Details of Scientific Program

The complete Scientific Assembly timetable indicating event dates and durations will be posted on the web in April 2020. In the meantime, please see the abstract submission website for updates and contact details of scientific event organizers, completed lists of scientific event organizing committees, etc.

MSO = Main Scientific Organizer DO = Deputy Organizer

A0.1 The Interface Between Spacecraft Instrument Technologies and the Science They Enable

MSO/DO(s): Ralph Kahn (NASA Goddard Space Flight Center, United States), Jérôme Benveniste (European Space Agency, Italy)

Organizing Committee: TBA

Event Information: One unique aspect of COSPAR, distinct from other large international geosciences meetings, is the emphasis on science and technology performed in space. For example, COSPAR affords opportunities for interdisciplinary sessions that link a geosciences focus with key, space-instrument-related engineering considerations. This event highlights current and/or future spacecraft technologies relevant to a range of instruments and applications, e.g., new geostationary and “small” satellites. We seek interdisciplinary presentations, simultaneously carrying both the sensibilities of engineering expertise and those relating to the science application. As such, we encourage pairs of presenters to develop and make joint presentations where possible, one with engineering expertise, broadly knowledgeable in the technology, and one with science expertise, broadly knowledgeable in the application and use of the resulting data. Critical to the success of this session is that the presentations not merely provide typical disciplinary science or engineering-oriented talks. Rather, they should offer a fresh look at the relationship between the engineering and the science of space-based geoscience observation.

A0.2 GEO

MSO/DO(s): David Halpern (), Yasuko Kasai (National Institute of Information and Communications Technology, Japan)

Organizing Committee: TBA

Event Information: The Group on Earth Observations (GEO) is building a Global Earth Observation System of Systems (GEOSS) to support three overarching themes: United Nations (UN) Sustainable Development Goals; UN Framework Convention on Climate Change Paris Agreement; and, UN Sendai Framework for Disaster Risk Reduction. The Symposium will highlight the science enabled by satellite observations of several major GEO program elements. GEO science leaders will describe current developments and future activities, and promote opportunities for COSPAR Associates to participate in GEO projects. All papers will be invited with oral presentations.

A0.3 Observing the Anthropocene from Space

MSO/DO(s): John P. Burrows FRS (Institute of Environmental Physics, University of Bremen, Germany), Christian Von Savigny
Organizing Committee: Pawan K. Bhartia (NASA GSFC, USA) Jame R. Drummond (Dalhousie University, Canada) Yasko Kasei (NICT / University of Tsukuba, Japan) Donal Murtagh (Chalmers tekniska högskola, Sweden) Nathaniel Livesey (Jet Propulsion Laboratory, USA) Russel R. Dickerson (University of Maryland, USA)

Event Information: Measurements of the earth from space have the unique ability to provide objective global and regional measurements of atmospheric constituents, ocean colour and the earth’s surface. As is well discussed by the scientific community and a cause for concern by the youth of the world, if not for key members of the political leadership of the developed world, the earth system is being modified by anthropogenic activity at an unprecedented rate. This is the result of the success of Homo sapiens in its development over the past 10000 years and in particular in the past two hundred years. From the Neolithic to the industrial revolutions, the earth’s population rose from several millions to 1 Billion powered by energy from a mixture of biofuels, water and solar power and some coal burning. Following the industrial revolution, which began in the UK in the late 18th century, and powered by the combustion of fossil fuels, a dramatic rise in both the human population and its standard of living has occurred. In 2020 more than 7.5 Billion, of which more than 50

A0.4 Land-Ocean-Atmosphere Interactions

MSO/DO(s): Severine Fournier (NASA Jet Propulsion Lab / California Institute of Technology, United States), Jérôme Benveniste (European Space Agency, Italy)

Organizing Committee: TBA

Event Information: The Earth system involves interactions of atmosphere, ocean, and land. These interactions affect energy, water, and carbon cycles, and thus the biosphere. Understanding the underlying processes of the interactions and quantifying the fluxes across different elements of the Earth’s system are of fundamental importance to human society. Satellite measurements allow us to observe different elements of the integrated Earth system, greatly increasing the capabilities to conduct interdisciplinary research. Sustaining and enhancing space-based integrated observing system for the Earth system is essential for the development of Earth System model, analysis, and prediction systems, which has important implications for the ability to project future climate change. This session encourages contributions that emphasize the linkages of the atmosphere, ocean, and/or land based on satellite observations or in conjunction with models. The objectives are to foster interdisciplinary collaborations and to advocate for the need to sustain and enhance remote sensing capabilities to observe the integrated Earth system.

A0.5 CubeSats for Scientific and Civil-use Studies of the Earth

MSO/DO(s): Anthony Freeman (Jet Propulsion Laboratory, California Institute of Technology, United States), Jason Hyon (Jet Propulsion Laboratory, United States)

Organizing Committee: Iver Cairns (Univ. of Sydney, Australia)
Event Information: A key factor for the rapid adoption and development of CubeSats is the existence of a standard form factor. The associated standards for linear dimensions, volume, mass, and power, mass have enabled new and existing technologies to focus on miniaturizing instruments and hardware systems into specific form factors. With the development of miniaturized instruments capable of making science-grade measurements, CubeSats and other small satellites are expected to play important roles in making key observations for science, public good, and industry objectives, often in conjunction with other remote sensing instruments. Multiple challenges exist, including sensor and payload development (e.g., better spatial, spectral, and/or time resolution in desired spectral bands, instrument calibration, coordinate registration, satellite capability, deployable structures, thermal management, power supply, and data rates). CubeSat developers, embracing this disruptive technology, have shown remarkable ingenuity in addressing these challenges. Meanwhile, associated Earth observation instruments and data are used widely for science, public good, and industry services. This Event is for presentations on the sensors and technology for Earth observations from CubeSats as well as for presentations on the actual or intended use for such data, whether for science, government, or industry. Possible systems include hyperspectral and other imagers, microwave spectrometers, IR sounders, radars, altimeters, polarimeters, GPS and Global Navigation Satellite Systems (GNSS) instruments, receivers for other Signals of Opportunity, gravity field measurements, and in situ plasma and field detectors, while the application areas range from the ionosphere and atmosphere to coastal, land, and marine surfaces to below these and from science to technology, government, and industry.
A1.1 Space-based and Sub-orbital Observations of Atmospheric Physics and Chemistry

