

ISSI-BJ WORKSHOP

Exploring the Jovian satellite system: from formation to habitability

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ISSI and ISSI-BJ Workshops always lead to a volume of the Space Science Series of ISSI (SSSI, Springer). The individual chapters are published as peer-reviewed papers in the Space Science Review Journal. See:

http://www.issibern.ch/aboutissi/tools.html http://www.issibern.ch/publications/sssi.html

1. Conveners (in alphabetic order):

Prof. Michel Blanc, IRAP, CNRS-CNES-Univ. Toulouse, France
Dr. Scott Bolton*, SwRI
Prof. Tomoki Kimura, Tokyo University
Dr. Valery Lainey, IMCCE, Observatoire de Paris, France
Prof. Lei Li, NSSC, CAS, China
Dr. Kathleen Mandt, JHU-APL, USA
Prof. Christophe Sotin, JPL, Caltech & LPG, Univ. Nantes, France
Prof. Daoyuan Sun, University of Science and Technology of China, China
Prof. Tim Van Hoolst, ROB, Belgium
*Representing the scientific leaders of current missions to the Jupiter system

2. Scientific relevance of the workshop and book:

The Jupiter system is the most massive secondary planetary 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 are 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 and its surroundings, one of which is operational (Juno), while others are in development (JUICE, Europa Clipper, and LUCY).

The science of the Jovian satellites, among which the four Galileans offer a diverse set of analogs to terrestrial planets, is as multi- and interdisciplinary as the study of our Earth-Moon system. To understand their uniqueness and diversity and unravel the mysteries of their origins, workings, mutual couplings and habitability, one must call in an extremely broad spectrum of geoscience and astrophysics disciplines: geology, cosmo- and geochemistry,



geophysics, space plasma physics, ocean and atmosphere sciences, astrobiology, astrometry, astrodynamics...

Juno arrival at Jupiter in 2016, 13 years after the end of the Galileo mission, provided a new perspective, addressing important Jupiter and satellite science questions. Now starting its extended mission, Juno offers the first close look at Jupiter's satellites and rings since Galileo and Voyager over 20 years ago, and just a decade before a the next wave of space missions (Lucy, JUICE, Europa Clipper) reaches the Jupiter system. Holding this workshop on the Jovian satellites in the 2021-2022 time frame will ideally serve the preparation of the analysis of the new harvest of observations these missions will return, and help establish the science rationale for new Jupiter system 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 new missions to the Jovian system are being considered (Europa Lander and Io Observer).

3. Workshop objectives:

- Review the current status of our understanding of the formation, evolution, workings, and habitability potential of the moons and small bodies (Galilean satellites, inner regular satellites, irregular satellites and Jovian Trojans).

- Review how current (Juno) and developing missions (JUICE, Europa Clipper and Lucy) will address these key questions and identify science objectives and goals for the next set of missions to further our understanding of the Jupiter system.

- Develop a plan for the next steps in exploring the Jovian system.

- Provide a high-level reference book for scientists currently researching the system or developing and planning future Jupiter system missions over the next two decades.

4. Objectives and readership of the book:

Objectives of the book: (a) Produce a comprehensive book on the Jovian satellite system as a whole; (b) review our current understanding of its formation, evolution and workings; (c) produce a tool to help scientists involved in the next wave of Jupiter missions prepare their observations and scientific analysis tools; (d) in addition, address a broader audience by presenting "hot topics" of Jovian satellites science of relevance to other scientific fields.

Readership: the book will be structured and written to address two main categories of readers: (a) planetary scientists from all fields preparing to take part in future space-based, Earth-based, modelling and theoretical studies of the Jovian satellites; (b) a broader community from geosciences, astrophysics and astrobiology interested to better understand the implications of discoveries and lessons learnt in the Jupiter system for their own field.

