the European Space Agency (ESA). Credit: ESA
3. The MMX Mission of the Japan Aerospace Exploration Agency (JAXA). Credit: JAXA.
4. The Akatsuki Mission (Venus Climate Orbiter) of the Japan Aerospace Exploration Agency (JAXA). Credit: JAXA.
5. The PLATO Mission of the European Space Agency (ESA). Credit: ESA
6. The SMILE Mission of the Chinese Academy of Sciences (CAS) and the European Space Agency (ESA). Credit: CAS/ESA
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MESSAGE FROM THE CHAIRMAN OF THE BOARD OF TRUSTEES

The past year posed great challenges to all of us, not just to ISSI-BJ but the whole scientific community and our societies due to the unpredictable outbreak of the COVID-19 pandemic. As it was announced in mid-January 2020, the activities and events of ISSI-BJ, which usually start after the Chinese New Year holidays, had to be temporarily postponed or suspended until further notice.

2020 was also an important turning point for ISSI-BJ. Under the leadership of Professor Maurizio Falanga, ISSI-BJ was established and started operating in 2013, and in June 2020 he handed over the leadership reins to the current Executive Director Prof. Wing-Huen Up, who is bringing ISSI-BJ to a new stage. As an internationally renowned scientist, Professor Ip put great energy into thinking about the future of ISSI-BJ's development and success. Great efforts were made to keep ISSI-BJ moving forward during these difficult times. As a result, the "On Things to Come" series of online seminars on space missions and the "1001 Space Nights" outreach seminars given by women scientists were initiated, which increased the visibility of ISSI-BJ in the space community, especially at the local level. More importantly, Professor Ip started reshaping ISSI-BJ from the strategic view: new Discipline Scientists joined ISSI-BJ and started planning future activities, and new cooperation opportunities between ISSI-BJ and international and local organizations were explored. Even more fruitful outcomes can be anticipated.

Under the ban on international travel, we started to turn our activities into virtual meetings; thus, several team meetings were organized online, which provided us an alternative solution to keep the ball rolling and get ready for the post-pandemic era.

Furthermore, in 2020, several groundbreaking milestones were set for the Chinese space program. CE-5 completed the sample-return mission; Tianwen-1 started its journey to Mars for orbiting and surface exploration; GECAM was successfully launched to start the detection of the electromagnetic counterpart of gravitational waves from space. All these missions will turn into valuable opportunities for ISSI-BJ.

I would like to express my appreciation for Prof. Ip's work, for his generous enthusiasm and dedication to ISSI-BJ. I believe that our institute is entering a new era of development and make significant progress and achievements under his leadership.

Finally, I would like to thank our staff, EN Lijuan and Laura Baldis as well as also LI Xiaoyu and DONG Xiaolong, whose efficient work contributes to making ISSI-BJ successful.

Wu Ji

Beijing, June 2021

MESSAGE FROM THE EXECUTIVE DIRECTOR

2020 has been a year of dangerous living. Looking back, we see terrible sufferings but also many heroic efforts by common people and leaders alike. The actions and inactions of different groups and nations will be a measure of their societal values in the years to come. And the same applies to scientific institutions.

The year 2020 has been particularly challenging for ISSI-BJ too, as its main task is to organize offline scientific meetings and invite international experts from all over the world to its premises. This challenge prompted us to reflect on the purpose and function of this international institute, which is to promote unselfish cooperation across national borders, cultures, and genders with a solid look to the future. It is for this reason that two new projects—taking advantage of the Internet technology—have been initiated, i.e. the "On Things to Come" and the "1001 Space Nights" online seminar series.

Our "On Things to Come" series aims to create a platform dedicated to the worldwide scientific community to exchange information on ongoing and new space missions in the exploration of the solar system and the universe. We believe that this kind of open communication and science-sharing will reinforce the spirit of international cooperation. The "1001 Space Nights" evening lectures, which take place on the first Monday of every month—with outstanding women scientists as invited speakers—aim to raise the curiosity and interest of young people in space science and narrow the gender gap in STEM in China. We believe that these two new projects will complement the existing scientific program and enhance the visibility of ISSI-BJ.

I would like to seize this opportunity to welcome the ISSI-BJ five new Discipline Scientists, Prof. Maurizio Falanga (ISSI/University of Bern, Switzerland), Prof. Jie Jiang (Beihang University, China), Prof. Ekkehard Kuerht (DLR, Germany), Prof. Jiancheng Shi (NSSC, China), and Prof. Takehiko Satoh (JAXA, Japan). Their contribution will surely push the scientific activities of ISSI-BJ to new heights.

With the enthusiastic and generous support of the international community, my colleagues at ISSI-BJ and I will do our best to catch up on lost time and more. Indeed, in this annual report, we want to show everybody that ISSI-BJ is thriving despite the COVID-19 pandemic and that there are many splendid things to come.

Wing-Huen Ip

Beijing, June 2021

ABOUT ISSI-BJ

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

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

History

In October 2011, Professor Ji Wu, the former 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 planned the proposal to establish an International Space Science Institute in Beijing (ISSI-BJ).

In February 2012, Simon Aegeter, Chair 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 belief that NSSC is a very 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 NSSC in Beijing on July 16, 2013. Professor Rafael Rodrigo, Executive Director of ISSI, and Professor Ji Wu, Chairman of the BoT of ISSI-BJ and former Director-General of NSSC, jointly inaugurated the new institute located on the 3rd 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 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 Chair 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 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.

WORKSHOPS

Workshops are study projects on specific scientific themes, selected in consultation with the Science Committee. The duration of a Workshop is typically one week. Workshops are organized by a group of conveners who define the theme, set up the program, and list the group of participants. Participation is by invitation only. The size of any Workshop is usually limited to a maximum of 45 participants, including some young scientists.

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

FORUMS

Forums are informal and free debates among 20-25 high-level participants on open questions of scientific or science policy nature. A Forum may lead to formal recommendations or decisions depending upon the topic or issues addressed in the Forum.

The TAIKONG magazine series makes up 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 advice gathered by the participants.

WORKING GROUPS

Working Groups are set up by the Directorate for specific tasks, often of technical nature. Their lifetime 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 bottom-up 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.

Research Tools

SPACE SCIENCE SCHOOL

The Space Science School is a biennial school on space science and space science missions for international students. It provides the students with the required scientific background relevant to producing a report. It is organized in collaboration with APSCO.

ON THINGS TO COME

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

UNDERSTANDING SCIENCE

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 and allow talking with either international or Chinese scientists in a relaxed atmosphere.

VISITING SCIENTISTS

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

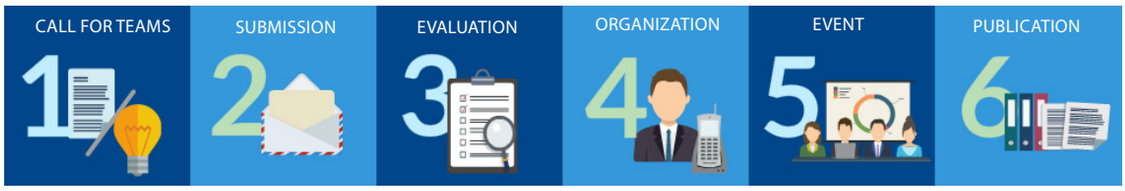
1001 SPACE NIGHTS

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

Statistics

In 2020, ISSI-BJ organized seven On Things to Come online seminars and one Understanding Science Seminar. Furthermore, seven new International Teams were selected.

How to use the ISSI-BJ Tools



International Teams (IT)

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

Workshops, Working Groups, and Forums

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

SCIENTIFIC ACTIVITIES 2020

ON THINGS TO COME ONLINE SEMINARS

The Comet Interceptor Mission - An ESA Mission to an Ancient World

September 23, 2020

Speaker: Geraint Jones (UCL Mullard Space Science Laboratory/Centre for Planetary Science at UCL/Birbeck, UK)

On September 23, 2020, Prof. Geraint Jones (UCL Mullard Space Science Laboratory/Centre for Planetary Science at UCL/Birbeck) gave an online seminar on the Comet Interceptor Mission.

"In Summer 2019, a multi-spacecraft project—Comet Interceptor—was selected by the European Space Agency as its next planetary mission and the first in its new class of Fast (F) projects. The mission's primary science goal is to characterize, for the first time, a long-period comet, preferably dynamically new, or an interstellar object. An encounter with a comet approaching the Sun for the first time will provide valuable data to complement that from all previous comet missions, which have by necessity studied short-period comets that have evolved during their time orbiting near the Sun from their original condition. Planned measurements of the target include its surface composition, shape, and structure, dust environment, and the composition of the gas coma. A unique, multi-point 'snapshot' measurement of the comet- solar wind interaction region is to be obtained, complementing single spacecraft observations made at other comets."

The full recording is available at:

https://youtu.be/jwfufMP8UsQ

NASA Dragonfly Mission

October 21, 2020

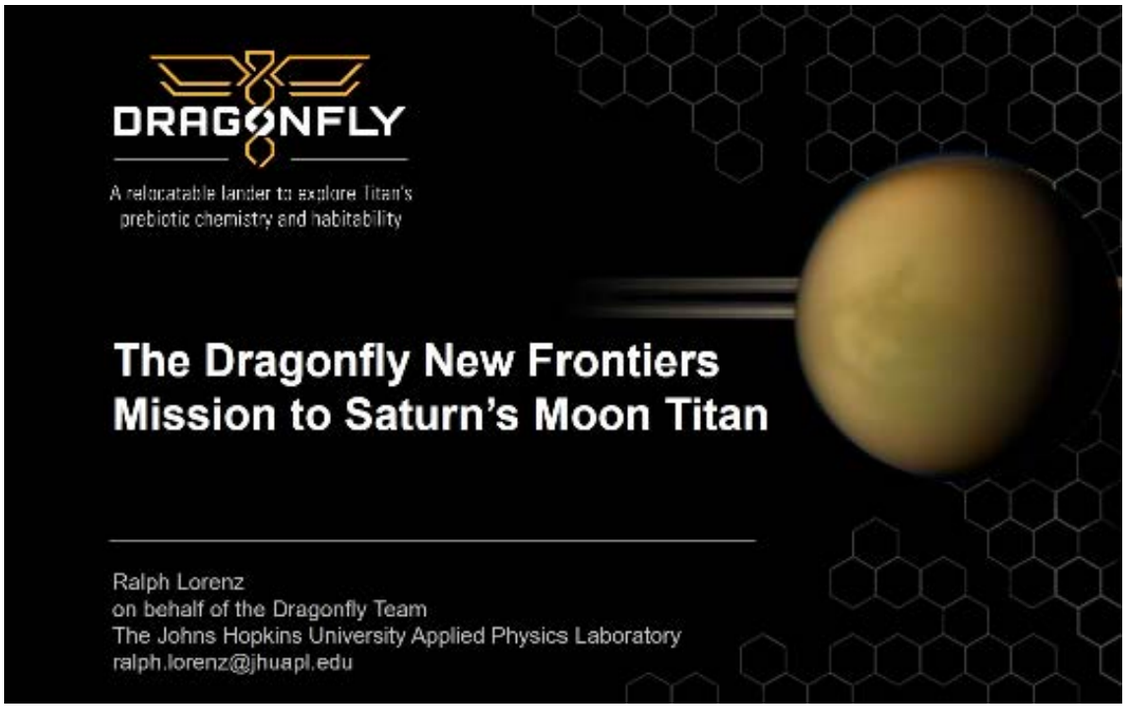
Speaker: Ralph Lorenz (John Hopkins University Applied Physics Lab, USA)

On October 21, 2020, Prof. Ralph Lorenz (Johns Hopkins University Applied Physics Lab) gave an online seminar on NASA's Dragonfly Mission.

"Saturn's giant moon Titan has been revealed to be remarkably Earth like, with a landscape of vast dune fields, river channels, and lakes under a smoggy sky punctuated by methane downpours. Titan serves as a frigid laboratory in which the same processes that shape our own planet can be seen in action under exotic conditions. Titan has a rich inventory of complex organic molecules that may provide clues to how the building blocks of life are assembled. NASA recently selected APL's Dragonfly mission concept as the next $1B-class New Frontiers mission to launch in 2026, to arrive in 2034. Dragonfly is an octocopter lander, able to repeatedly take off and fly tens of kilometers in Titan's dense atmosphere and low gravity to sample the surface in a wide range of geological settings. This presentation will describe the mission and how the concept was developed."

The full recording is available at:

https://youtu.be/72_wo8wQ_O8



CAS/ESA SMILE Mission

November 4, 2020

Speaker: Wang Chi (NSSC, CAS, China)

On November 4, 2020, Prof. Wang Chi (Director General of the National Space Science Center, Chinese Academy of Sciences) gave an online seminar on the "Solar wind Magnetosphere Ionosphere Link Explorer" SMILE mission, a joint project between the European Space Agency and the Chinese Academy of Sciences.

"The interaction between the solar wind and the Earth's magnetosphere and the resulting geospace dynamics is one of the key questions in plasma physics. In situ instruments on a fleet of solar wind and magnetospheric constellation missions now provide the most detailed observations of the Sun-Earth connection. However, we are still unable to quantify the global effects of those drivers, including the conditions that prevail throughout the geospace. This information is the key missing link for developing a complete understanding of how the Sun gives rise to and controls Earth's plasma environment and space weather.

Solar wind Magnetosphere Ionosphere Link Explorer (SMILE) is a novel self-standing mission dedicated to observing the solar wind-magnetosphere coupling via simultaneous in situ solar wind/magnetosheath plasma and magnetic field measurements, Soft X-ray images of the magnetosheath and polar cusps, and UV images of global auroral distributions. Remote sensing of the magnetosheath and cusps with X-ray imaging is now possible thanks to the relative discovery of solar wind charge exchange (SWCX) X-ray emission, first observed at comets, and subsequently found to occur in the vicinity of the Earth's magnetosphere. SMILE is a collaborative mission between ESA and the Chinese Academy of Sciences (CAS) that was selected in November 2015 and is due for launch at the end of 2024. The SMILE science, as well as the technical developments jointly undertaken by ESA and CAS, will be presented."

The full recording is available at:

https://youtu.be/8MK2_ibGYy0

ESA PLATO Mission

November 23, 2020

Speaker: Heike Rauer (DLR Institute of Planetary Research/Free University of Berlin, Germany)

On November 25, 2020, Prof. Dr. Heike Rauer (Institute of Planetary Research, German Aerospace Center, DLR) gave an online seminar on the PLATO mission of the European Space Agency.

"PLATO (PLAnetary Transits and Oscillations of stars) is ESA's M3 mission and designed to detect and characterize extrasolar planets. PLATO will provide small planets around bright stars, including terrestrial planets in the habitable zone of solar-like stars. PLATO will characterize these planets for their radius, mass, and age with high accuracy. PLATO is currently scheduled for a launch date end of 2026. Its payload consists of 26 cameras with a 12cm aperture each. For at least four years, the mission will perform high-precision, long-term photometric, and asteroseismic monitoring of a large number of stars to detect extrasolar planets and derive their radii and ages. The satellite data are complemented by a ground-based observing program to derive the planetary masses. The mission's catalog of well-characterized small planets at intermediate orbital periods will be an important constraint to planet formation theories and will provide targets for future spectroscopy follow-up observations to characterize planetary atmospheres. These data will be a significant step forward to address the key questions on how planets form and evolve and how frequent rocky planets suitable for the development of life have formed in our milky way."