MSO/DO(s): Christian Von Savigny (Ernst-Moritz-Arndt-Universitaet Greifswald, Germany), Yasuko Kasai (National Institute of Information and Communications Technology, Japan)

Organizing Committee: John Burrows (Institute of Environmental Physics, University of Bremen, Germany) James Drummond (Department of Physics and Atmospheric Science, Dalhousie University, Canada) Ralph Kahn (NASA Goddard Space Flight Center, U.S.A.) Jean-Christopher Lambert (Belgian Institute of Space Aeronomy, Brussels, Belgium) Jean-Pierre Pommereau (LATMOS, France) Makoto Suzuki (JAXA, Japan) Kaley Walker (Department of Physics, University of Toronto, Canada)

Event Information: Space-based remote sensing observations of the Earth’s atmosphere have become an indispensable tool for monitoring the state of the atmosphere as well as improving the scientific understanding of physical-chemical processes in the Earth system. Many satellite data products have reached a state of maturity that qualifies them to be used as essential climate variable (ECV) data sets. One of the main aims of COSPAR session A1.1 is to provide a forum for interaction between space-based and sub-orbital remote sensing communities working in related science areas of atmospheric chemistry and physics, in order to facilitate interaction across the sub-discipline boundaries. Contributions to the following areas are welcome: New missions and techniques, validation, technical and spacecraft engineering issues, greenhouse gases, tropospheric pollution, tropospheric and stratospheric aerosols, the UT/LS region, dynamics and chemistry of the stratosphere and mesosphere. Contributions on small satellites and geostationary satellites are particularly encouraged.

A2.1 Science and applications enabled by oceanographic satellite measurements

MSO/DO(s): Tong Lee (JPL, United States), David Antoine (Curtin University, Australia)

Organizing Committee: Naoto Ebuchi (Hokkaido University, Japan) Andrey Kostianoy (P.P. Shirshov Institute of Oceanology, Russia)

Event Information: The aim of this session is to foster scientific and operational utility of oceanographic satellite measurements from the past and current missions to study variability of the ocean and its relationships with changes in other elements of the Earth system, including atmosphere, cryosphere, and land. We invite contributions to all aspects of satellite oceanography (both physical and biological) associated with the use of satellite observations and derived estimates of various oceanographic parameters, including sea surface temperature, salinity, and height, ocean surface wind and current, ocean color, ocean mass, and sea ice. Potential topics include scientific analysis of these data and their assimilation into models. Synergistic use of satellite measurements of different oceanic parameters is particularly encouraged. Contributions to advance the science of planned missions in the future and the development of future mission concepts are also welcome.
A3.1 Advances in Quantitative Remote Sensing and Application for Global Terrestrial Ecosystems

MSO/DO(s): Kanako Muramatsu (), Jadumandan Dash (University of Southampton, United Kingdom)

Organizing Committee: TBA

Event Information: Earth Observation plays a central role in developing the global capability to understand planet Earth, predict changes, and mitigate negative effects of global change on its population. The Symposium will highlight the essential importance of space for monitoring Earth as a whole and understanding the impact of human activity on our planet. We invite contributions to following topics: vegetation and the terrestrial carbon cycle, biosphere studies, land use, land use changes, sustainable cities, terrestrial water cycle, water management, water use, water quality, natural disasters and their impacts, advances in solid earth science from satellite and airborne geodesy, data assimilation, synergistic use of remote sensing techniques of land, inland water and ecosystem process, and future mission concepts.

B0.1 Unifying planetary system formation out of elementary building blocks: from dust, gas and ice to our Solar System and exoplanets

MSO/DO(s): Maria Drozdovskaya (University of Bern, Switzerland), Diego Turrini ()

Organizing Committee: Michael Ireland, ANU, Australia; Stavro Ivanovski, INAF-IAPS, Italy; Niels Ligterink, CSH, Switzerland; Gianfranco Vidali, Syracuse, U.S.A.; Eric Herbst, UVA, U.S.A.; Martin Rubin, UniBe, Switzerland; Trevor Ireland, ANU, Australia; Raphael Marschall, ISSI, Switzerland; Sho Sasaki, Osaka, Japan; Sean Andrews, CfA, U.S.A.

Event Information: The assembly of planetary systems can no longer be considered a process of mature circumstellar disks. Strings of evidence are pushing planet formation processes into the earliest phases of star formation. These findings subsequently require previously separate communities to come together and to exchange expertise. This proposed event is a unique interdisciplinary platform for putting together the full evolutionary sequence of our Solar System and of systems analogous to ours. The event is to include experts on the Solar System, its small and large bodies; exoplanets; protoplanetary disks; embedded and prestellar phases of star formation. The session considers theoretical, observational and experimental perspectives on this topic and covers studies of gas, ice, dust and larger bodies. This science is stimulated by the increasing amount of in-situ measurements from past missions such as Cassini and Rosetta, present missions like New Horizons, and upcoming missions such as JUICE and Europa Clipper. Simultaneously, the field is being revolutionized with interferometric observations from powerful facilities such as ALMA, exoplanet demographics from transits and radial velocities (e.g., TESS, ESPRESSO) and with experimental studies in state-of-the-art laboratories simulating the various space environments. This event has the sponsorship of representatives from commissions B1, E4 and F3. It is to be organized in a coordinated fashion in order to avoid overlaps and to focus our efforts towards understanding the greater scientific impact of the results from space missions within the
framework of COSPAR.