5. Tentative book chapters and pre-workshop & workshop sessions:

1- Introduction to the Jupiter system (WG 1)

(Michel Blanc, Scott Bolton, LI Lei)

General architecture Jupiter Moons and small bodies (small regular moons, Galilean moons, irregular satellites, Jupiter Trojans) Rings





Magnetosphere Open questions and critical measurements

2- Internal structure and dynamics of the Galilean satellites (WG 2)

(Christophe Sotin, Francis Nimmo)

Io

Icy moons (Europa, Ganymede, Callisto) *Open questions and critical measurements*

3- Geology and surface properties of the Galilean satellites (WG 3)

(Olga Prieto-Ballesteros, Min Ding, Federico Tosi)

Io

Icy moons (Europa, Ganymede, Callisto)

Open questions and critical measurements 4- <u>Tidal/gravitational interactions and orbital evolution in the Jupiter system (WG 4)</u> (<u>Tim Van Hoolst</u>, <u>Valery Lainey</u>) Moon-moon and moon-Jupiter tidal interactions Effects on secular orbital evolution Implications for habitability Interactions between inner regular moons, rings and dust

Open questions and critical measurements

5- Jupiter-Moon-magnetosphere electrodynamic interactions (WG 5)

(Tomoki Kimura, LI Lei)

Io and its torus as the source of the magnetospheric plasma

Transport processes in the torus and magnetodisk

Icy moons-magnetosphere interactions

Auroras at moons and footprint auroras at Jupiter

Moon's ionosphere and neutral atmosphere

Implications for habitability

Open questions and critical measurements

6- Origin and early evolution of the Jovian satellites (WG 6)

(Kathleen Mandt, Daoyuan Sun)

Review of formation scenarios

- Galilean moons
- Small inner satellites and rings
- Irregular satellites and Trojans

Open questions and critical measurements



7- From planned missions to open questions and new initiatives

(<u>LI Lei, Scott Bolton, Michel Blanc</u>, and scientific leaders of the different space missions to the Jupiter system)

a) Review of science returns expected from current and planned missions: Juno; Juno extended mission; Lucy; JUICE; Europa Clipper; Hisaki and LAPYUTA Key questions for new initiatives

b) Future missions

Jupiter origins (Callisto and irregular satellites); Io mission(s); Europa lander; Other...

8- Wrap-up, finalization of book plans

6. Objectives and format of pre-workshops:

- Pre-workshop on-line sessions lasts two hours and address one session/chapter;
- Each session team is autonomous for the organization of its session;
- Tasked to determine:
 - Main items and open questions for each chapter theme;
 - Potential speakers/co-authors for the workshop session
- Typical agenda:
 - Initial review of the chapter subject by one/two invited speakers;
 - Additional contributions
 - Final discussion on the corresponding workshop session/book chapter, invited contributors (speakers and co-authors)
 - Summary: first draft of the chapter + presentations at the workshop.
- Invitees for pre-workshops:
 - o (mandatory) invitees for each specific session
 - (optional) invitees for the other sessions
- Workshop invitees: all invitees of pre-workshop (at most 6 per pre-workshop) + special Chinese invitees (in relation to mission(s) of interest to Chinese community.
- 7. Tentative dates:

Kick-off meeting: July 19th

Session 1, Working Group 2: September 2nd

- Session 2: September 29th
- Session 3: October 13th
- Session 4: October 20th
- Session 5: October 27th
- Session 6: November 10th
- Session 7: November 24th

(Dates t.b.c. early September)

Wrap-up by conveners and final WS plans: December 8th





In-person workshop in Beijing:

March 21 to 25 (t.b.c.)

8. Support provided to participants by ISSI-Beijing:

The logistics of virtual meetings, like zoom virtual room, recording of session and archiving of presented documents and minutes, book chapter outlines etc. will be made available to preworkshop participants by ISSI-Beijing.

For the in-person workshop, tentatively planned for March 21-25, 2022, ISSI-Beijing will directly cover the hotel accommodation and provide a per diem. Travel costs to/from Beijing, however, are expected to be covered by participants except for a few duly justified cases.