The full recording is available at:

https://youtu.be/vRMbpXm5Vr4

JAXA Akatsuki Mission (Venus Climate Orbiter)

December 9, 2020

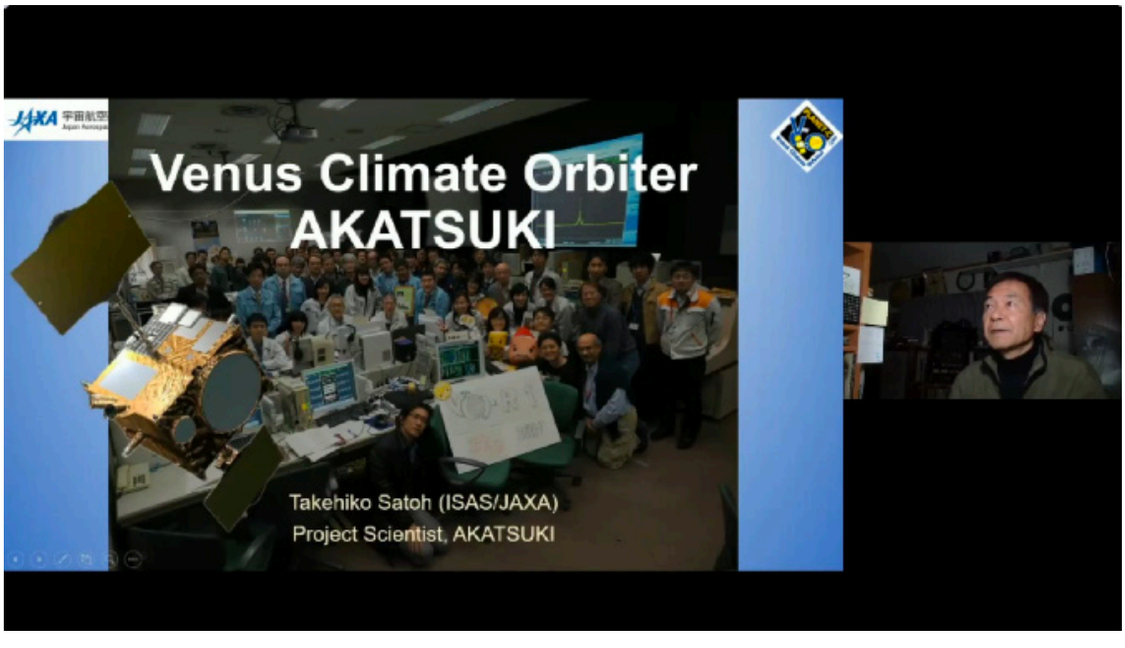
Speaker: Takehiko Satoh (ISAS/JAXA, Japan)

On December 9, 2020, Prof. Takehiko Satoh (Department of Solar System Sciences, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency) gave an online seminar on the Akatsuki mission to Venus of the Japan Aerospace Exploration Agency.

"The Venus Climate Orbiter mission was approved in the spring of 2001, was later given the Japanese name 'Akatsuki', meaning the dawn. Akatsuki is the first "planetary meteorology" mission of which primary target is Venus' super-rotating atmosphere. To obtain the 3-dimensional views of the atmosphere of Venus, Akatsuki is equipped with 5 cameras, from the ultraviolet (UVI) to the thermal infrared (LIR), plus the ultra-stable oscillator for radio science (RS). Two near-infrared cameras, IR1 and IR2, as well as the lightning/airglow camera (LAC), complete the instrument set. Akatsuki, launched on May 21, 2010, attempted the Venus orbit insertion (VOI-1) on December 7, 2010 but failed. After orbiting around the sun for 5 years, it finally became an orbiter around Venus at the second attempt (VOI-R1) on December 7, 2015. Akatsuki's unique orbit, near the equatorial plane and the same direction of motion as the Venus' super-rotation, is best suited to study the atmospheric dynamics. The major findings of Akatsuki include "stationary gravity wave features", "equatorial jets in the middle to lower clouds", "sharp and long-lived cloud discontinuity", "global structure of thermal tides", and "the importance of thermal tides to the super-rotation". The mission overview and some representative findings by the mission will be presented."

The full recording is available at:

https://youtu.be/f070KbaPBO8



ESA JUICE Mission

December 18, 2020

Speaker: Olivier Witasse (ESA)

On December 18, 2020, Olivier Witasse (European Space Agency) gave an online seminar on the JUpiter ICy Moons Explorer (JUICE) mission of the European Space Agency.

"JUpiter ICy moons Explorer (JUICE) is the first large mission in the ESA Cosmic Vision 2015-2025 program, and it was selected in May 2012. Due to the launch in June 2022 to reach Jupiter in October 2029, it will spend at least 3 years making detailed observations of Jupiter and three of its largest moons, Ganymede, Callisto, and Europa. The focus of the mission is to characterize the conditions that might have led to the emergence of habitable environments among the Jovian icy satellites. Studies of Jupiter's atmosphere and magnetosphere, their interaction with the Galilean satellites, minor moons, and rings will further improve our understanding of the evolution and dynamics of the Jovian system. The payload consists of 10 state-of-the-art instruments plus one experiment that uses the spacecraft telecommunication system with ground-based instruments. The presentation will address the science objectives, mission design, spacecraft, payload, challenges, and the trajectory of the JUICE mission."

The full recording is available at:

https://youtu.be/FWJ61D25904

JAXA Martian Moons Exploration Mission (MMX)

December 21, 2020

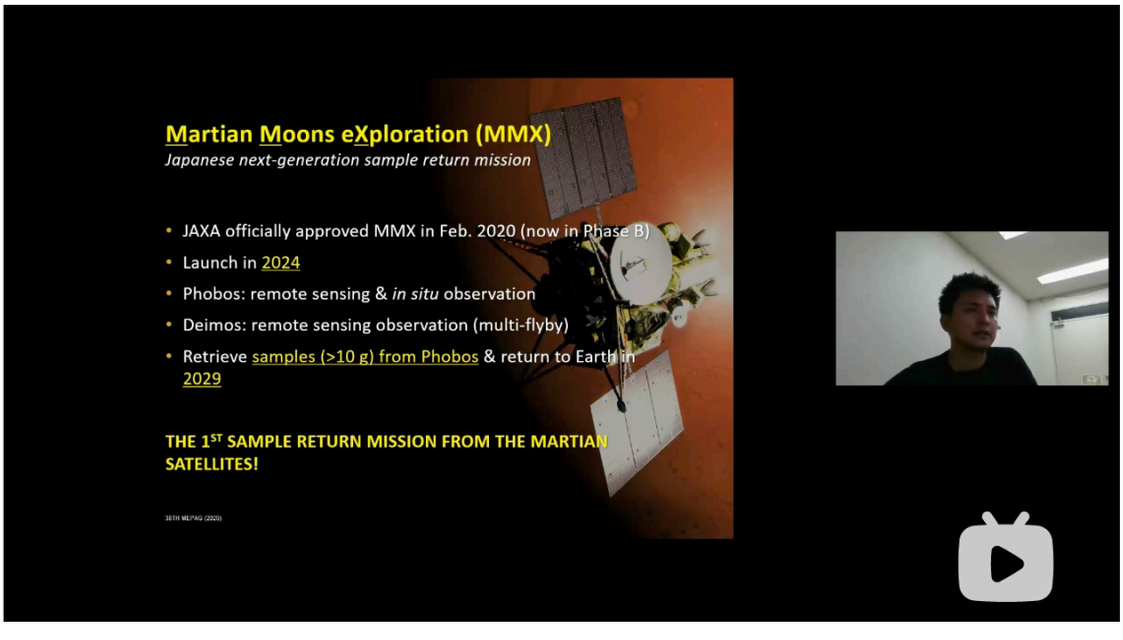
Speaker: Tomohiro Usui (JAXA, Japan)

On December 21, 2020, Tomohiro Usui (Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency) gave an online seminar on the Martian Moons eXploration (MMX) mission of the Japan Aerospace Exploration Agency (JAXA).

"Martian Moon eXploration (MMX) is the 3rd Japanese sample return mission following Hayabusa and Hayabusa-2. The MMX mission transitioned to become a JAXA Project: an official step in mission development (Phase B) in February 2020. The MMX spacecraft is scheduled to be launched in 2024, orbit both Phobos and Deimos (multi-flyby), and retrieve and return >10 g of Phobos regolith to Earth in 2029. The origins of Phobos and Deimos are still a matter of significant debate: the capture of asteroids or in-situ formation by a giant impact on Mars. In either case, MMX will provide clues about their origins and offer an opportunity to directly explore the satellite building blocks or juvenile crust/mantle components of Mars. MMX will also aim to understand physical processes in the circumplanetary environment of Mars. The new knowledge of Phobos/Deimos and Mars will be further leveraged to constrain the initial condition of the Mars-moon system and to gain vital insights regarding the sources and delivery process of water (and organics) into the inner rocky planets."

The full recording is available here:

https://youtu.be/Yw0DwLIbOhY



COSPAR SmallSat Town Hall -- Asia Pacific Sector

September 29, 2020

Speakers: Wu Ji (NSSC, CAS, China); Lennard A. Fisk (COSPAR); Jean-Claude Worms (COSPAR); Daniel Baker (COSPAR); Rudolf von Steiger (ISSI, Bern, Switzerland); Wang Jindong (NSSC, CAS, China); Jong Uk Park (KASI, South Korea); Praveen K. Kumar (ISRO, India)

COSPAR Smallsat Town Hall Webinar

Asia Pacific Region

BEIJING – In the context of the Task Group on establishing a Constellation of Small Satellites (TGCSS) proposed by the Committee on Space Research (COSPAR) in 2019 to develop an "actionable" plan for an international constellation of small satellites, the COSPAR SmallSat Town Hall Webinar for the Asia Pacific sector was held on September 29, 2020, at 3:30 pm (GMT+8). The webinar was co-organized by ISSI-BJ.

Joined by six panelists and about 70 participants, the Asia Pacific webinar followed the meeting for the American sector, that took place on September 2, 2020, to introduce the audience to the plan and the regional activities on SmallSats, encourage the participation of the scientific communities from different countries, collect feedback for the advancement of the project, and address several key issues and concerns, such as the SmallSat design/system engineering; Spacecraft bus standards; Access to space; Ground systems/communications; Data archiving/sharing/standards.

Chaired by Prof. Ji Wu (NSSC, CAS, China), and Dr. Jean-Claude Worms (COSPAR) and opened by the welcome videos of the President of COSPAR Prof. Lennard A. Fisk as well as the Chair of the TGCSS Prof. Daniel Baker, the webinar featured the presentations of Dr. Rudolf von Steiger (ISSI, Bern, Switzerland) on the COSPAR 4S Roadmap, Dr. Wang Jindong (NSSC, CAS, China) on the MUSE mission and Prof. Jong Uk Park (KASI, South Korea) as well as Dr. Praveen K. Kumar (ISRO, India) on the South Korean and Indian regional activities respectively.

The reports generated interest and raised numerous questions, which were partially answered during the webinar and will lead to a deeper follow-up session.

The full transcript of the webinar is available here: https://www.youtube.com/watch?v=AMEV25pxD7U

Read more about the TGCSS Asia Pacific Webinar here: http://www.issibj.ac.cn/News/202010/W020201002500305991732.pdf

Listening to the Universe

May 14, 2020

Richard de Grijs

In the context of the Understanding Science Seminars (US seminars), jointly organized by the UK Royal Society of Chemistry, Beijing University of Chemical Technology, the International Space Science Institute-Beijing (ISSI-BJ), as well as SELF (格致论道), this lecture represented the concerted effort to shorten the gap between science and the general public, i.e. science for the laymen, as well as to guarantee continuity to the US scientific talks despite the current unfortunate circumstances. The lecture was moderated by ISSI-BJ former Executive Director, Prof. Maurizio Falanga.

Thanks to Prof. de Grijs' extensive experience and vast knowledge in the field of astrophysics and asteroseismology (or astroseismology), the audience was given the opportunity to explore and understand the Universe from an unusual point of view, i.e. its vibrations, its sounds, its music. Despite it having large empty swathes and being usually considered an empty vacuum that does not allow matter propagation — in other words, sounds cannot be carried in space since sound waves need a medium to vibrate through — it is not empty, as it contains dust and gas left behind by old star and sometimes used to create new stars. Thus, this material represents the medium that makes it possible for sound waves to propagate in the Universe, even though at such a low frequency that they are beyond the capabilities of human hearing. However, with the right instruments, scientists are now able to detect the vibrations and signals in the Universe and convert them into sounds.

After a brief depiction of how hearing works and what sound waves are (see Figure 1), a short introduction to the sounds of the Earth was given. As earthquakes probably constitute the most representative sound emitted by our planet, the 'noise' produced by the massive Tohoku earthquake (Japan) in 2011 was played for the audience to get familiar with the sounds of the Earth. Following the voice of earthquakes, Prof. de Grijs moved to the sky and the near-Earth

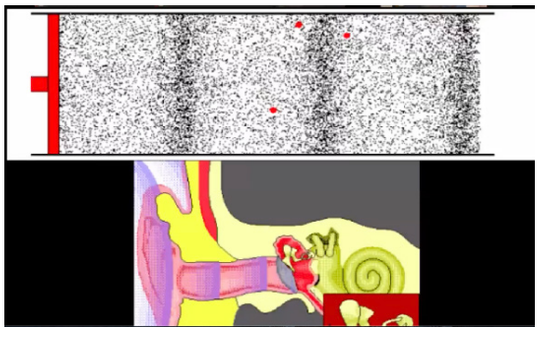


Figure 1 Sound waves — longitudinal waves, either vertical or horizontal — travel into the ear canal until they reach the eardrum. These vibrations are then passed by the eardrum through the middle ear bones into the inner ear and through the hearing nerve to the brain, where they are finally converted into sounds.

atmosphere by discussing the noises that can be derived from the Aurora Borealis and the Aurora Australis, respectively the northern and southern lights visible in high-latitude regions.

How are these Aurorae produced?

As the highly charged particles emitted by the Sun and traveling at supersonic speed reach the protective outer layer of the Earth and hit the bow

shock (see the yellowish bow in the center of Figure 2), they finally go around the magnetic field of the

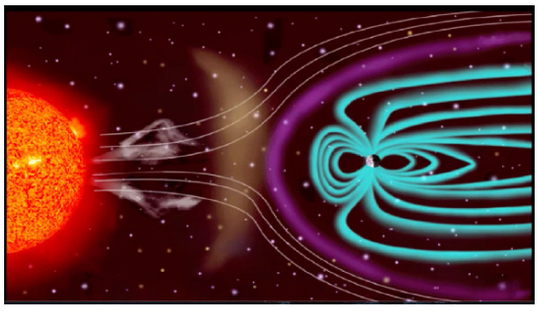


Figure 2 The Sun emits solar flares made of high-energy particles that hit the Earth's magnetic field, move around the heliosphere (purple screen) and interact with the Earth's magnetic field. From this interaction, the Aurorae are thus produced and visible in high-latitude regions around the Arctic and Antarctic, especially in dark autumn and winter nights.

Earth (the blue lines connecting the north and the south pole) and hit the Earth near the Arctic and the Antarctic. The result of such interaction is the so-called northern and southern lights, which can then be converted into sounds.

Not only can these lights' vibrations be heard, but also the Earth's magnetic field can be transformed into a hearable noise that can be used to measure the strength of the Earth's magnetic field using a magnetometer, as achieved by the Bepicolombo European-Japanese satellite sent into space in 2018.