**B0.2 Human and Robotic Exploration of Moon, Mars, and Asteroids**

**MSO/DO(s):** Bernard H. Foing (ESA/ESTEC, Netherlands), Christiane Heinicke (ZARM, University of Bremen, Germany)

Organizing Committee: Guenther Reitz (DLR, Germany), Tadashi Mukai (Kobe Univ., Japan), Henk Rogers (Blue Planet/Intl MoonBase Alliance), TaiSik Lee (Korea Engineering Society), Greg Schmidt (SSERVI NASA), J.F. Clervoy (NOVESPACE), L. Zelenyi (IKI), J. Blamont (CNES), Armin wedler (DLR), Ian Crawford (UK), Carle Pieters (Brown U).

**Event Information:** Thenbsp;COSPAR-20-B0.2/PEX session quot;Human Exploration on the Moon, Mars and NEOsquot;:, co-sponsored by Commissions B, F will include solicited and contributed talks and poster/interactive presentations. It will also be part of the 15th International Conference on Exploration and Utilisation of the Moonnbsp;from the ILEWG ICEUM series started in 1994. It will address various themes and COSPAR communities: Sciences (of, on, from) the Moon enabled by humans; Research from cislunar and libration points; From robotic villages to international lunar bases; Research from Mars amp; NEOs outposts; Humans to Phobos/Deimos, Mars and NEOs; Challenges and preparatory technologies, field research operations; Human and robotic partnerships and precursor missions; Resource utilisation, life support and sustainable exploration; Stakeholders for human exploration. One half-day session will be dedicated to a workshop format and meetings/reports of task groups: Science, Technology, Agencies, Robotic village, Human bases, Moon amp; Mars Villages, Society amp; Commerce, Outreach, Young Explorers. COSPAR has provided through Commissions, Panels and Working Groups (such as ILEWG, IMEWG) an international forum for supporting and promoting the robotic and human exploration of the Moon, Mars and NEOSnbsp;Subsessions;Sciences (of, on, from) the Moon, Mars amp; NEOs enabled by HumansTechnologies, field research operations; Human and robotic partnerships; Resource utilisation, life supportStakeholders for sustainable Moon-Mars/Neos Villages: reports from task groups: Science, Technology, Agencies, Robotic village, Human bases, Habitats design, Society amp; Commerce, Outreach, Young Explorers

**B0.3 Lunar, Mars, and Asteroid Resources**

**MSO/DO(s):** Ian Crawford (Birkbeck College, University of London, United Kingdom), James Carpenter (European Space Agency (HE Space Operations), Netherlands)

Organizing Committee: Mahesh Anand (Open University, UK), Ben Bussey (NASA, USA), Andrew Dempster (UNSW, Australia), Martin Elvis (Harvard Smithsonian Center for Astrophysics), Amara Graps (PSI/University of Latvia/Baltics in Space, USA/Latvia), Wenzhe Fa (Peking University, China), Jessica Flahaut (CNRS, France), Junichi Haruyama (JAXA, Japan), Clive Neal (University of Notre Dame, USA), Heather Smith (NASA, USA)

**Event Information:** There is growing interest in the possibility that the resource base of the Solar System might in future be
used to facilitate space exploration activities, enable the development of a space economy, and perhaps also supplement the economic resources of our own planet. This event will address the extent to which lunar, asteroid, and martian resources may contribute to these objectives. Papers are invited on all aspects of the science and engineering of space resource utilisation, and especially on the development of synergies between techniques developed to access resources on different Solar System objects.

B0.4 Technologies for Planetary Research

MSO/DO(s): Patricia M. Beauchamp (Jet Propulsion Laboratory, California Institute of Technology, United States), Bernard H. Foing (ESA/ESTEC, Netherlands)

Organizing Committee: TBA

Event Information: To accomplish the goals of Planetary research in the next decade more complex missions, instruments and space vehicles are being envisioned. In addition, the advent of disruptive technologies such as Autonomy and CubeSats/SmallSats brings new opportunities to achieve scientific discoveries previously considered out of reach. This session explores diverse technologies that can enable new instruments and missions that survive and operate in extreme environments from the moon to the inner and outer reaches of the solar system, enable swarms of spacecraft to collect scientific data throughout our solar system, drill through ice, determine if life is present on planetary bodies, increase data rates from distant bodies and much more.

B0.5 Planetary Cubesats and Small Sats

MSO/DO(s): Pierre W. Bousquet (Centre National d’Etudes Spatiales, France), John Baker (JPL, United States)

Organizing Committee: TBA

Event Information: This session will present planetary science and space mission concepts using SmallSats (lt;100 kg). Recent miniaturization advances in science instruments and spacecraft technologies make it possible for SmallSats, including CubeSats, to be considered for use in planetary exploration. This has been illustrated since the Cospar 2018 Conference by the relay of Insight’s entry and descent; by the MarCO cubesats, and by the enhancement of the Hayabusa 2 mission with various small probes and rovers. Various auxiliary. Mission concepts may either be an augmentation to larger missions or as stand-alone missions of their own. We will review possible mission architectures and associated technologies, discuss measurements that can be performed for Planetary science and future mission opportunities.

B0.6 Planetary Instruments

MSO/DO(s): Justin Maki (Jet Propulsion Laboratory, California Institute of Technology, United States), Oleg Korabev (Space Research Institute (IKI), Russia)

Organizing Committee: Jim Bell (Arizona State University, USA)

Event Information: The Planetary Instruments session solicits contributions related
to past, current, and future instruments on planetary missions. The session will discuss instruments on all mission types, including flyby, orbiter, touch-and-go, landed, and roving surface missions. Of particular interest are papers by instrument Principal Investigators and/or designees on missions with recent launch dates as well as those currently in active development. All planetary instrument types are solicited, including remote sensing instruments such as imagers, spectrometers, radars, as well as in situ instruments such as seismometers, magnetometers, mass spectrometers, and meteorological packages. Papers describing the history and current state of particular classes of instruments are also of interest. The intent of the session is to bring together active practitioners for open discussion of the current state of the field, including challenges, lessons learned, calibration, in-flight usage, performance, and future directions.

B0.7 Planetary Exploration, Horizon 2061: Report to COSPAR and Discussion

MSO/DO(s): Michel Blanc (IRAP/University of Toulouse-France/CNRS, France), Oleg Korablev (Space Research Institute (IKI), Russia)

Organizing Committee: TBA

Event Information: "Planetary Exploration, Horizon 2061" is a long-term foresight exercise led by scientists, engineers and technology experts whose objective is to draw a long-term picture of the four pillars of planetary exploration: (1) our major scientific questions on planetary systems; (2) the different types of space missions that we need to fly; (3) the key technologies we need to master; (4) the ground-based and space-based infrastructures and services needed. Its principal motivations are to inspire international collaborations to better meet technology and mission challenges and increase the overall science return of planetary exploration, and to share with the communities and leaders its major scientific questions and technological challenges. This COSPAR event devoted to "Planetary Exploration, Horizon 2061" will present its tentative conclusions to the participants to the COSPAR General Assembly, invite additional contributions, and stimulate future long-term forward-look activities related to the sciences and technologies of Planetary Exploration.

B1.1 Small Body Exploration Science in the New Decade

MSO/DO(s): Hajime Yano (Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Japan), Ernesto Palomba (INAF - IAPS Rome, Italy)

Organizing Committee: TBA

Event Information: At the time of the 2020 Sydney assembly, Hayabusa2 and OSIRIS-Rex, two carbonaceous asteroid sample return missions will complete their vicinity observations and samplings and move on their ways back to the Earth. Space telescopes such as HERSCHEL, NEOWISE, and Gaia continue producing observational results to advance our understanding of the Solar System formation and evolution, while completed missions like Rosetta and Dawn will deepen their discoveries to next levels. A fleet of new missions such as Psyche, Destiny+, Lucy, MMX, CAESAR and OKEANOS are under the development to explore a M-type
asteroid, an active asteroid, Jupiter Trojans, Martian satellites, a cometary nucleus and more. Interplanetary cubesats will also explore NEOs and beyond while explorations to Trans-Neptunian Objects, irregular satellites of gas giants and interstellar asteroids are also under the study. This session also hosts multidisciplinary researches with telescopic observations, meteoritic analyses, laboratory experiments, computational and theoretical studies to support and advance these space missions. In particular, research on small bodies as gravitational aggregates is a rapidly growing subject. This session serves as a one-stop forum to cover recent results and future prospects of all spectra of small body exploration sciences as well as instrumentations, technologies and mission designs that enable these sciences.

B1.2 Asteroids, Friends Or Foe: Planetary Defense and Resources

MSO/DO(s): Patrick Michel (Université Côte d’Azur, Observatoire de la Côte d’Azur, CNRS, France), Andrew F. Cheng ()

Organizing Committee: TBA

Event Information: The session will address the asteroids both as a natural hazard to human life, ecosystems, and global environment, and as resources that may support human expansion beyond Earth. For impact risk assessment and mitigation, and no less for resource exploitation, physical characterization of these bodies is needed, including asteroid physical properties, internal structure, surface morphology, small body dynamics, and spin states. The AIDA collaboration that includes the NASA DART and ESA Hera missions to the binary asteroid Didymos will perform the first asteroid trajectory deflection experiment and will address all these topics. The assessment of Earth impact effects, kinetic impact effects, and planetary defense scenario development using high-performance computer simulations are important activities that also require characterization data. Simulation models inform mission designers of the suitability and effectiveness of techniques for asteroid mitigation and for resource exploration. Laboratory experiments also contribute critical information. Presentations on advances in all these area are welcome.

B1.3 Results from the Exploration of the Kuiper Belt by NASA’s New Horizons Mission

MSO/DO(s): Alan Stern (Southwest Research Institute, United States), Dale Cruikshank (NASA Ames Research Center, United States)

Organizing Committee: Marc Buie (Southwest Research Institute, USA), Cynthia Conrad (Southwest Research Institute, USA), Catherine Olkin (Southwest Research Institute, USA), Joel Wm Parker (Southwest Research Institute, USA), Kelsi Singer (Southwest Research Institute, USA), Joel Wm Parker (Southwest Research Institute, USA), John Spencer (Southwest Research Institute, USA), Anne Verbiscer (University of Virginia, USA), Harold Weaver (Johns Hopkins Applied Physics Laboratory, USA).

Event Information: This session will summarize the results obtained from the exploration of KBO 2014 MU69 (Ultima Thule) by New Horizons. Emphasis will be made on the shape, other bulk parameters, color, composition, and geology of MU69, including its cratering record, with the objective of understanding the formation of cold classical
KBOs. The session will also examine the loss of primordial volatiles from MU69 and its space weathering evolution, and the exploration of KBOs that New Horizons observed in the distance to assess satellite populations, phase curves, rotational lightcurves, and shapes.