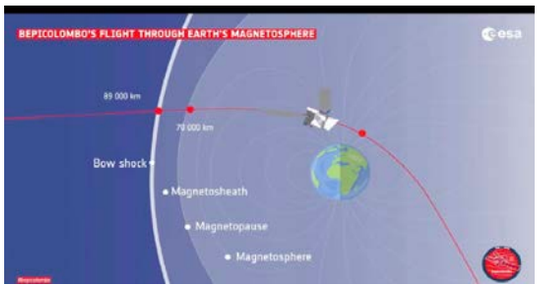


Figure 3 The BepiColombo joint mission satellite of the European Space Agency (ESA) and the Japan Aerospace Exploration Agency (JAXA) sent to the planet Mercury.

The lecture consequently moved up further from the Earth and to space, as Prof. de Grijs illustrated the sounds that we can be derived from the vibrations produced by the planets and stars present in our solar system. A graphic representation of the different stars' 3D vibrations, their distribution, and speed, including the pulsation of red giants (bottom left in Figure 3) was provided. Such information about the frequencies of sound waves resonating inside of stars and caused by turbulence on the stars' surface is very relevant for astronomers to better understand their internal structure, their age, and their mass.

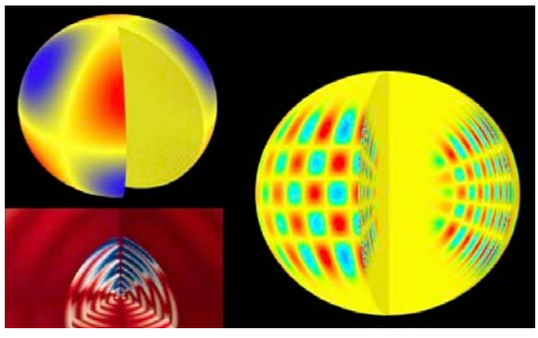


Figure 4 The vibrations' pattern of stars.

Even further from our near-Earth space, stars with a much different vibration pattern were discovered in the 1960s by a Ph.D. student, Jocelyne Bell Burnell, a now very famous scientist and advocate of girls in sciences.

Since at first scientists had no idea what the origin of the very regular, heartbeat-like pulsations detected by Prof. Bell Burnell was — sent by the star CP1919 —, the signal was initially mistaken for a message coming from an alien civilization and therefore called LGM1 (standing for 'Little Green Men'). Only later, thanks to a better understanding of the nature of these vibrations, this kind of celestial bodies were rebaptized Pulsating Stars, or Pulsars, as it was discovered that their pulsations are produced by a ray of light emitted by the star and hitting the Earth at a regular pace (see Figure 5). As explained by Prof. de Grijs, since Prof. Bell Burnell's Ph.D. advisor Antony Hewish did not

give her credit for this discovery, he was awarded the Nobel prize in Physics in 1974, thus stirring outrage in the scientific community.

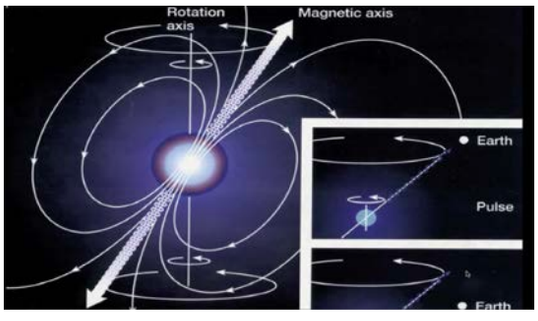


Figure 5 Pulsars can be better understood if compared to a lighthouse regularly hitting the Earth with its light beam. Since Pulsars' magnetic axis is not aligned with the rotation axis of this kind of stars, their magnetic field funnels jets of particles out along the two magnetic poles, which conversely produce very powerful beams of light sweeping around as the star rotates.

Although these Pulsars have finally proved to be fast-pulsating stars and not alien signals, such discovery set the starting point for discussions on extraterrestrial civilizations, which consequently led to the establishment of the Search for Extraterrestrial Intelligence Institute (SETI) in California, USA, in the late 1960s. Since the very first conference on extraterrestrial intelligence held in 1969 — the Green Bank conference — did not have a specific agenda due to the lack of information and data on the topic, one of the SETI founders, Prof. Francis Drake, came up with a kind of equation—the so-called Drake Equation—to estimate the number of alien civilizations in the Milky Way galaxy.

Despite not having yet received any alien signal so far, scientists do now and then pick up unknown signals coming from the Universe, such as the one from the Hercules galaxy cluster HD 156668, or the Wow! Signal (6EQUJ5), discovered in 1977 in Ohio, USA, and which, since it remains unexplained, is deemed to bear the hallmarks of extraterrestrial origin, even though it happened only once.

Another kind of signal that scientists still do not fully understand is the so-called Fast Radio Burst, fast signals detectable all over the sky. Furthermore, given their scattered characteristic,

Figure 6 Two black holes orbiting around each other. The result of such interaction is what we call gravitational waves, while the merging sound of two black holes is called chirp.

scientists are wont to think that they are likely to be of extragalactic origin, i.e. signals coming from outside our Milky Way.

Even though some of the signals detected by telescopes remain indecipherable, this should not necessarily lead us to jump to conclusions, meant Prof. de Grijs, as exemplified by the Peryton short radio signal detected by the Australian Parker telescope in 1998. Having initially left scientists puzzled and baffled about their origin, Perytons were later found to be the result of the premature opening of a microwave oven door located at the Parkes Observatory.

Moving further and further away from the Earth, Prof. de Grijs introduced the audience to the sounds detectable in galaxy clusters — i.e. groups of hundreds to thousands of galaxies — such as the Perseus galaxy cluster and produced by the gas-emitted X-rays. When a smaller galaxy cluster passes by, this is going to disturb the bigger galaxy cluster, and therefore, their interaction and merging process provokes disturbance waves, which are equivalent to sound waves. Moreover, massive galaxies contain (supermassive) black holes right in their center, which emit high-energy particles from their poles and keep bumping matter

in the surrounding area, therefore producing longitudinal, sound waves.

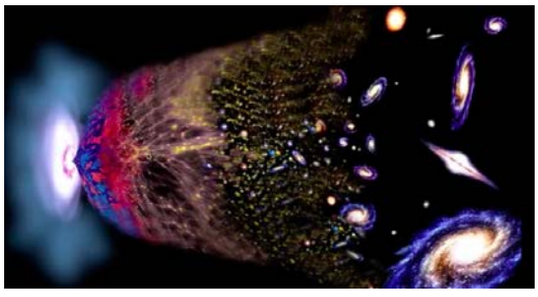


Figure 7 The Universe as a function of time. From left to right: The Big Bang, the first galaxies and black holes, normal galaxies, until the galaxies we can observe today in our local environment (far right).

Furthermore, when two black holes orbit around each other, before finally colliding and merging and thus producing a 'chirp' sound, they also produce gravitational waves, which expand through the Universe and reach the Earth, stretching and squeezing everything they pass through in an invisible way.

Finally, the conclusive image and sounds of the Universe provided by Prof. de Grijs consisted of the representation of our Universe as a function of time, from the Big Bang to the current galaxies' pattern.

The finding of the remnant of the Big Bang — the Cosmic Microwave Background (Figure 8) — earned the discoverers the Nobel Prize in 1978, and it represents the electromagnetic radiation from an early stage of the Universe, also known as "relic radiation". Observed with the European

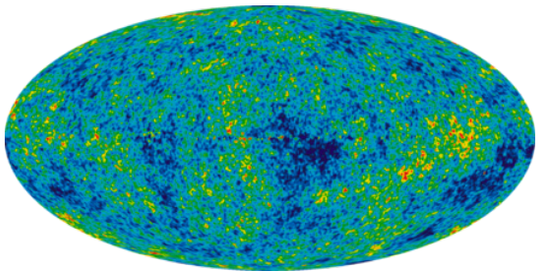


Figure 8 The Cosmic Microwave Background

Planck Satellite, tiny temperature fluctuations were made visible in the background of the Universe, where the red-yellow spots are hot-temperature locations, while the blue ones are cold.

To conclude the seminar, Prof. de Grijs played the sound of the expansion of the Big Bang, i.e. of the Cosmic Microwave Background.

The lecture was concluded with some questions taken online and moderated by Prof. Falanga.

The seminar was jointly organized in collaboration with SELF (格致论坛).

格致论道 非凡思想的跨界交流

INTERNATIONAL TEAMS

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

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

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

2. Earth Sciences using space data

Teams Selected in 2017

1. Heger A. (Monash University, AU) & Lugaro M. (Konkoly Observatory, HU)

Radioactive Nuclei in the Cosmos and in the Solar System

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

Scientific Rationale: The presence of today's 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 the 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. The goal of this team is to exploit these nuclei and the information that they carry by combining the most current sophisticated experimental, observational, theoretical, and numerical modeling 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.

The team includes experts on gamma-ray observations, accelerator mass spectrometry, nuclear experiment and theory, and modeling of stars, supernovae, and galactic chemical evolution. We will take advantage of new nuclear research facilities in China (e.g., JUNA), Europe (FAIR), and the 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.

The 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 the origin and history of the matter in our Solar System.

2. Zimovets I. (IKI, RAS, RU/ISSI-BJ, CN) & Ning Z. (PMO, CN)

Pulsations in Solar Flares: Matching Observations and Models

Last ISSI-BJ Session: October 16-20, 2017

Scientific Rationale: The team will focus on a comprehensive analysis of solar flare space- and 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. use new methods of analysis of nonlinear and non-stationary datasets; 3. develop an advanced classification of different 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 the adequacy and improve the existent flare models; 6. evaluate the role of pulsations in solar-terrestrial connections; 7. develop a strategy of exploration of pulsations in solar and stellar flares with space- and ground-based instruments in the coming years.

3. Zhang H. (University of Alaska Fairbanks, US) & Zong Q. (PKU, CN)

Dayside Transient Phenomena and their Impact on the Magnetosphere-Ionosphere

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

Scientific Rationale: The team 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 generates field-aligned 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 this team is to provide a fundamental physical understanding of dayside transient phenomena and their impact on the magnetosphere-ionosphere system. Specifically, the team 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?

Teams Selected in 2018

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

Chemical abundances in the ISM: the litmus test of stellar IMF variations in galaxies across cosmic time

Last ISSI-BJ Session: November 11, 2019

Scientific Rationale: For three decades it has been speculated that the stellar initial mass function (IMF) is more biased towards massive stars in starburst environments, especially in massive galaxies at high-redshift, which could explain the overabundance of magnesium with respect to iron observed in local elliptical galaxies.

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

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

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

Weak Gravitational Lensing Studies from Space Missions

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

Scientific Rationale: Arising from light deflections by large-scale structures in the Universe, the weak gravitational lensing (WL) effect has been identified as one of the most important probes in cosmological studies, in particular for understanding the nature of dark matter and dark energy, and the law of gravity. To investigate critical issues and explore the synergy and complementarities of Euclid and CSS-OS, the team consists of key WL members of the Euclid project and the CSS-OS.

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

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

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

Cross-calibration of Laser-Induced Breakdown Spectroscopy (LIBS) instruments for planetary exploration

Last Session: April 29 - March 3, 2019

Scientific Rationale: A revolutionary technique for planetary science: Laser-induced Breakdown

Spectroscopy (LIBS) is an active analytical technique that makes use of a pulsed laser to ablate material of interest at a distance.

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

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

4. Li J. (Deutsches Elektronen-Synchrotron, DE)

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

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

Scientific Rationale: The physical mechanisms responsible for particle acceleration and the nature of the resulting high energy emission are two of the key questions of current astrophysics research. X-ray binary systems visible in gamma rays are especially interesting laboratories for this investigation. This gamma-ray emission has been explained by wind interactions, microquasar jets, and the propeller effect. All of these are realized both in high mass X-ray binaries (HMXBs) and low mass X-ray binaries (LMXBs). However, even with the same underlying scenario, the 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 systematically investigate similarities and differences between different systems, finally seeking to unify the gamma-ray launching conditions for HMXBs and LMXBs. In this project, we plan to extend the sparse population of known systems and search for commonalities, differences, and unification between the different classes.

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

Relativistic Electron Precipitation and its Atmospheric Effect

Last Session: October 14-18, 2019

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

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

One of the outputs of the Team project is the preparation of international balloon experiments (measurements of relativistic electron precipitation) above subauroral regions and around the arctic circle. We expect to publish peer-review papers, acknowledging

the important facilitating role of ISSI/ISSI -BJ in allowing these interdisciplinary activities to develop new synergies.

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

The Eruption of Solar Filaments and the associated Mass and Energy Transport

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

Scientific Rationale: Eruptions of solar filaments are associated with flares and coronal mass ejections but are often considered as playing a secondary role in the whole process.

The objective of the Team is to focus on evaluating the associated mass and energy transport from the lower solar corona to the orbit of the Earth and beyond with the partially ionized and warm plasma, which is an important issue in Space Weather. The Team will investigate the whole chain of filament eruptions starting from their initiation to their impact on the Earth through evolution and transport, to determine the mechanisms at work. It will gather complementary expertise in magnetohydrodynamics, plasma diagnostic, radiative transfer, etc.

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

Teams Selected in 2019

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

Dynamical Signatures of Energetic Particle Precipitation in Atmospheric Re-analyses

Upcoming Session: TBD

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

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

The main tasks will be:

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

2. to carry out supporting model studies to quantify the impact of extreme geomagnetic activity on atmospheric composition, temperatures, and dynamics, and to provide an

envelope for what could be found in re-analyses.

The interdisciplinary research activities will rely on Multi-decadal re-analyses using assimilated satellite and in-situ observations; whole-atmosphere chemistry-climate models (namely WACCM); satellite observations of ozone to benchmark re-analysis ozone (e.g., SBUV, MLS, SAGE, SABER, MIPAS, HALOE, POAM) and multi-satellite combined ozone datasets.

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

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

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

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

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

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

3. Orosei R. (INAF, IT)

Searching For Subglacial Water On Mars With Orbiting Ground Penetrating Radars

Upcoming Session: TBD

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

This proposal aims at creating the capabilities needed to expand the analysis presented in Orosei et al. (2018) to the whole of the Martian polar caps, involving also the next radar sounder to Mars. Observing the same area with three

different sensors will allow the combination of their different resolution and penetration capabilities to produce a more detailed mapping of the physical properties and the stratigraphy of the subsurface.

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

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

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

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

Upcoming Session: TBD

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

To answer this question, the team proposed a comprehensive investigation that includes both observations and simulations with three main objectives. First, extending the FVDA analysis to STEREO-A and STEREO-B data, and search for events where simultaneous observations from multiple spacecraft exist. For these events, the resulting path lengths from the FVDA analysis will be compared. Secondly, modeling the transport of energetic electrons and ions in the turbulent solar wind, with a particular focus on the effect of the meandering field line. Finally, performing MHD simulations to examine how preceding CMEs can affect the configuration of the solar wind magnetic field.

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

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

Modeling Space Weather And Total Solar Irradiance Over The Past Century

Upcoming Session: TBD

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

With the goal of developing a clear physics-based understanding of long-term changes in

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

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

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

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

Upcoming Session: TBD

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

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

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

7. Ward M. (Durham University, UK)

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

Upcoming Session: TBD

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

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

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

Teams Selected in 2020

1. Toshi N. (Boston University, US)

Multi-scale magnetosphere-ionosphere-thermosphere Interaction

Upcoming Session: TBD

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

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

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

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

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

Population-dynamical archeology of galaxies

Upcoming Session: TBD

Scientific Rationale: Galaxies show a huge diversity of structure and stellar populations, reflecting a complex and unknown mixture of star formation episodes and hierarchical merging

events in their past that are impossible to observe directly. Promising new methods to recover the distribution of stellar orbits within a galaxy can reveal its dynamical 'skeleton', which in turn sets the spatial distribution of its baryons. However, to reconstruct the assembly history of the galaxy, we must simultaneously infer ages for the recovered orbits of stars and star clusters. Age dating these stellar tracers provides a dynamical memory for the galaxy, as the orbits are imprinted by discrete events (galaxy mergers, starbursts) in the galaxy's history. We have begun the first steps towards this novel combination of stellar population and orbit-based dynamical modeling.

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

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

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

Strong Gravitational Lensing Studies with CSS-OS and EUCLID

Upcoming Session: TBD

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

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

Specifically, we will address the following key problems:

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

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

3) Optimum synergy between the two survey designs

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

Use of geostationary satellites to improve air quality characterization and forecasts

Upcoming Session: TBD

Scientific Rationale: We propose to assemble an international team of experts in air quality studies, atmospheric chemistry modeling, and remote sensing to make the best use of the most recent and forthcoming high spatial and temporal resolution satellite instruments dedicated to atmospheric composition. Space observations of the chemical composition of the atmosphere are a primary source of information on the formation and fate of large-scale and regional air pollution. In the very recent period, there have been major advances in space observations of chemical species, with the launch of the Sentinel-4 satellite, which includes the TROPOMI instrument. This unique instrument observes several key air pollution species at a much higher spatial resolution than earlier instruments. Furthermore, in February 2020, a geostationary

satellite, GEO-KOMPSAT-2, was successfully launched, which includes the GEMS spectrometer (Kim et al., 2020), the first geostationary instrument measuring air pollution from space. GEMS is the Asian element of a constellation of three geostationary satellites, which will include in a few years the Sentinel-4 European component and the TEMPO component for North America.

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

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

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

Upcoming Session: TBD

Scientific Rationale: The team proposes to assemble an international team for gravity field modeling in the context of the GRACE and GRACE-FO missions. These missions are dedicated to determining gravity field variations, hence mass transfers on the Earth, at a daily to monthly periodicity. Besides, the numerical simulation for possible synergistic observing of gravity satellites from Europe and China will be investigated for retrieving mass changes with higher spatiotemporal resolutions and accuracy shortly.

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

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

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

Solar eruptions: preparing for the next generation multi-waveband coronagraphs

Upcoming Session: TBD

Scientific Rationale: Space- and ground-based

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

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

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

Long term ionospheric effects and their associated modeling during extreme space weather events over the African sector

Upcoming Session: TBD

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

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

2) Is it the forcing from above (SW-magnetosphere-ionosphere coupling) or from below (lower thermosphere-ionosphere coupling

such as the role of atmospheric gravity waves (AGWs), planetary waves, and tides)?

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

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

FUTURE ACTIVITIES

Please note that given the COVID-19 pandemic, the ISSI-BJ 2021 Event Schedule could be considerably affected.

FORUMS

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

TBD

Conveners: Wang Chi (NSSC, CAS, China); Yu Dengyun (CAST, China), Wing-Huen Ip (ISSI-BJ, China).

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

Such an achievement represented the peak of the Chang'e missions promoted by the country, whose four satellites CE-1, CE-2, CE-3, and CE-4, focused on the circling (CE-1 and CE-2), landing (CE-3 and CE-4), and returning (CE-5) before 2020. As the first three phases are now concluded, the new phase four, spanning over 15 years (2020-2035), will concentrate its efforts on the primary unmanned research station.

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

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

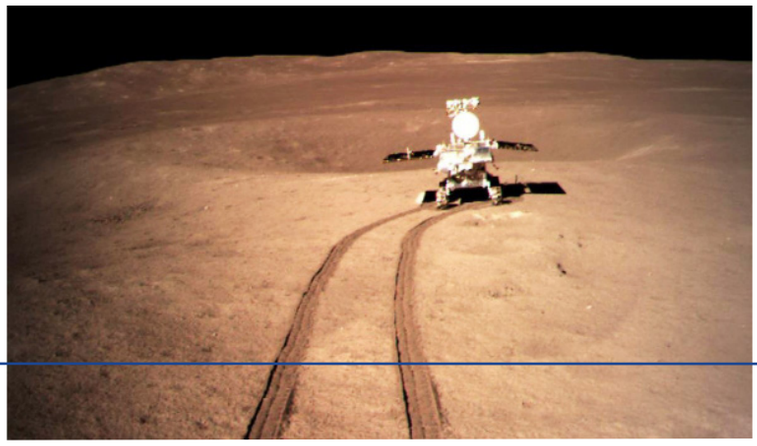
Mission 1: Lunar surface exploration and geological survey on landing site (Orbiter, Lander, Rover, Flying robot, Relay satellites);

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 of the phase 4 of CLEP, which will prioritize international collaboration, several leading international scientists in moon science will gather at ISSI and ISSI-BJ in the year 2020-21. The first forum session will be held at ISSI, while the second part will be hosted by ISSI-BJ, and its overall objectives include: the selection of landing site for scientific research station; the optimization of scientific objectives; the possibility of international cooperation (including payload, scientific research, etc.).

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

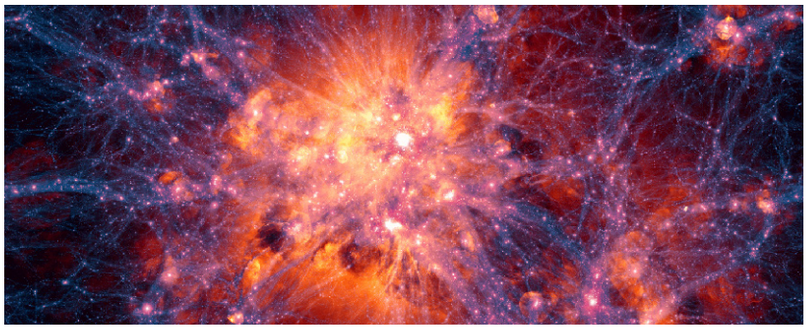


China's Chang'e-4 - Credits: NSSC, CAS, China

FORUM “Detecting “Missing” Baryons in the Universe”

TBD

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



Missing Baryons - Credits: Illustris Collaboration

The goal of this ISSI-BJ forum is to discuss the problems of missing baryons on scales of galaxies and large-scale structures and to make plans for X-ray missions that are dedicated to solving these problems. The missing baryons are deemed to constitute a major component of the circumgalactic medium (CGM) and intergalactic medium (IGM), but they are difficult to observe due to the limitations of the current instrumentation, and thus, they represent a key obstacle to our understanding of the galaxy evolution. During this activity, the forum participants will discuss the results yielded from cosmological hydrodynamical simulations on the properties of the hot CGM and IGM, the observational evidence for their existence, and the implications on galaxy evolution. Moreover, it will be discussed how to fill the observational gap of directly detecting the missing baryons and thus measuring their properties and distributions. Since they are postulated to exist in the form of low-density, hot CGM/IGM, and to radiate mainly in soft X-rays, the discussions will center on effective X-ray means. To this end, a number of proposed mission concepts will be presented. Consensus will be sought on an optimal strategy to collectively push for a high-resolution X-ray spectroscopic mission and to sustain the momentum over the long run. Besides the subject of missing baryons, the participants will also discuss some important scientific issues related to the topic that can benefit from high-resolution X-ray spectroscopic observations, including diffuse X-ray background, supernova remnants, and cluster outskirts, as well as techniques of modeling the high-resolution X-ray spectra obtained.

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

Objectives

The meeting will be divided into five main sessions, including:

1. Census of cosmic baryons
2. Theoretical understanding of missing baryons
3. Recent observations of WHIM and implications
4. High resolution X-ray spectroscopic observations and modeling
5. Synergies and collaborations

FORUM “Performing High-Quality Science in Astronomy on Space Stations”

TBD

Conveners: Wing-Huen Ip (ISSI-BJ, China)

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

- Forecasting Solar Energy Particle Events;

- Spectroscopic Investigation of Nebular Gas;

- POLAR-2: Gamma-Ray Burst Polarimetry.

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

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

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

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

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

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

The Chinese Space Station - Credits: CMSEO

WORKSHOPS

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

TBD

Conveners: Fa Wenzhe (PKU, China); Mark Wieczorek (OCA, France); Doris Breuer (DLR); Jessica Flahaut (Univ. Orlean, France); Brad Jolliff (U. Washington, St. Louis, USA); Mihali Horanyi (U. Colorado, Boulder, USA); Nori Namiki (NAOJ, Japan); Clive Neal (U. Notre Dame, USA)

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).

Before 2020, China's Lunar Exploration Program (CLEP) has focused on and researched the circling (CE-1 and CE-2), landing (CE-3 and CE-4), and returning (CE-5) of its mission 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 brightness 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 the main orbiter and two small satellites, and the main orbiter will be at a distance of 100 km from the moon, flying on a circular track of several kilometers. It aimed at exploring the origin, formation, and evolution of the moon, its space environment, as well as at observing outer space.

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

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

Full Moon in Beijing - Credits: Xinhua/Chen Duo

WORKSHOPS

ISSI-BJ Workshop “Exploring the Jovian satellite system: from formation to habitability”

TBD

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

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

The workshop will aim to:

1. Explore the Jovian satellite system, including all moons and small bodies (Galilean satellites, inner regular satellites, irregular satellites and Jovian Trojans) and review our current understanding of their formation, evolution, workings, and of the possible emergence of habitable moons among them;
2. Review the way these key questions will be partly addressed by space missions to the Jupiter system currently in flight (Juno) and in development (JUICE, Europa Clipper, LUCY), and identify the science base for new mission initiatives, particularly in China and the U.S., that will further address these open questions.
3. Provide a high-level reference book for the scientists who prepare these missions and will analyze their observations in the coming two decades.

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

1. Exploring the diversity of the Jovian satellite system
2. Origin and early evolution of the Jovian satellites
3. Geophysics and geochemistry of the Galilean satellites
4. Coupling processes in the Jupiter system and implications for habitability
5. Planned missions and future initiatives: science return and scientific synergies

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WORKSHOPS

ISSI-BJ Workshop "Laser-Induced Breakdown Spectroscopy (LIBS) instruments for planetary exploration"

TBD

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

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

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

As the next instruments will land on Mars in spring 2021, the year 2022 will be an ideal time for the three rover teams to start comparing their in-situ results and calibration procedures and discuss with other international specialists of LIBS.

The goals of the workshop will be fourfold:

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

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

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

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

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Planet Mars - Credits: NASA/ESA

WORKING GROUPS

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

September 21-25, 2020 (ISSI)

Conveners: Vlada Stamenković (NASA Jet Propulsion Laboratory, USA), Barbara Sherwood Lollar (CIFAR Earth 4D Program & University of Toronto, CA), Fa Wenzhe (Institute of Remote Sensing & GIS, Peking University, CN), Cara Magnabosco (Geobiology, ETH Zurich, CH)

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

There are first indications that the subsurface could be hiding liquid water and/or life, though, as highlighted also by the US National Academy of Sciences report on the Astrobiology Strategy for Exploration of life in the Universe and the International Center for Deep Life Investigation in Shanghai, China. 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 modern-day subsurface habitability and extant life in the Martian subsurface, from science to implementation.

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

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 probably need to be international because of 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 to plan mission concepts, from small spacecraft applications to larger missions on an international platform.

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

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

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

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

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

SPACE SCIENCE SCHOOL

ISSI-BJ/APSCO Space Science School 2020

Analysis and Investigation of Scientific Moon Data

TBD

Conveners: Mohammad Ebrahimi Seyedabadi (APSCO, CN), Maurizio Falanga (ISSI-BJ, CN)

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

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

With this project, we do not only aim to provide an international platform for students and experts

to exchange knowledge, ideas, and know-how to advance space science studies but also to build a valuable social net between participants as well as between teachers and participants to facilitate future collaboration in the field.

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

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

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

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

Preliminary Arrangement

Thailand

Application

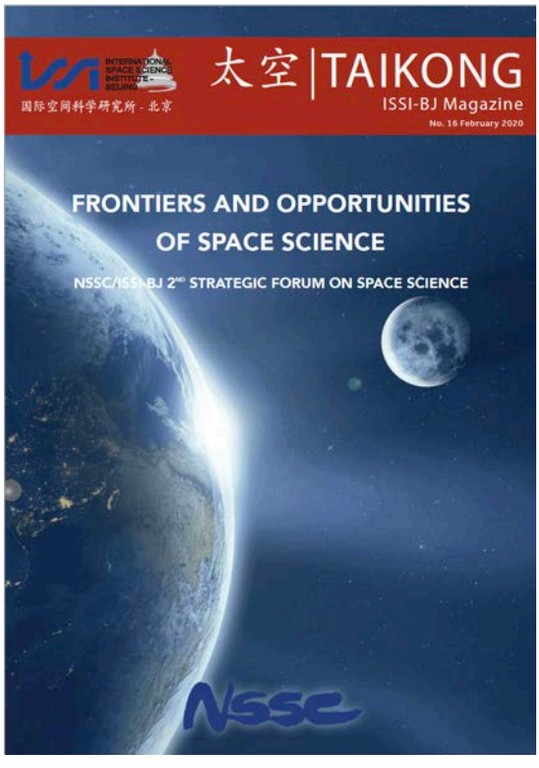
More info and registration soon online at www.issibj.ac.cn.

PUBLICATIONS

TAIKONG MAGAZINE

No. 16, February 2020

Frontiers and Opportunities of Space Science: NSSC/ISSI-BJ 2nd Strategic Forum on Space Science



Giménez, A., Wu, J. (Feb. 2020). Frontiers and Opportunities of Space Science: NSSC/ISSI-BJ 2nd Strategic Forum on Space Science. ISSI-BJ TAIKONG No. 16

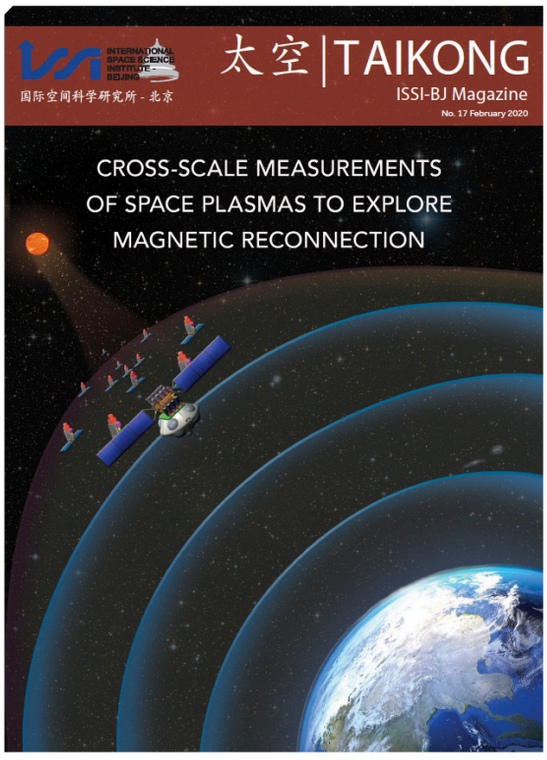
Editor: Laura Baldis (ISSI-BJ, China)

Jointly organized by the National Space Science Center (NSSC) and the International Space Science Institute-Beijing (ISSI-BJ), the "2nd Strategic Forum on Space Science" held in Huairou, Beijing, was dedicated to the discussion on the frontiers and opportunities in space science. The two-day forum involved prominent scientists in open discussions encompassing a wide variety of space science disciplines, i.e. space astronomy, solar physics, space physics, space earth science, and planetary science. Not only were important scientific frontiers for space science analyzed and key questions identified, future space science missions and their planning were also taken into consideration to give exhaustive answers to these questions. As a new player in space science, since 2011, China is increasingly making efforts to improve its contributions in this area with several science missions, such as DAMPE or QUESS, which were successfully launched and are now still in operation.