B2.1 Reference Frames

Event Information: See PSD.1

B3.1 Lunar Science and Exploration

MSO/DO(s): Carle Pieters (Brown University, United States), Bernard H. Foing (ESA/ESTEC, Netherlands)

Organizing Committee: Guenther Reitz (DLR, Germany), Tadashi Mukai (Kobe Univ., Japan), Henk Rogers (Blue Planet/Intl MoonBase Alliance), TaiSik Lee (Korea Engineering Society), Greg Schmidt (SSERVI NASA), L. Zelenyi (IKI), J. Blamont (CNES), Armin wedler (DLR), Ian Crawford (UK), Carle Pieters (Brown U),

Event Information: Lunar science and exploration are having a renaissance with as many as twelve missions (and 18 vehicles) sent to Moon during the last “International Lunar decade”; as well as surface landers ChangE-3-4 operating on near and farside, ample return missions and upcoming landers from multiple countries and commercial endeavours; as a start of a robotic lunar village; This session is aimed at discussing new progress in lunar science from recent missions, latest science results, newer insight into our understanding of Moon, modelling and synthesis of different scientific data, future missions, and science questions. It will include invited, contributed, and poster papers. Papers on new lunar mission concepts, instrumentation for the future missions, the upcoming lunar decade of landers and lunar robotic village, and preparations for human lunar exploration are also welcome in this session. COSPAR-20-B3.1 will also part of the 15th International Conference on Exploration and Utilisation of the Moon from the ILEWG ICEUM series started in 1994.

Sub-sessions: Results from Recent Lunar Missions
Upcoming missions extending the lunar robotic village
Concepts, studies, technology and support research towards future lunar exploration
Exploration interactive workshop

B3.2 Science Enabled by a Lunar Outpost

MSO/DO(s): Ian Crawford (Birkbeck College, University of London, United Kingdom), Bernard H. Foing (ESA/ESTEC, Netherlands)

Organizing Committee: Ben Bussey (NASA, USA), James Carpenter (ESA-ESTEC, The Netherlands), Jean-Pierre de Vera (DLR, Germany), Wenzhe Fa (Peking University, China), Heino Falcke (Radboud University, The Netherlands), Tom Hei (Columbia University, USA), Christiane Heinicke (ZARM, Germany), Katherine Joy (University of Manchester, UK), Clive Neal (University of Notre Dame, USA), Makiko Ohtake (JAXA, Japan), Carol Stoker (NASA, USA), Pietro Ubertini (INAF, Italy), Christiane Heinicke (ZARM Bremen)

Event Information: A human-robotic outpost on the Moon would offer significant
scientific opportunities by providing a scientific infrastructure on the lunar surface. An analogy is provided by human outposts in Antarctica, which facilitate research activities across multiple scientific disciplines in a hostile environment. This event will explore the multiple scientific areas expected to benefit from a lunar outpost, including planetary science, astronomy, astrobiology, life sciences, and fundamental physics. In addition, a lunar outpost will help develop the use of lunar resources, which may yield additional longer-term scientific benefits. Papers are invited which address any of these aspects of science enabled by a lunar outpost. Papers are also welcome from affiliates of other relevant COSPAR Scientific Commissions, for example SC-E (Astrophysics), SC-F (Life Sciences) and SC-H (Fundamental Physics).

B4.1 Mars Science Results

MSO/DO(s): Leslie Tamppari (JPL, United States), Oleg Korablev (Space Research Institute (IKI), Russia)

Organizing Committee: Ashwin Vasavada (JPL, USA) Serina Dirigea (JPL, USA)

Event Information: Mars has been extensively studied using spacecraft data, theoretical modeling, laboratory studies, and comparative planetology over the last several decades. As of the conference, there are expected to be six operating orbiters (ODY, MEx, MRO, MAVEN, MOM, and TGO), one operating rover (Curiosity), and one operating lander (InSight), and two more rovers on the way. These spacecraft are exploring Mars’s atmosphere, surface, and subsurface to understand the planet’s history and habitability. This session will address new science resulting from these missions, as well as studies reliant on theory, modeling, laboratory studies, and comparative planetology.

B4.2 Forward Planning for the Robotic Exploration of Mars

MSO/DO(s): David Beaty (Jet Propulsion Laboratory, California Institute of Technology, United States), Jorge Vago (European Space Agency, Netherlands)

Organizing Committee: TBA

Event Information: Mars continues to be a compelling planetary exploration target in spite of, or perhaps even because of, the large number of prior and ongoing missions. The findings of each mission are typically met with an equal or greater number of questions raised to be answered by future missions. This session focuses on forward planning for the robotic exploration of Mars including 1) future hypothesis-driven or discovery-driven science instruments or missions and 2) The robotic precursors that may help us prepare for future human missions. Topics of interest include the primary scientific drivers that require future missions to Mars, recent developments in our engineering and technological capabilities related to missions to Mars, an updated understanding of current mission concepts, and candidate instrumentation for future missions. The session will consist of a mixture of solicited and contributed presentations. The program will be developed with a special regard to achieve international representation.

B4.3 Mars Sample Return
Event Information: NASA and ESA have embarked on a highly collaborative endeavor to return samples from Mars. A fundamental premise of this partnership is that scientists working around the world would share access to the samples such that the scientific benefits and discoveries are maximized. Progress in this international endeavor will be presented, including the nature of the samples expected to be cached at Jezero Crater and the planned mission architecture for returning the samples from Mars. In addition, there has been a series of workshops organized by the Mars Sample Return Science Planning Group to formulate and propose mechanisms through which the international scientific community can achieve our shared scientific objectives with the returned samples. The challenges of ensuring the best international science is accomplished, while adhering to planetary protection requirements will be discussed. Contributions to this sessions are sought to reflect international interest in sample return and its potential scientific benefits.

B4.4 Venus Science and Exploration

MSO/DO(s): Colin Wilson (University of Oxford, United Kingdom), James A. Cutts

Organizing Committee: Masato Nakamura (ISAS/JAXA, Japan)

Event Information: This session welcomes presentations on all aspects of the Venus system including interior, surface, atmosphere and ionosphere. We welcome presentations based on current and past observations, including those from the Akatsuki and Venus Express orbiter, as well as from ground-based observations. Modelling and theoretical work, and supporting ground-based studies are also welcomed, as are presentations related to future instruments and investigations. COSPAR offers a particular opportunity for the discussion of international collaboration in space exploration; accordingly, the session seeks to include future exploration plans from all international agencies considering Venus missions, including NASA, ESA, Roscosmos, ISRO, CNSA, and JAXA.