Several other missions, such as the Einstein Probe, ASO-S, and SMILE, are currently under development and will be carried out in the near future. However, the identification of the next steps in the Chinese space science program is still an open question that needs to be carefully thought through in the immediate future.

No. 17, February 2020

Cross-Scale Measurements of Space Plasmas to Explore Magnetic Reconnection



Wang, C., Liu, W., Blanc, M., et al. (Feb. 2020). Cross-scale Measurements of Space Plasmas to explore Magnetic Reconnection. ISSI-BJ TAIKONG No. 17

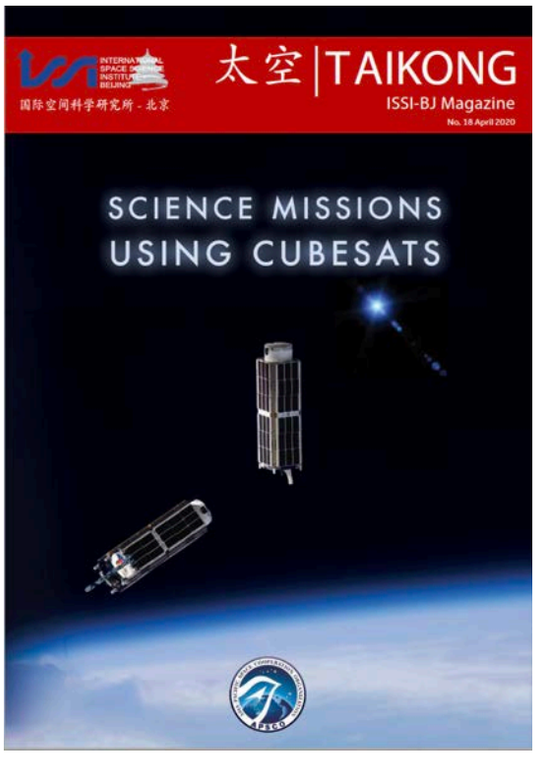
Editor: Laura Baldis (ISSI-BJ, China)

Given the need of improving our understanding of magnetic reconnection, on September 5-6, 2019, the two-day Forum on "Cross-scale Measurements of Space Plasmas to Explore Magnetic Reconnection" was successfully organized by the International Space Science Institute in Beijing (ISSI-BJ). ISSI-BJ Forums are informal, free debates and brainstorming meetings among high-level researchers on open questions of scientific nature. Specifically, around 30 leading scientists from 12 different countries took part in this forum.

The activity started with an overview of magnetic reconnection and the Constellation missions (Cluster, PROSPERO, SAME, MagCon, MMS), followed by the cross-scale and multiple-scale science of reconnection, including cross-scale measurements. The second day continued with turbulence, electron acceleration, waves, and MI-coupling as additional points of discussion regarding reconnection and related to the space missions and their measurement approaches. The participants addressed also the Self-Adaptive Magnetic Reconnection Microscope Mission (SAMRM) formulated by the National Space Science Center of the Chinese Academy of Sciences (NSSC, CAS), 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.

No. 18, April 2020

Science Missions using CubeSats



Seyedabadi, E. M., Falanga, M., et al. (Apr. 2020). Science Missions using CubeSats. ISSI-BJ TAIKONG No. 18

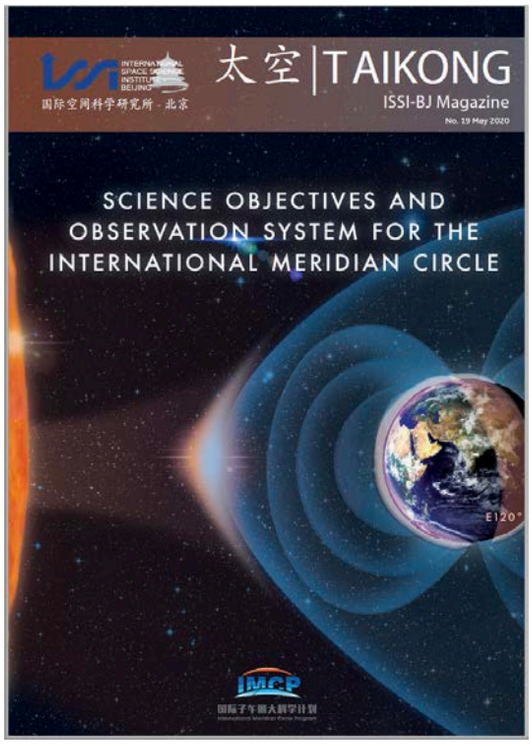
Editor: Laura Baldis (ISSI-BJ, China)

Given the numerous possibilities and the great advantages deriving from the sharing of know-how and knowledge of these small satellites, CubeSats-based international and interdisciplinary collaboration currently assumes a great significance for the promotion of cross-country cooperation on joint studies and space missions. And it is exactly for all these reasons that the APSCO training course on CubeSats as well as the forum on "Science Missions using CubeSats" were convened by Mohammad Ebrahimi Seyedabadi (APSCO, China) and Maurizio Falanga (ISSI-BJ, China) from June 3 to June 7, 2019, in Thailand.

The Asia-Pacific Space Cooperation Organization (APSCO), as a multilateral inter-governmental organization, not only promotes regional space cooperation but also enhances the capacity building of its member states in different disciplines. Such a goal was perfectly coupled with ISSI-BJ's efforts to advance space science studies based on its principles of international collaboration and interdisciplinary research. For this purpose, well-known experts were invited to share their profound experiences and valuable thoughts and insights to train students and researchers from member states on the use of small satellites, and for the joint forum to discuss key scientific tools that can be developed for CubeSats science missions.

No. 19, May 2020

Science Objectives and Observation System for the International Meridian Circle



Blanc, M., Liu, W. et al. (May 2020). Science Objectives and Observation System for the International Meridian Circle. ISSI-BJ TAIKONG No. 19

Editor: Laura Baldis (ISSI-BJ, China)

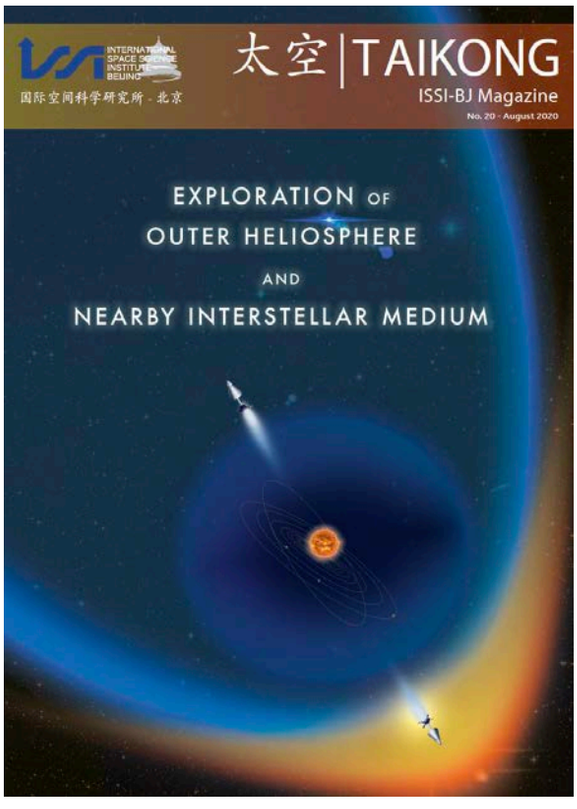
The central objective of the Forum on "Science Objectives and Observation System for the International Meridian Circle", whose scientific debates are summarized in this issue of Taikong Magazine, was to address this important gap in the current description of the Earth System and to offer directions to cover the climate/weather system and space weather in a unified scientific perspective.

Jointly organized by the International Meridian Circle Project at NSSC, CAS, and the International Space Science Institute - Beijing (ISSI-BJ), this forum was held at ISSI-BJ on September 23-25, 2019. It was convened by William Liu (NSSC, CAS, China), Michel Blanc (NSSC, CAS, China and IRAP, France), Eric Donovan (University of Calgary, Canada), John Foster (MIT Haystack Observatory, USA), Mark Lester (Leicester University, UK), Mioara Mandea (CNES, France) and Maurizio Falanga (ISSI-BJ, China), with the participation of 34 scientific experts from 13 countries. Our primary goal was to take stock of our research legacy and arsenals in the Space Weather discipline and apply them to the detection and possible prediction of major natural and anthropogenic hazards. This can be done using the deployment of a global natural screen on which these hazards can be projected and detected: our Ionosphere, Middle and Upper Atmosphere (IMUA).

The international team of participants undertook rigorous and enlightening discussions on future steps to meet this major scientific challenge by joining forces across the five continents.

No. 20, August 2020

Exploration of Outer Heliosphere and Nearby Interstellar Medium



Wang, C., McNutt, R. et al. (August 2020). Exploration of Outer Heliosphere and Nearby Interstellar Medium. ISSI-BJ TAIKONG No. 20

Editor: Laura Baldis (ISSI-BJ, China)

Symbolically marking the first anniversary of NASA-led Voyager 2 mission since it first entered the interstellar space on November 5, 2018, the forum “Exploration of outer heliosphere and nearby interstellar medium” represented one of the most relevant activities held at ISSI-BJ in 2019 thanks to the pioneering researches and results thoroughly discussed by international scientists during two days, on November 7-8, 2019.

Convened by internationally renowned scientists — Prof. Wang Chi (NSSC, CAS, China), Dr. Ralph L. McNutt Jr. (Johns Hopkins University, USA), Prof. Robert WimmerSchweingruber (University of Kiel, Germany), Prof. John D. Richardson (MIT, USA), Prof. Li Hui (NSSC, CAS, China), and myself — the event attracted more than 20 experts devoted to the study of heliophysics, space physics, and space exploration.

The invited scientists aimed to identify the key problems related to some still uncharted territories, including the heliosphere, the interstellar medium, our solar system, and their interactive dynamics. Experts were also faced with the complexity of a new interstellar mission proposal, i.e., the Interstellar Express (IE).

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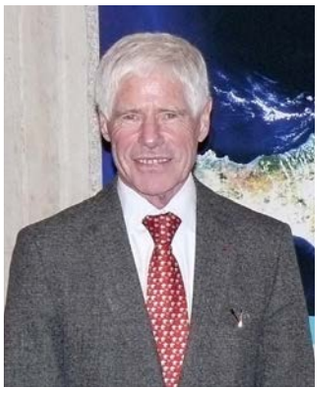
INTERVIEWS

Interview with Roger-Maurice Bonnet (ISSI)



Prof. Roger-Maurice Bonnet is the former Executive Director of ISSI, Bern, from 2003 to 2012, and he is currently an ISSI Senior Discipline Scientist. With a Ph.D. in Physics from Paris University (Sorbonne), he was appointed Director of Laboratoire de Physique Stellaire et Planétaire of CNRS from 1969 to 1983, and subsequently, he was the Director of ESA Science Programme from 1983 to 2001. In these duties, he established the first long-term program 'Horizon 2000'. He was also entrusted with defining the European strategy for Earth Sciences and Observation, now called the 'Living Planet' program. Among others, he also took up the post of President of COSPAR (Committee for Space Research) from 2002 to 2010.

Prof. Bonnet is the author of more than 150 articles and scientific publications and he received several awards and distinctions, including Officier de la Légion d'Honneur, médaille d'Argent du CNES (1976), prix Deslandres de l'Académie des Sciences (1980), Gagarine (1985) and Tsiolkovsky (1993) Medals by The Russian Federation of Cosmonautics, Laurel Aviation Week and Space Technology (1985), 'personnalité de l'année dans les Sciences en France' (1987), Grand Prix of Association Aéronautique et Astronautique de France (1996), Doctor Honoris Causa of the University of London (Imperial College) (1997), COSPAR Award (2000), NASA Public Service Medal (2001), etc.

Your extensive experience and outstanding results make you a pillar in the history of the European Space Agency. How has the international arena changed in regard to space missions and how do you see its future development?

In 1957, Sputnik-1 initiated the space adventure, in particular in science, and determined my decision to become a space scientist, even though the adventure was dominated by the two Cold War superpowers. The situation lasted until Europe made the first move and develop its launchers. Before this moment, all missions had to be considered in cooperation with the two giants. China was still not involved back then. Today, the main actors in space science and space exploration are still the USA, Europe, including ESA and some big member states, and Japan. Russia has not yet recovered from the Perestroika which, to a certain extent, seemed to not consider fighting to maintain Russia's historical leadership. A sad fate for the heroes of Sputnik1!

Now, at the beginning of the 21st century, two phenomena characterize the development of space science, which will most surely induce major changes in that development (or not?): first, the very spectacular come into play of China (especially in lunar exploration and manned flights); second, the increasing number of low-cost and small missions, attracting a growing number of international players. That situation is paralleled with an increasing number of international adventures and the development of a very fruitful and peaceful international cooperation among nearly all the players. In principle, this is very encouraging as it opens numerous high-level perspectives for 21st-century scientists all around the world. However,

the consequent accumulation of space hardware might announce the danger of saturation of space. Unless international treaties are established and are endorsed by all fairing nations, this danger might well become a reality.

Let me insist that China promises to be one of the most active players in that phase of international space exploration. China has crafted excellent scientists and engineers, inventing new fascinating missions for the exploration of the solar system, including the moon, of course, and also in astronomy and manned exploration. Every effort in fostering such international initiatives will be well received by the scientific community and, at the same time, will contribute to the safeguard of world peace.

ISSI just marked its 25th anniversary—an incredible milestone for the institute and in your career, as you were its Executive Director from 2003 to 2012. How did the institute contribute to the advancement of space studies and what are the main challenges that it had to face throughout the years?

ISSI was created in 1995 by a very clever Swiss scientist, Professor Johannes Geiss, who passed away in January of last year. The unique characteristic of the institute, as defined by Geiss, was to invite all space scientists of the world, independently of their nationalities and race, to meet at ISSI in Bern for discussing the scientific results and achievement of their respective mission(s), in view of identifying scientific problems that the data obtained by each individual mission were not fully able to solve.

ESA, the European Space Agency, would finance ISSI together with the Swiss government, but under the clear condition that ISSI should not interfere with ESA's fundamental remit of selecting future missions of its program, through severe competition. That limitation was respected by Geiss and by his successors, including me.

After 25 years, the success of ISSI is undeniable as illustrated through the following numbers: 6310 visitors, from 57 countries, gathering 513 scientific teams, publishing 79 books, together with 2600 peer-reviewed articles in the highest-level journals. The main challenges that confronted Geiss and his successors were to maintain ISSI at the highest scientific level and to create new science from a confrontation of the achievements of the international space scientific community, while respecting the conditions just described above, keeping in mind that, all that had to respect the limit of a rather small budget.

Given these difficult times, how was your research and work routine shaped and challenged?

Of course, ISSI is strongly affected by the present worldwide situation resulting from the COVID/19 pandemic. The remedies to that situation, affecting institutes, laboratories, and universities through the implementation of distance-working techniques are not ideal in my opinion, and cannot last for too long. For example, one important basic fundament of ISSI's working method rests on the power of establishing human contacts between scientists specialized in different disciplines, through interdisciplinary discussions. It is important to mention here that one of the ideas of Prof. Geiss, of which he was very proud, was to use the cafeteria of the institute as a very productive tool for generating scientific discussions, across different branches of space science.

Certainly, I cannot deny that the Game Changer series of webinars recently introduced in the ISSI and ISSI-BJ programs, which analyze the uniqueness and the scientific performances of international space science missions, has been a real success and was well appreciated by the scientific community. However, ISSI would run into a dangerous trap if its future activities were to rest on increasing too far the recourse to such approaches, at the detriment of human meetings. We can only expect that the present Pandemic will come to a stop soon and that ISSI can come back to normal, recovering its usual

working means of presentations, simultaneous discussions and re-establish direct interactions face to face, in the cafeteria and through the corridors, which importantly contributed to make ISSI an undisputable success.

Why is ISSI-BJ unique and where would you like to see it in the future, especially considering its collaboration with ISSI to promote international cooperation?

Let me first say how proud I am to have, together with Prof. Wu Ji, initiated the development of an ISSI-type of space science institute in China. The level of the Chinese Space Science Program in 2010, when the concept of ISSI-BJ was discussed, could not be compared to that of NASA or even ESA, and that constrained our ambitions. Let me stress at this point that the political and financial support of ESA was essential in the constitution and for the support of ISSI. Similarly, NSSC has been essential in the creation and support of ISSI-BJ. Logically, the concept of ISSI-BJ, just only because of its very name, had to adopt some of the working principles operating in ISSI, though in a substantially different context characterized in particular by a just-starting China's space science program. Hence, the orientation adopted early by NSSC, of benefiting from the existence of ISSI-BJ as a tool which would contribute to increasing China's international visibility in the development of their future space science missions, a responsibility that ESA, for reasons of the principle mentioned earlier, could not accept.

What did impress me most in the development of ISSI-BJ is undoubtedly the increasing number of forums and foreign visitors as described in your excellent annual reports. I did participate in several of these forums and all, without any exception, impressed me by the high level of the Chinese and international participants, and by the level of their discussions. Particularly impressive were the two "Strategic Forums on Space Science", which offered a unique occasion to review the global space science activities of China and the other countries. I attended the last one in 2019 and learned a lot, not only on the Chinese Program but on several others.

Two supplementary impressive achievements of ISSI-BJ are the publication of the series of Taikong journals largely distributed and also the invention of the ISSI-BJ Space Summer School, a very important tool for developing science and international cooperation with future new players, in particular young students from Pacific countries participating to the APSCO organization. A great success!

Overall, ISSI-BJ has also been a success thanks to the excellent management, of the successive directors: Prof. Maurizio Falanga, Prof. Michel Blanc, and Professor Ip Wing-Huen and also the whole staff of the institute for their professionalism and their remarkable spirit of service to international scientists in search of cooperation. Naturally, my wishes for the future phases of the ISSI and ISSI-BJ institutes are simple: keep going along the tracks you explored already so successfully.

"Back to the future"! My personal view at this point would be for ISSI-BJ to continue inviting and accreting high-level scientists, from all the components of space science: physicists: experimentalists and theoreticians, astronomers, planetary explorers, meteorologists, biologists, and so on! ISSI in Bern, for many years, has been regularly (every 4 years or so), discussing these objectives, and it would be creative for both ISSIs to jointly enlarge these discussions, for example through the organization of joint forums of reflection, on lessons learned from their undertakings, and how they could improve them. A larger interaction and cooperation between the two ISSIs, in the respect of their differences, will help promote more international cooperation. Of course, more activities mean an increase in the budget. One solution often discussed at the ISSI-BJ Board of Trustees would be to attract more external supporters. But that should be done reasonably! As Professor Geiss often repeated, while talking about ISSI: "small is beautiful", and the success of ISSI and of its management, in the respect of its remit, as of today, has been its

clever capability to continuously remember these three words.

Interview with Yao Zhonghua (University of Liege) of the International Team "The morphology of auroras at Earth and giant planets: characteristics and their magnetospheric implications"

This ISSI-BJ team, made up of ca. 12 scientists from different backgrounds and research areas—planetary and space science, physics, astrophysics—was approved by the ISSI/ISSI-BJ Science Committee in 2019. Led by YAO Zhonghua (University of Liege, Belgium) and SHI Quanqi (Shandong University, China), the group, characterized by its multi- and interdisciplinarity, has made breakthrough discoveries that will be published in the upcoming months. One of its members, William Dunn, recently received the 2021 Division Outstanding Early Career Scientist Awards from the European Geosciences Union.

Given the current circumstances, the team could not organize its first in-person meeting at ISSI-BJ in 2020; nonetheless, since they've seized the chance to meet online for the first time in November 2020, they have organized one more meeting and are planning to have more regularly to keep their cooperative research going and make the most out of the resources currently available. Thus, we've asked Prof. Yao a couple of questions about their research, how they organize their work online, and their future scientific plans.

Dear Prof. Yao, could you give us a brief introduction to your team and your research focus?

Sure, it is my honor to introduce our team. Our team members come from very different backgrounds, including theoreticians, data scientists, and modelers from both the terrestrial and giant planetary scientific communities. As we know, the planets of our solar system present very different characteristics, such as solar wind states at different distances and different moons' geological activities. The Earth's magnetic field and the magnetic fields of giant planets present many similarities in fundamental magnetospheric processes. There's the need to advance the studies on the similarities between the terrestrial and the giant planetary backgrounds; however, the combination of the results from both in data analysis is not straightforward. Thanks to the magnetospheric space missions (Cluster, THEMIS, Van Allen Probes, and MMS), the global picture of terrestrial magnetospheric dynamics has significantly shifted in the past two decades. Similarly, the understanding of the giant planetary magnetosphere has also significantly improved thanks to the Cassini, Galileo, and Juno spacecraft, as well as space/ground observatories. Therefore, researchers in the cutting edge of both communities need to work together and carefully compare the progress and results in each study area.

Our research focuses on the comparison of the fundamental magnetospheric and auroral processes around the Earth and giant planets—Jupiter and Saturn. Because of the different planetary environments, one fundamental plasma process may result in very different observational features at different planets. For example, due to the rapidly co-rotating nature of giant planetary magnetospheres, the auroral evolution is strongly modulated by azimuthal rotation, showing very different morphologies compared to the terrestrial aurorae. Our team members who are proficient

in terrestrial and giant planetary fields are the ideal candidates to identify the fundamental magnetospheric processes by comparative investigations of different planets.

Could you please tell us more about your background and why did you choose ISSI-BJ International Teams Program?

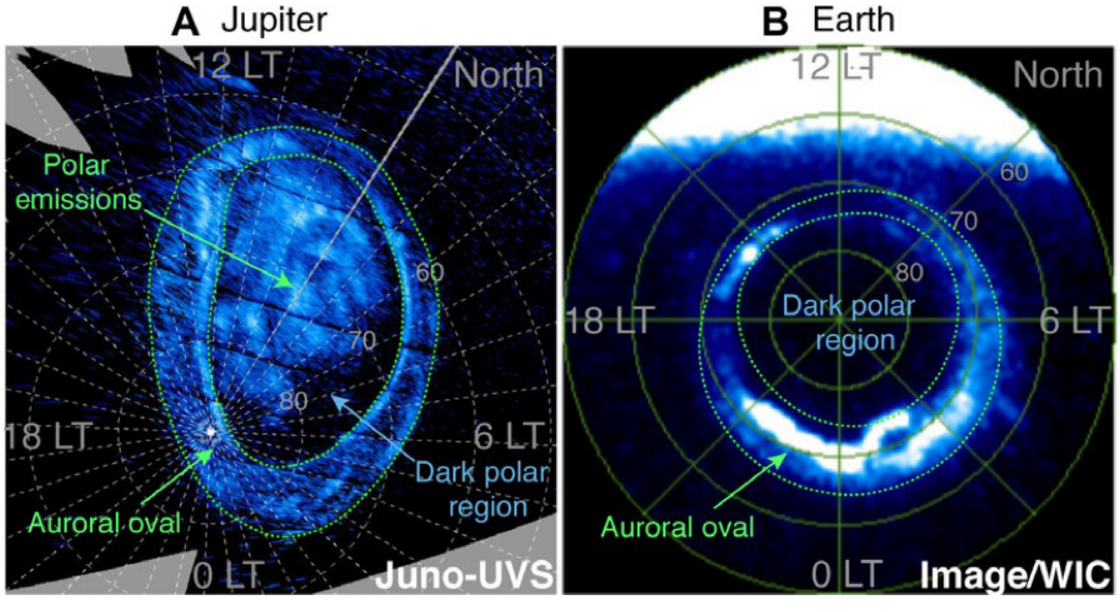
Unlike most other researchers, I have often changed my research topic since my graduate studies, spanning from nuclear fusion to terrestrial sub-storms, Saturn's magnetosphere, and Jupiter's aurora in the past ten years. As all my research focuses are based on a central theoretical frame named plasma physics, I would probably describe my career as the application of plasma physics to different environments. In my research experience, I noticed that similar morphologies and terminologies are often used in different communities, demonstrating the importance of knowledge transfer between different fields. However, similar morphologies may mislead if the differences of planetary environments are not considered. I have also realized that terminologies are transferred only based on similar morphologies, but not on fundamental physics. Therefore, my collaborators and I feel it is very important to create a team that can focus on fundamental processes rather than morphologies. If we understand the fundamental processes, we will have a better understanding of the similarities and differences of morphologies or observational signals.

Is there any breakthrough discovery that you would like (and can) share with us?

Several breakthrough discoveries are resulting from our teamwork. Some of them are already available, and some others are still work-in-progress. Our team has paid special attention to the fundamental processes on different planets, including plasma injection, ion aurora, sub-storm, field-aligned current formation, magnetic reconnection and dipolarization, etc.

I would like to highlight two breakthrough discoveries made by our team, i.e., Bonfond et al. (2021) and Zhang et al. (2021).

Bonfond et al. (2021) discovered for the first time the development of Jupiter's dawn storm from the onset. Jupiter has many distinct auroral features; among them, the dawn storm is quite spectacular and rapidly evolving, showing the most intense perturbations of energetic particles and



Polar projections of Northern UV aurora at Jupiter and Earth.
(A) Juno-UVS, image was acquired on May 19, 2017 at 04:21:56; UVS, ultraviolet spectrograph. (B) WIC image was acquired on January 14, 2001 at 05:00:55UT. LT, local time; WIC, wide-field maging camera.

electromagnetic fields in Jupiter's magnetosphere. Before the Juno era, the Hubble Space Telescope has captured the dawn storm on the morning side, while the onset on the night side cannot be captured due to the limited viewing field. Using the new dataset from the Juno ultraviolet spectrograph, Bonfond et al. (2021) were successful in detecting all the stages of the development of dawn storm events, and the authors further reveal surprising similarities with terrestrial substorms. These findings show that, regardless of their sources, the dissipations of magnetospheric energy share fundamental similarities. The paper was recently accepted by the high-impact journal "AGU Advances".

Zhang et al. (2021) solved the long-existing question of Jupiter's unique ability to produce the near-pole aurora. Jupiter has the most powerful aurora emission in our solar system as a consequence of the most energetic planetary space aurora. Although the morphology of Jupiter's aurora was discovered in the 1990s by the Hubble Space Telescope, the reason why there is a great number of auroral emissions near the magnetic pole which was confirmed to not exist on the Earth and Saturn, was still an open question. Based on first-principles and physics-based calculations, Zhang et al. (2021) discovered that most of the Jovian polar region is threaded by helical, closed magnetic field lines connecting the two magnetic poles. Since planetary space environments are connected via magnetic fields, the novel magnetic topology revealed in this study will reshape the current understanding of Jupiter's energy and mass coupling picture. Their results demonstrate that the Earth and Saturn's magnetic field configuration is only a simplified condition, i.e. magnetic field with a negligible helicity, while Jupiter's configuration is the fundamental situation. The paper was accepted by the highly influential journal "Science Advances".

4. How do you think these online meetings are contributing to the advancement of your research?

It sounds self-evident, as we are 12 scientists from five different countries—Belgium, Greece, UK, USA, and China—but being all in the same virtual room at the same time made us open our eyes to the cultural differences that can enrich us and contribute to our research. Our members contribute to the research by bringing in multiple perspectives and views thanks to their different scientific backgrounds. This was possible given my work experience that spans several countries, projects, and organizations, where I got to meet and work with experts from various research fields. That's unique, as I'm in the position of being able to grasp everyone's perspective on our common topic and mediate with others to contribute to a deeper understanding of the subject. We address tough subjects that require our painstaking attention, but if we raise our gaze to look beyond our research area, we may realize that there are fundamental


AGU Advances

Research Article | Open Access

Are Dawn Storms Jupiter's Auroral Substorms?

B. Bonfond, Z. H. Yao, G. R. Gladstone, D. Grodent, J.-C. Gérard, J. Matar, B. Palmaerts, T. K. Greathouse, V. Hue, M. H. Versteeg, J. A. Kammer, R. S. Giles, C. Tao, M. F. Vogt ... See all authors

First published: 16 March 2021 | https://doi.org/10.1029/2020AV000275

flaws, misunderstandings, or loopholes produced by a non-comprehensive, non-interdisciplinary approach. Discussions should be focused on specific subjects, but having representatives of various disciplines in the same research group makes the brainstorming sessions much more stimulating and productive.

5. What are some challenges of organizing online meetings?

Apart from the linguistic and cultural obstacles that we may face now and then, probably the biggest difficulty is to find a common date and time to hold the meeting, as we come from three different continents. We often have to choose the night slot in China and the morning slot in the USA to make sure we'll all get the chance to join the discussion. We are looking forward to the in-person meetings, but until then, we plan to have one online meeting per month.

6. What's the status of your team's research and what's the next step?

In our monthly meeting, we focus on those subjects that would likely bring new publications soon. For example, in our second and third meetings, we discussed auroral beads and plasma injection, respectively. Our team members are working on these subjects in either terrestrial or giant planetary space environments so that the focused discussions from the two sides are timely in their research and will be useful to achieve high-impact results. At the end of the ISSI-BJ meetings, we expect to have breakthrough discoveries in several key research areas and eventually provide an improved bigger picture of comparative auroral processes between the Earth and giant planets.

Our team members just started working on comparing the auroral processes of the Earth and Jupiter/Saturn. I can foresee many more collaborations to come in the future. Several publications will likely result from the team discussion, and I plan to lead a review paper on comparative auroral processes at different planets.

Many thanks to Prof. Yao for his time and his exhaustive answers, we are looking forward to the upcoming publications!

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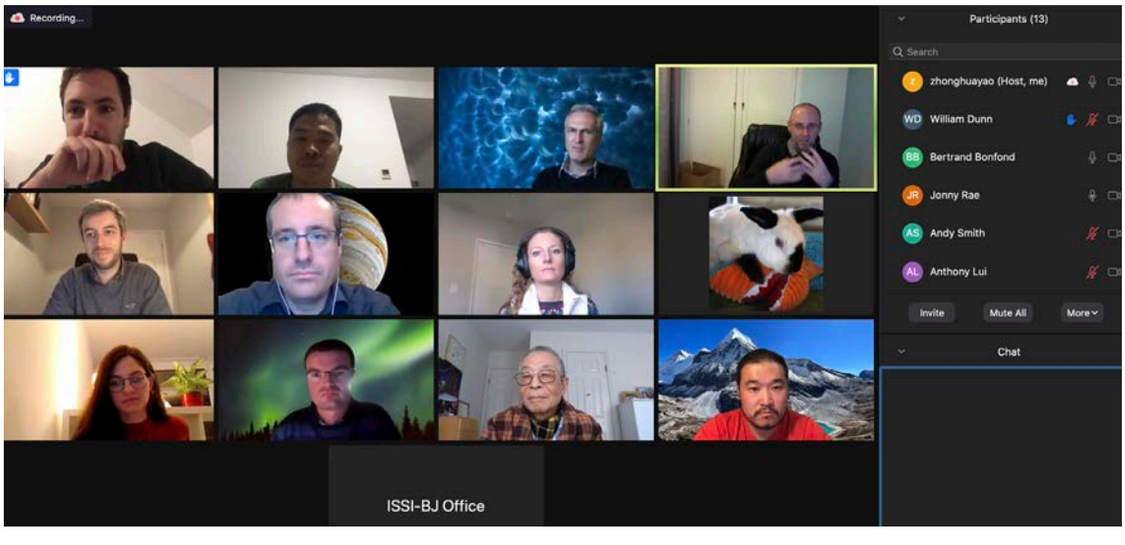


Interview with Olivier Witasse (ESA)

Dr. Olivier Witasse is a scientist working in the fields of planetary upper atmospheres. He obtained his Ph.D. at the University of Grenoble (France) in 2000. He joined the European Space Agency first as a research fellow and later as a staff member to work on the Huygens mission. After working on different projects (Venus Express, Chandrayaan-1, Mars Express, ExoMars Trace Gas Orbiter, ice giant mission concept), he is currently the Project Scientist of the Jupiter Icy Moons Explorer (JUICE) mission and head of the solar system section.