B4.5 Mercury Science and Exploration

MSO/DO(s): Gabriele Cremonese (INAF - Padova Astronomical Observatory, Italy), Johannes Benkhoff (ESA/ESTEC, Netherlands)

Organizing Committee: Maria Teresa Capria (INAF, Italy), Daniel Heyner (University Braunschweig, Germany), Go Murakami (ISAS, Japan)

Event Information: The ESA-JAXA mission BepiColombo has been successfully launched on 20 October 2018 from Kourou and it started the long trip up to Mercury. The two modules MPO and MMO will start the nominal mission in the spring 2026. In this session, we aim to invite contribution on the Mercury science, from the internal structure to the new surface features discovered from MESSENGER, up to the planet environment. It will also include the science expected and the observing strategy during the flyby
of Venus. New projects on Mercury research will be welcome, in hopes of stimulating new collaborations. The instruments on board passed successfully the commissioning and they are confirming their performances. This session will allow to describe the BepiColombo mission, and its status, and the performances of the new instruments on travelling toward the planet.

B5.1 Juno at Jupiter

MSO/DO(s): Scott Bolton (Southwest Research Institute, United States), Steve Levin

Organizing Committee: Jack Connerney (SRC, USA) Steve Levin (JPL, USA) Heidi Becker (JPL, USA) Michel Blanc (OMP, France) Alberto Adriani (INAF, Italy)

Event Information: Juno arrived into orbit around Jupiter on July 4, 2016, and is a bit more than halfway through its prime mission. Juno is revolutionizing our knowledge of the nature, origin, formation and evolution of Jupiter; through study of the solar system’s largest planet, our understanding of general planetary formation processes is changing as well. Juno unique polar orbit enables a complete mapping of the planet from very close range due to the extremely close perijove distance of only 5000 km. The Juno science objectives include the investigation of Jupiter’s origin, interior structure and magnetic field, the deep atmospheric dynamics and composition and the exploration of Jupiter’s polar magnetosphere and aurora. Results from the nine scientific instruments that make up Juno’s payload will be presented along with theoretical implications applicable to planetary science, solar system origin and the formation of exoplanetary systems. An extensive campaign of Earth based observations of Jupiter and the solar wind were orchestrated to complement Juno measurements during Juno’s approach to Jupiter and during its orbital mission around Jupiter. This session provides results from the Juno measurements and the collaborative campaign during Juno’s prime mission. This session also welcomes results from the Earth-supporting observations and from comparative planetology studies with other giants in the solar system.

B5.2 Gas Giant Planet Systems

B5.3 Ocean Worlds

MSO/DO(s): Alexander Hayes (Cornell University, United States), Robert Pappalardo

Organizing Committee: Kevin Hand (JPL, USA), Morgan Cable (JPL, USA), Elizabeth Turtle (JHU/APL, USA), Ellen Stofan (Smithsonian Institute, USA) Michel Blanc (IRAP, France). Athena Coustenis (CNRS, France), Jun Kimura (Osaka University, Japan), Olga Preito-Ballasteros (INTA, Spain), Paolo Tortora (University of Bologna, Italy), Giuseppe Mitri (University de Nantes, France)

Event Information: Solar system exploration stands on a precipice, offering the opportunity to search for signs of life in one or more of the ocean worlds of the Outer Solar System in the coming decades. This event welcomes papers describing one or more of the confirmed or potential ocean worlds that harbor subsurface oceans of liquid water and/or, for Saturn’s moon Titan, surface reservoirs of liquid hydrocarbon and solid organics. These bodies represent targets for
future standalone and cooperative missions led by the major space agencies in the quest to understand the potential for life in the solar system. Submissions that describe new observations of ocean properties, stimulate/describe future observations, or review our current state of knowledge are encouraged. We also welcome laboratory investigations and future mission plans that could extend our understanding of the habitability of the outer solar system. Presentations will include a mix of solicited and contributed papers.

**B5.4 Ice Giant Systems**

MSO/DO(s): Leigh Fletcher (University of Leicester, United Kingdom), Amy Simon (NASA/GSFC, United States)

Organizing Committee: Olivier Mousis (Laboratoire d’Astrophysique de Marseille, France), Mark Hofstadter (Jet Propulsion Laboratory, USA), Adam Masters (Imperial College, UK), Yasumasa Kasaba (Tohoku University, Japan), Tristan Guillot (Observatoire de Nice, France), Imke de Pater (University of California, Berkeley, USA), Glenn Orton (Jet Propulsion Laboratory, USA), Michele Bannister (Queens University Belfast, UK)

**Event Information:** The Ice Giants Uranus and Neptune are among the least explored worlds in our Solar System, and yet they represent of a planetary class that may be commonplace. The properties of their interiors are poorly known, but may hold clues to the formation of our planetary system. Their atmospheres represent two extremes: Uranus being forced by extremes of solar heating due to its axial tilt, and Neptune’s climate being driven by a powerful source of internal energy. Their tilted and asymmetric magnetospheres provide an interaction between the solar wind and the magnetic field that is not found elsewhere. Their satellites range from the natural, primordial icy moons of Uranus; to massive Triton, a captured Kuiper Belt Object with a potential subsurface ocean and active geology. We welcome presentations spanning these themes, as well as those on future mission architectures and enabling technologies to make missions to these tantalising destinations a reality.

**B6.1 Exoplanet Detection and Characterisation: Current Research, Future Opportunities and the Search for Life Outside the Solar System**

MSO/DO(s): L.B.F.M. Waters (SRON Netherlands Institute for Space Research, Netherlands), Francesca Altieri (INAF - IAPS Rome, Italy), Michael Ireland (Australian National University, Australia)

Organizing Committee: TBA

**Event Information:** Exoplanet searches using ground- and space-based facilities have revealed a remarkable variety in observed properties of exoplanets and the planetary systems they are part of. It is clear by now that planetary systems are commonly found in low- and intermediate mass stars. In order to understand the observed diversity in planetary systems we begin to link their architecture to the properties of planet forming disks around young stars, and to trace the present-day properties of exoplanets (mass, radius, chemical composition, atmosphere) to their formation history and evolution to mature planetary systems. Such studies are important to understand which planets in which planetary systems have prop-
erties that would support the emergence of life as we know it. The CHEOPS, TESS, JWST, ARIEL and PLATO missions, and ground-based facilities such as the 30-m class telescopes and long baseline interferometers, open a new era in the exoplanet studies and will revolutionize our picture of exoplanets, their atmospheres, and their habitability. Accurate mass and radii determinations will constrain the composition and interior structure of rocky exoplanets. Spectra of increasing quality and resolution enable us to investigate exoplanet rotation, atmospheric chemical composition, the presence of clouds and day to night side differences of large samples of exoplanets, and to study important biomarkers. These more detailed observations require more sophisticated modelling efforts, including understanding potential abiotic origins of biomarkers and evolutionary models of processes such as atmospheric escape. In view of the outcomes from the next exoplanet investigations, this COSPAR event aims to put together the broad community interested in the field to review major results, discuss models and present new projects.

C0.1 International Standards on Space Environment from ISO

MSO/DO(s): Vladimir Kalegaev (Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Russia), W Kent Tobiska (Space Environment Technologies, United States)

Organizing Committee: TBA

Event Information: Starting from 1994 Working Group 4 (WG4 – Space Environment, Natural and Artificial), of ISO / Technical Committee 20 / Subcommittee 14 (Space systems and operations) develops the international standards and other normative documents related to space environment factors. WG4 experts has been involved in the number of projects related to physical phenomena in space during the recent years. During 25 years, WG4 published about of 20 international standards in the field of space radiation, magnetospheric magnetic field, space materials interaction with space environment, etc. These standards address users to scientific models, which enable to estimate the space environment conditions. Their predictions are strongly needed during the design and development of space systems and their operations. This session supplies an important opportunity to foster the contacts between engineering community, main users of the standards, and scientific community, developing the models of space environment. The main topics are: solar and geomagnetic activity, energetic particles and fields under quiet and disturbed conditions, space debris, lunar and planet’s environment. The topics also include definition of test conditions, procedure of risk analysis and operational guidelines based on the space environment information and research. Contributions on developments of international standards, the user requirements and the on-going research activities that can be transferred to user-oriented engineering tools are welcomed.

C0.2 Advances in Remote Sensing of the Middle and Upper Atmosphere and Ionosphere from the Ground and from Space, including Sounding Rockets and Multi-Instrument Studies

MSO/DO(s): David Rees (The Paradigm Factor, United Kingdom), Mamoru Yamamoto (Research Institute for Sustainable
Event Information: Advances in Remote Sensing of the Middle and Upper Atmosphere and Ionosphere from the Ground and from Space, including Sounding Rockets and Multi-Instrument Studies. This event will provide a forum for the presentation and discussion of novel instruments for exploring the middle and upper atmospheres and ionospheres of the Earth and planets by remote sensing techniques deployed from space platforms. The meeting will include a special session on two space missions of the European Space Agency. Aeolus — now measuring global winds by means of a Lidar System — was launched in August 2019. EarthCARE — which will make very detailed studies of clouds and aerosols relating to climate is expected to be launched in 2021. The meeting will consist of Solicited and Contributed papers and a Poster session related to the topics of the Meeting.

C0.3 Variabilities of Radio Wave Propagation Characteristics in Lower Ionosphere

Organizing Committee: Sandip Kumar Chakrabarti (Indian Centre for Space Physics, India), Katsumi Hattori (Chiba University, Japan), Mashashi Hawakawa (University of Electro Communication, Japan), Jean Pierre Raulin (Centro de Rádio Astronomia e Astrofísica Mackenzie – CRAAM, Brazil), Eugene Rozanov (Physikalisch-Meteorologisches Observatorium, Switzerland), Pao Wang (Academia Sinica, Taiwan) (More names will be added)

Event Information: Ionospheric disturbances from terrestrial and extra-terrestrial sources leave impressions on the natural and manmade sources of radio signals during its propagation through the earth-ionosphere waveguide. The signals get modulated due to the variabilities of the ionospheric characteristics. This session focusses on the methods of both ground and space-based studies of such ionospheric variabilities from observation and theoretical viewpoint. In this session, we invite participants who have specialized in the following aspects: (a) Disturbances due to solar flares and solar winds. (b) Disturbances due to X-rays and Gamma ray events in space (Terrestrial Gamma-Ray Flashes, Gamma-Ray Bursts, Soft Gamma-Ray Repeaters, etc.) and their interpretations. (c) Disturbances due to solar eclipse (current, historical). (d) Numerical modeling of ionospheric response due to various sources. (e) Magnetospheric and Ionospheric coupling processes. (f) Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) mechanism using thermal, acoustic and electromagnetic channel (observations and simulations). (g) Polar ionospheric characteristics and their interpretations. (h) Chemical physics of low ionosphere (D-layer). (i) Low ionosphere as quantum resonance medium for radio-signal propagation. (j) Comparison of ground and space-based responses of ionospheric perturbations. (k) Instrumentations, campaigns, networking etc. Lead representatives from various countries are most welcome.
Organizing Committee: Michael Pezzopane (INGV, Italy), Venkatesh Kavutarapu (NARL, India)

**Event Information:** Papers are invited for a session on the recent advances in the field of equatorial, low- and mid-latitude mesosphere, thermosphere and ionosphere from observational (ground-based and space-borne), theoretical and simulation studies. Contributions related to all aspects in these areas are welcome. Topics include: MLT region; response of the thermosphere-ionosphere system to forcing from above and below; coupling between high-, mid- and low latitude regions; magnetosphere-ionosphere coupling; Ionospheric response to SSW; ionosphere F-layer stratification; data-assimilation and tomography; space weather events; latitudinal and/or longitudinal variability; ionospheric irregularities and scintillations. The session will include both solicited and contributed (oral and poster) papers.