In December 2020, he gave an On Things to Come online seminar on the JUpiter ICy moons Explorer (JUICE) mission of the European Space Agency. JUICE is the first large mission in the ESA Cosmic Vision 2015-2025 program, and it is to be launched in June 2022 to reach Jupiter in October 2029. It will spend at least 3 years making detailed observations of Jupiter and three of its largest moons, Ganymede, Callisto, and Europa.

You were a guest speaker on the JUICE mission of ESA in the context of our 'On Things to Come' online seminar series, and your webinar had a very successful turnout. How did you enjoy introducing the mission to the audience, and why is it of particular relevance?

First, thank you very much for the invitation to give a talk. It is always a pleasure to promote and explain our projects to the scientific community and the public. I always enjoy presenting the JUICE mission as it is a fantastic project. JUICE is the kind of mission that will make great discoveries. It will make the scientists busy for a while! I think it's important to promote JUICE as much as possible, such that as many people as possible could work later on the data analysis, to contribute to the scientific harvest of the mission. It is also essential to inspire the young generation. In the end, they will work on the data for decades, and they will prepare the next missions to explore the solar system. The Q&A part was great; the audience asked excellent questions, I could feel the interest and the curiosity of the people.

As the Project Scientist of JUICE, how was your research routine shaped and challenged in these hard times? How did you cope with it?

This moment is hard for everybody. The project accumulated some delays because of COVID-19, unfortunately. However, everybody works very hard to keep pace and the schedule, I am very impressed by all my colleagues. From my perspective, I tried to focus on the big priorities in my work and to avoid bothering the colleagues with less urgent activities, while keeping in contact with them.

Do you have any recommendations to the scientific community for future international collaboration opportunities?

Space projects always work better when there is a fruitful international collaboration in the background. One of the greatest examples for me is the NASA/ESA/ASI Cassini-Huygens mission. It is always difficult to predict the future, but I could see a potentially excellent collaboration opportunity with China in the exploration of Jupiter. I dream of an international mission to one of the icy giant planets. Greater scientific exchanges should take place also between the communities

of atmospheric science and exoplanetary science. In this area, the boundary between planetary and astronomy missions is even thinner. The preparation of the first sample return from Mars and later the first human mission to the red planet will rely on solid international collaboration. I would love to see the launch of an interstellar probe built by several space agencies! There are so many things to do, I am very excited!

What are ISSI-BJ's strengths, in your opinion, and how would you like it to develop further?

ISSI-BJ offers a recognized and useful platform to allow scientific exchanges between different scientific communities. Keep up the splendid work! Maybe ISSI-BJ could develop more remote interactions, as this way of communicating will most likely be important in the future.

Interview with Wang Linghua (Peking University)

Prof. Wang Linghua obtained her Ph.D. in Physics from the University of California, Berkeley, and worked there as Postdoc and Assistant Research Physicist until 2012. She then moved to Peking University, where she's focused her research on planetary science and physics of high-energy particles in space. Given her outstanding research results, she was awarded with the The National Youth Qianren Scholar in 2012, The Peking University "Tanglixin" outstanding Scholar in 2014, and the China Youth Female Scientist Award in 2015.

In February 2021, she gave a online seminar on solar eruptions and geomagnetic storms in the context of the 1001 Space Nights of ISSI-BJ.

How did you first learn about ISSI-BJ and its program?

I regularly receive the ISSI-BJ newsletter, and I also keep an eye on the news published online on the ISSI-BJ website.

Your '1001 Space Nights' webinar on solar eruptions and geomagnetic storms reached thousands of viewers online. Why do you think it attracted such a wide audience and why is the topic of particular relevance?

Our students helped advertise the webinar at different schools, which really helped reach and attract a wide audience. At the same time, the topic is very relevant to the quality of everyone's life, thus it has the potential to reach beyond experts in the field.

How did your study routine change and how did you face the unexpected challenge of the pandemic?

I must say that my routine mostly remained unchanged, except that I need to organize or attend virtual meetings and online seminars instead of in-person lectures. However, the efficiency of online meetings cannot compare to what can be achieved during on-site activities, especially when it comes to Q&As. It is also not convenient to attend virtual events when they take place late at night or very early in the morning. We are trying to do our best to face these challenges.

In which direction is your research focus going, and could you tell us more about some of your most exciting research results and projects?

My research is focused on the acceleration and transport of solar and heliospheric energetic particles, as well as the development of space-borne energetic particle instruments. My most recent research accomplishments include three main achievements. First, we have discovered the existence of super halo electrons in the solar wind, extending the highest energy of the solar wind electron spectrum from 2 keV to 200 keV. We proposed that these super halo electrons could originate from the solar wind source region and/or coronal heating. Second, we found that impulsive solar energetic particle events (SEPs) are closely associated with narrow coronal mass ejections, not with solar flares. This suggests that impulsive SEPs could be due to narrow coronal mass ejections, a theory that differs from the previous ones about impulsive SEPs originating directly from solar flares. Third, we reported the evidence of solar energetic electrons and solar wind super halo electrons entering the terrestrial cusp, and we proposed that solar and solar wind energetic particles could contribute to the energetic particles in the magnetosphere.

How do you think ISSI-BJ is serving the scientific community and what additional opportunities would you like it to provide, especially to attract women students to space science disciplines?

ISSI-BJ represents an efficient platform to host different kinds of activities, such as workshops, working groups, international teams, etc., which considerably encourages and promotes collaboration between Chinese researchers and international space communities. The webinar series launched in the second half of 2020 are also very useful tools to bring together the space community in these difficult times. For what concerns the gender quota in the space science disciplines, I think it may be good to have some summer internship programs to offer financial support to female students—especially high school ones—to study and work with researchers and professors from different space science areas of focus.

Interview with Takehiko Satoh (JAXA)

Takehiko Satoh is a Professor at the Department of Solar System Sciences, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (ISAS/JAXA). He started his research career as a visiting scientist at the University of Hawaii in 1992, after receiving his Ph.D. from the Science University of Tokyo (SUT). Studies of Jupiter's infrared aurorae opened his way to NASA Goddard Space Flight Center (1993-1997), and then to the Frontier Research Center for Computational Sciences, SUT (1997-2001). He has been with Japan's Venus orbiter mission, Akatsuki, since 2001, serving as PI of the IR2 near-infrared camera. He came to the current position at ISAS/JAXA in 2006 and devoted most of his time to the Akatsuki mission. He has also been the Project Scientist of the mission since the summer of 2016.

In December 2020, he gave an On Things to Come online seminar on the Akatsuki mission (Venus Climate Orbiter) of the Japan Aerospace Exploration Agency. The "Venus Climate Orbiter" mission was approved in the spring of 2001, was later given the Japanese name "Akatsuki", meaning the dawn. Akatsuki is the first "planetary meteorology" mission on which primary target is Venus' super-rotating atmosphere.

We can't get tired of stressing how great and valuable the Akatsuki mission to Venus. Has the COVID-19 pandemic affected its scientific operation significantly? How?

We regularly carry out spacecraft tracking operations (several passes per a week) through which commands are sent to Akatsuki and telemetry data (both acquired Venus data and house-keeping data) are downlinked to the ground station. The COVID-19 pandemic significantly limited number of staff members who can attend (in person) these regular but essential operations. Currently, only science team members who live in proximity of the JAXA Sagamihara campus, i.e., being able to commute without using the public transportation, are assigned to serve as the supervisors of tracking operations. Despite such limitation, volume and quality of the data are maintained at the same level as were before the pandemic. Thanks to all ground staff members and the software team at NEC for making operations as efficient as possible.

How relevant is international scientific collaboration and how have cooperation opportunities changed in the past few years?

Before the launch (May 2010), collaboration with ESA's Venus Express (VEx) team had great influences to us. The VEx data helped our software team to develop/test our own data processing pipeline and numerous scientific findings from VEx encouraged us continuously. There have been several US researchers, closely collaborating with us, through NASA's Akatsuki Participating Scientist Program (PSP) since the launch. Their participation stimulated us in many aspects, not only science but instrument operations, data processing and archiving, through warm and friendly atmosphere. We probably could not achieve what we've done by today without such good relationships with VEx team and NASA PSP researchers. We want ourselves be a similar research group for the next generation Venus missions (some are in advanced stages of competition now). It should also be mentioned that the radio signals from Akatsuki are occasionally received at stations in India (IDSN) and in Germany (Weilheim) to increase the opportunities of radio occultation experiments. We are very grateful to the cooperation of ISRO and of DLR.

JAXA has done splendidly in solar system exploration. What are its future developments, and what other exciting missions are underway?

Solar system exploration is two-faced: one is literally "exploration" (manned or unmanned), and another is "space science". JAXA takes a part of the International Space Exploration Coordination Group (ISECG) to conduct the "exploration" program via international collaboration. For the latter, "space science", JAXA currently has SLIM (a lunar-landing demonstration mission), and MMX (Martian moon exploration mission) to come shortly. DESTINY+ is more engineering, which is going to demonstrate the capability of deep-space exploration with the electric propulsion system. Researchers in the solar physics area are developing Solar-C_EUVST, a successor of Solar-B (Hinode) solar telescope. As participation to ESA's JUICE (Jupiter icy moon exploration mission) signifies, the larger a mission is, the more international collaboration is needed.

4. How do you think is ISSI-BJ serving the scientific community and what additional opportunities would you like it to offer?

a. The currently-available menu of ISSI-BJ looks pretty much standard for an organization of the kind. This pandemic, ironically, enhanced the importance of "remote (online)" activities. Lectures/seminars are okay (if in convenient time zones) but activities in which in-person interactions are more essential, such as hands-on workshops, may be difficult at this moment and is so very likely for a while. Under such situation, distinguishing one organization (ISSI-BJ) from similar others would be more difficult. One possible idea would be an "online Q and A" system: (1) anybody who needs assistance in one's research can submit a question; (2) people at ISSI-BJ, including Disciplinary Scientists, pick up researchers who would be most appropriate to answer the Q; (3) the answer will then be forwarded to the one who asked. Being bridged by a recognized organization, such as

ISSI-BJ, chances of getting a good answer would be higher than the case one directly asks the researcher a question. I would think such a system could help early-career researchers who face difficulties of in-person interactions.

ISSI-BJ IN THE PRESS

In 2020, ISSI-BJ and its staff program have been the topic of some interviews carried out by Chinese as well as international media outlets. Below you can find the list with the links to the full interviews.

Interview with Prof. Wing-Huen Ip "Promoting Transdisciplinary and Transcultural Cooperation in Space Science in Face of COVID-19".

BCAS
Bulletin of the Chinese Academy of Sciences

Bulletin of the Chinese Academy of Sciences, October 13, 2020.

"Prof. Wing-Huen Ip, a world-renown scientist in cometary physics, planetary science, solar system evolution and exoplanets, took the post of the Executive Director of the International Space Science Institute – Beijing (ISSI-BJ) in June. As the only partner of the well-known International Space Science Institute (ISSI) in Bern outside Switzerland, ISSI-BJ has adopted the same tools as ISSI to facilitate international cooperation and academic exchanges: workshops, forums, and others that rely on in-person communications. At a time when the COVID-19 pandemic has forced the science community to move many activities online, how will he and his colleagues secure the progress of academic exchanges across disciplines and cultures? At the invitation of staff reporter SONG Jianlan, he shares his thoughts with the readership of BCAS.

BCAS: We are glad to know that you assumed the office of the Executive Director of the International Space Science Institute - Beijing (ISSI-BJ) in June. Congratulations! When taking up this post, you are also taking the enormous challenges posed by the fast-changing situation. We are eager to know what you will do during your office term to strengthen ISSI-BJ's role as a neutral and science-only platform in promoting space science research across disciplines and cultures? What will be the first thing(s) you do and the most important agenda set for your office term?

The most important thing is, of course, to take advantage of ISSI-BJ's neutrality and 'science-only' approach to produce a scientific program of the highest standard and value possible and to better benefit the international space science community. In this sense, two aspects should be considered. The first one depends on the successful participation of the most outstanding and forward-looking scientists in the discussion on novel scientific mission

concepts. Moon-based science laboratories and space observatories for the search of extraterrestrial life fall in this category. On the other hand, we should not lose sight of the most pressing problems of our time that space science and technology could help solve. In this regard, the first thing that comes to my mind is the challenge posed to human kind by climate change. Therefore, one of my goals is to strengthen the Earth observation research activities carried out at ISSI-BJ. As a result, the promotion of regional cooperation and the active participation of the Asian space community should be a must since the consequences of climate change will hit Asia hardest in the coming decades. This way, ISSI-BJ will hopefully be able to play a key role in helping space science research reach new heights across disciplines and cultures."

Read the full interview at:

http://www.bcas.cas.cn/cooperation/202010/t20201013_244739.html

Interviews with Prof. Alvaro Giménez and Prof. Maurizio Falanga.

Go Taikonauts! Issue #28 February 2020.

"The GoTaikonauts! Team took the opportunity to speak with Prof. Maurizio Falanga, Executive Director of ISSI-Beijing and Álvaro Giménez, Professor for Astrophysics at the Spanish National Council for Scientifi c Research (CSIC), to discover more about the current challenges and progress in the fi eld of space science. The interview took place during the informative event "Understanding Science Seminar" at the International Space Science Institute - Beijing on December 5, 2019.

Álvaro Giménez is Professor of Astrophysics at the Spanish National Council for Scientifi c Research (CSIC). He works since 17 years for the European Space Agency (ESA) where he served as the former Director of Science at the establishment in Noordwijk ESTEC. Currently he is the Science Policy Coordinator in the ESA Director General's Cabinet in Paris.

Professor Giménez, what is your motivation to give a talk in Beijing?

Giving a talk in Beijing is part of my commitment to connect space science with our society in general, and the opportunity off ered by ISSI-Beijing during one of my regular visits to China, could not be missed.

How was your talk perceived by the audience?

I think the audience got the main point of the current status of research in the fi eld of astrobiology, and was excited by the new challenges in the search for life beyond the Earth. The questions received after the talk clearly showed the connection with the big questions of science today. What is your impression of ISSI-Beijing? ISSI-Beijing is a great initiative for the promotion of international cooperation in space sciences for China. ISSI-Beijing keeps a high level of international standards, allowing upcoming scientists feel like at home, share data and projects.

You have been ESA's Director of Science and you are now Science Policy Coordinator in the Director General's Cabinet. How do you evaluate the

chances for closer European space science cooperation? We are aware of the cooperation for Double Star,1 for the Earth Observation Dragon Programme,2 for the Chang'e lunar missions[3] and currently for SMILE.[4] However, considering the size and scope of science in Europe and now also in China: Could there be more possible?

I have been personally involved in the developing of cooperation between Europe and China in space sciences, particularly in the SMILE mission which is currently under development. Nevertheless, future cooperation opportunities are possible and looked for. For instance, the European involvement in the Chinese-led Einstein Probe mission has been approved."

Read the full interview at:

http://www.issibj.ac.cn/Media/media_coverage/201909/W020200326526238677913.pdf

All about the Chinese Space Programme

GO TAIKONAUTS!

Spreading the Knowledge among Society about Space Science

An Interview with. Prof. Álvaro Giménez and Prof. Maurizio Falanga at the Science Seminar "Life in the Universe"

by Iana Grytsenko (Belt-and-Road Space Education)

Interview with Prof. Maurizio Falanga "The Mars Race "..appears to be a display of power" (in Portuguese).

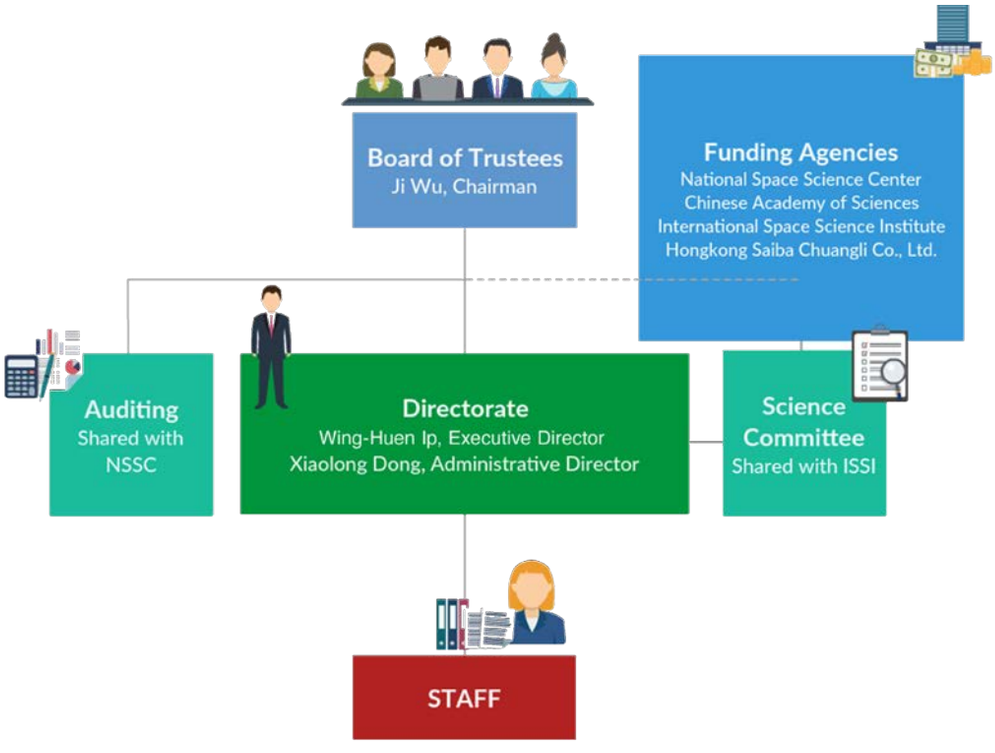
Jornal Tribuna de Macau, August 10, 2020.

Read the full interview at:

https://jtm.com.mo/actual/corrida-marte-parece-ser-uma-exibicao-de-poder/

Prof. Maurizio Falanga. Credit: Jornal Tribuna de Macau.

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 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.

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

Science Committee

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

Chaired by Louise Harra, the Science Committee advises and supports the Directorate in the establishment of the scientific agenda providing a proper equilibrium among the activities and reviews and grades the International Team proposals in response to the annual call.

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

BOARD OF TRUSTEES & STAFF

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- Qi Yu, APSCO, China
- Georges Meylan, ISSI, Bern, Switzerland
- Wing-Huen Ip, Executive Director, ISSI-BJ, China
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Xiaolong DONG,

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Xiaoyu LI,

Deputy Administrative Director

Lijuan EN,

Assistant to ED

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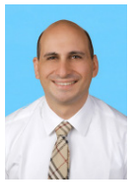
PR & Editorial Manager

Jie JIANG,

Discipline Scientist



Maurizio Falanga,

Discipline Scientist

Takehiko Satoh,

Discipline Scientist

Jiancheng SHI,

Discipline Scientist

Kuehrt Ekkehard,

Discipline Scientist

DISCIPLINE SCIENTISTS

Starting from March 2021, ISSI-BJ has appointed four Discipline Scientists to conduct their research in Solar Physics, Planetary Science, Astrophysics, and Earth Observations at and through ISSI-BJ.

Jiang Jie

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

Takehiko Satoh

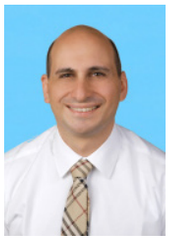
Takehiko Satoh is a professor at the Department of Solar System Sciences, Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA). After receiving his Ph.D. from the Science University of Tokyo in 1992, he started his study of Jupiter's infrared auroras, magnetospheric,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

Shi Jiancheng

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

remote sensing of water cycle-related components and data assimilation. Dr. Shi is a fellow of the Electromagnetics Academy and the Society of Photo-Optical Instrumentation Engineers (SPIE).

Maurizio Falanga



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

Ekkehard Kührt

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

SCIENCE COMMITTEE

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
- Peng-Fei Chen, Nanjing University, China
- Fréderic Courbin, EPFL, Observatoire de Sauverny, Versoix, Switzerland
- Xiaolong Dong, International Space Science Institute Beijing, Beijing, China (ex officio)
- Vladislav Izmodenov, IKI, Russian Academy of Sciences, Moscow, Russia (ex officio RAS)
- Catherine L. Johnson, University of British Columbia, Vancouver, Canada
- Karl-Ludwig Klein, Observatoire de Paris, LESIA, Meudon, France
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- Mark McCaughrean, ESTEC ESA, Noordwijk, The Netherlands (ex officio ESA)
- Michael Rast, ESA ESRIN, Frascati, Italy (ex officio ESA)
- Kanako Seki, University of Tokyo, Japan
- Giovanna Tinetti, UCL, Dept. Astrophysics & Astronomy, Didcot, United Kingdom
- Karina von Schuckmann, Mercator Océan, Ramonville Saint-Agne, France
- Endawoke Yizengaw, Aerospace Corporation, Los Angeles, CA, USA
- Linda Parker, STI, Huntsville, Alabama, USA (ex officio LPI/NASA)
- Céline Péroux, ESO (European Southern Observatory), Garching, Germany
- Emmanuelle J. Javaux, Université de Liège, Belgium
- Elena Amato, INAF, Osservatorio Astrofisico di Arcetri, Firenze, Italy
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Tohoku Forum for Creativity, Tohoky University

FINANCIAL OVERVIEW

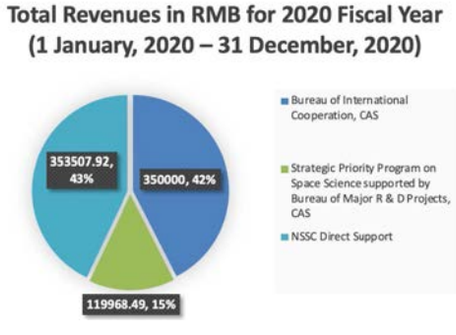
In the 2020 fiscal year, from January 1, 2020 to December 31, 2020, ISSI-BJ was operated with total revenue of 823,476.41 RMB and the total expenses were 394,319.01 RMB, besides the direct support of 353,507.92 RMB from the National Space Science Center (NSSC), moreover, the funding covered the deficit of 2019: 60,108.13 RMB; Thus, the surplus is 15,541.35 RMB.

The funding includes direct financial support of 350,000.00 RMB from the Bureau of International Cooperation of Chinese Academy of Sciences (CAS) as an international organization project for ISSI-BJ activities; project fund of 119,968.49 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 353,507.92 RMB from the National Space Science Center (NSSC) for expenses on-premises, facilities, a half salary of one staff member. The NSSC in-kind support, including the use of premises, financial management, IT support, and support for the administrative director, is not included in the statistics.

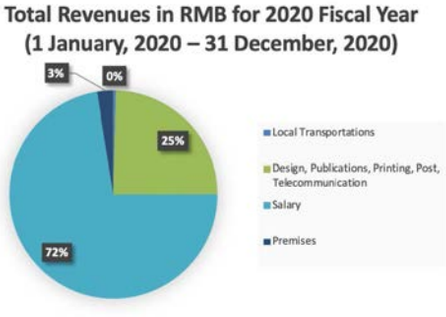
The expenses include expenses on the salary of 1.5 staff members; other daily operating and maintaining expenses. The expenses of premises use, administrative expenses, the salary of the administrative director for the ISSI-BJ activities, which are in-kind support from NSSC, are not included.

Total Revenues in RMB for 2020 Fiscal Year (January 1, 2020 – December 31, 2020)

Funding Sources	Amount
Bureau of International Cooperation, CAS	350,000.00
Strategic Priority Program on Space Science of the Bureau of Major R & D Projects, CAS	119,968.49
NSSC Direct Support	353,507.92
Total	823,476.41



Expenses	Amount
Local Transportation	1,681.38
Design, Publications, Printing, Post, Telecommunication	96,712.81
Salary	285,881.22
Premises	10,043.60
Total	394,319.01



[1] *Scientific activities expenses include one workshop, seven international team meetings, and seven forums;*

[2] *Salary includes the salaries for the Executive Director and the staff members (salary for administrative director is not included);*

[3] *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^2 ISSI-BJ facilities include one small meeting room (suitable for up to 12 participants) with a coffee break area, as well as a library with all ISSI-BJ and ISSI publications, and one big meeting room (suitable for up to 36 participants).

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

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

Furthermore, ISSI-BJ shares its conference facilities with the National Space Science Center of the Chinese Academy of Sciences. The facilities are composed of six seminar rooms (20-30 participants each), two lecture halls (up to 100 participants each), and one multimedia conference hall (30 participants).

All rooms are equipped with overhead projectors for large screen presentations and high speed wireless network connection.

Saturn Hall meeting room

Coffee break area

Small library

INTERNATIONAL SPACE SCIENCE INSTITUTE IN BERN

About ISSI

The International Space Science Institute (ISSI) was created by space pioneer Professor Johannes Geiss in 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 strictly scientific framework, controversial issues and to promote a science program related directly to the most pressing issues raised by space and Earth science missions.

Operations

Three statutory bodies interact regularly in matters of strategy, operation, finance, or public relations: The Board of Trustees, the ISSI Directorate, and the Science Committee. The latter gives also scientific advice to ISSI-BJ. The ISSI Directorate consists of Tilman Spohn (Executive Director), 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 15 members.

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

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

2020 Activities

The year 2020 is related to a period that has been unusual in many ways: Above all, it is with great sadness that the ISSI staff and community learned the passing away of Johannes Geiss, ISSI's founding father, first Executive Director, and Honorary Director. This is a momentous loss for the institute, which would not exist without his foresight and dedication.

In mid-March, 2020, Switzerland was ordered into a lockdown due to the Covid-19 pandemic, and all activity at ISSI came to a sudden stop. At first, ISSI postponed Workshops and International Team meetings by a few months, but it became clear that the situation would not improve so quickly. So ISSI developed a new, alternative scheme involving much online collaboration for Workshops and Forum.

In July 2020, ISSI started a weekly "Game Changers" webinar series on how missions change(d) our view of the solar system, the universe, and the Earth. All videos of the webinars are available on its webpage: www.issibern.ch/publications/game-changers-seminars/

International Teams

Up to the lockdown in mid-March 2020, 17 face-to-face Team meetings at ISSI took place, a larger number was postponed.

32 new International Teams, five of which are organized jointly with ISSI-Beijing, have been selected for implementation from the proposals received in response to the 2020 Call for International Teams.

Workshops

In 2020, ISSI organized the followings Workshops:

- Surface Bounded Exospheres and Interactions in the Solar System (January 20-24, 2020)
- Probing the Deep Earth Interior by using in synergy observations of the Earth's gravity and magnetic fields, and of the Earth's rotation (partially remote: September 1-4, 2020)

The other planned Workshops for 2020 were postponed or are using the alternative scheme, namely:

- The Heliosphere in the Local Interstellar Medium (alternative scheme)
- Strong Gravitational Lensing (alternative scheme)
- Venus: Evolution through Time (postponed to July 2021)
- Solar and Stellar Dynamos: A New Era (postponed to 2022)
- Magnetic Reconnection: Explosive Energy Conversion in Space Plasmas (postponed to 2022)

Forums

The planned Forum on "Ground and Space Astronomy: Opportunities and Challenges" was postponed to 2021.

Publications

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

- Volume 69: "Cosmic Dust from the Laboratory to the Stars" edited by R. Rodrigo, J. Blum et al., ISBN 978-94-024-2009-8, 2020.
- Volume 71: "Forest Properties and Carbon Sycle Studies form Earth Observations" edited by K. Scipal, A. Cazenave, T. Lopez, ISBN 978-3-030-32838-2, 2020.
- Volume 73: "Cometary Science – Insights from 67P/Churyumov-Gerasimenko" edited by N. Thomas, B. Davidsson et al., ISNB 978-94-024-2089-0, 2021.
- Volume 74: "Role of Sample Return in Addressing Major Questions in Planetary Sciences" edited by M. Anand, S. Russell et al., ISBN 978-94-024-2074-6, 2020.
- Volume 75: "Relationships Between Coastal Sea Level and Large Scale Ocean Circulation" edited by R.M. Ponte, B. Meyssignac et al., ISBN 978-3-030-45633-7, 2020.

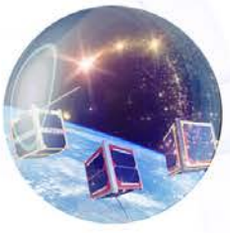
- Volume 77: “Ocean Worlds” edited by A. Coustenis, R. Rodrigo et al., ISBN 978-94-024-2069-2, 2020.

- Volume 83: “Star Formation” edited by A.M. Bykov, C. Charbonnel et al., ISBN 978-94-024-2061-6, 2020.

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

Group photo of the participants of the Workshop “Surface Bounded Exospheres and Interactions in the Solar System’ held at ISSI on January 20-24, 2020.

ISSI-BJ TOOLS



January Annual Call

INTERNATIONAL TEAMS

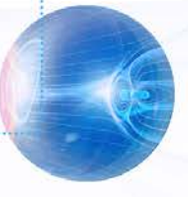
Spontaneous Application

WORKSHOPS

FORUMS

VISITING SCIENTISTS

WORKING GROUPS



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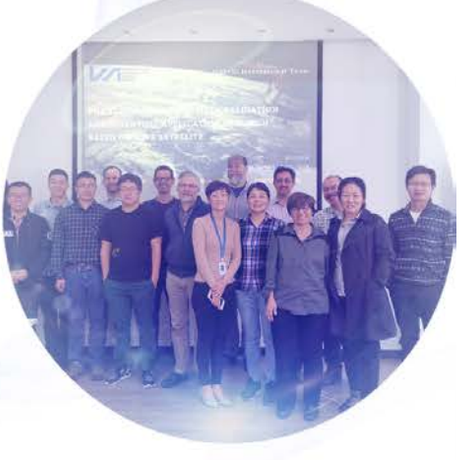

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