C1.2 The Coupled Solar Wind-Magnetosphere-Ionosphere-Thermosphere System and the Impact of Solar and Geomagnetic Storms on Geospace

Organizing Committee: Anita Aikio (University of Oulu, Finland) Mats André (Swedish Institute of Space Physics, Sweden) Brett Carter (RMIT University, Australia) Masha Kuznetsova (NASA Goddard Space Flight Center, USA) William Liu (National Space Science Center, China) Yoshizumi Miyoshi (Nagoya University, Japan) Claudia Stolle (GFZ Potsdam, Germany)

**Event Information:** The transfer of energy from the solar wind and magnetosphere to the ionosphere and thermosphere occurs primarily but not exclusively at high and mid latitudes. Solar and geomagnetic storms are primary drivers for high-latitude geospace during disturbed conditions. However, the entire geospace gets affected in one way or another through both coupled and coincident processes. At high latitudes following the passage of coronal mass ejections (CMEs), solar wind high-speed streams (HSSs), and other events, the impact is often seen in the form of disturbed electric fields, currents, electron densities, ion and electron temperatures, brightening aurora displays, increase in small-scale plasma-density irregularities, and energetic particle precipitation. At mid and low latitudes under storm conditions the impact is seen in the form of ring current intensification, stable auroral red arcs, storm-enhanced electron densities, sub-auroral polarization streams, sub-auroral electric fields and their penetration to equatorial latitudes, F3 layer strengthening, disturbance neutral winds and dynamo electric fields, plasma bubbles, and change in total electron contents. Many of these “space weather” processes are coupled through magnetospheric drivers, and they affect communications, navigation, orbiting satellites, ground power grids, etc. Satellites and ground based facilities provide a powerful set of synergistic tools for observational studies of these processes over a wide range of spatial and temporal scales. We invite contributions of both observations and modeling results on
these processes and the impact of solar and geomagnetic storms on geospace. This event will be of particular interest to the planned PSW events, particularly PSW.5, and will include joint sessions with PSW.5.

### C1.3 Conditions for Enhanced Risk in Ionospheric Weather

**MSO/DO(s):** Feza Arikan (HACETTEPE UNIVERSITY, Turkey), Tamara Gulyaeva (Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation of the Russian Academy of Sciences (IZMIRAN), Russia)

**Organizing Committee:** TBA

**Event Information:** Ionosphere and plasmasphere present very complicated, time and space varying, inhomogeneous, temporally and spatially dispersive environment. The ionosphere varies under the influence of solar, interplanetary, geomagnetic, gravitational, atmospheric and seismic activities. Since the beginning of 20th century, scientists have tried to infer information about this ever changing and challenging structure. With the development of earth and space based sophisticated measurement devices such as sounders and satellites, scientists and engineers have started to observe the complicated nature of the surrounding system. The risks due to space weather may originate from solar and interplanetary environment in the form of the geomagnetic storms, or they may originate due to variability in earth's crust in the form of earthquakes, volcanoes or tsunamis. The goal of the proposed session is to bring geophysicists, geodesists, electrical and electronics engineers, ionospheric and atmospheric physicists, meteorologists, environmental engineers, seismologists, and space weather observers under one special roof so that a platform might be generated to share information and observation to determine regions of enhanced risk for the ionospheric weather.

### C1.4 CSES and Swarm Data Analysis of the Ionosphere Dynamics at Different Temporal and Spatial Scales

**MSO/DO(s):** Piero Diego (IAPS/INAF, Italy), Mirko Piersanti (IAPS/INAF, Italy)

**Organizing Committee:** Picozza Piergiorgio, INFN - University of Rome “Tor Vergata”, Rome, Italy. Shen Xuhui, China Earthquake Administration · Lab. for Earthquake Observation from Space, IES, Beijing, China. Ubertini Pietro, INAF-IAPS, Rome, Italy. Consolini Giuseppe, INAF-IAPS, Rome, Italy. Conti Livio, Università UniNettuno, Rome, Italy. Waters Colin, School of Mathematical and Physical Sciences, Centre for Space Physics, Faculty of Science, University of Newcastle, Newcastle, Australia.

**Event Information:** Observations provided by Chinese Seismo-Electromagnetic Satellite (CSES) and Swarm satellites are of uncommon variety and quality, and can play a key role for both Space Weather analysis (Geomagnetic activity, Magnetosphere-Ionosphere coupling) and Magnetosphere-Ionosphere-Lithosphere (MIL) coupling processes. CSES satellite can provide a large set of measurements: plasma parameters, geomagnetic field, ionospheric electric field and particles precipitation fluxes. Swarm satellites provide very accurate magnetic field and plasma parameters (electron density and temperature) and velocity drift (vxB) measurements. The coupling
between observations from those two satellites (measured in a Sun-synchronous orbit for CSES and at preceding LT for Swarm), gives an exceptional spatial coverage for unprecedented ionosphere dynamic investigations for different temporal and spatial scales. In addition, such amount of data can allow the testing of innovative data analysis tools for non-linear time-frequency analysis.

C2.1 The Physics and Dynamics of the Middle Atmosphere from Mid to High Latitudes

MSO/DO(s): Gerd Baumgarten (Leibniz-Institute of Atmospheric Physics (IAP), Germany), Michael Gerding (Leibniz-Institute of Atmospheric Physics (IAP), Germany)

Organizing Committee: TBA

Event Information: Physical and chemical processes in the Mesosphere and Lower Thermosphere (MLT) lead to the occurrence of layered phenomena like noctilucent clouds (NLC) / polar mesospheric clouds (PMC), Polar Mesosphere Summer Echoes (PMSE), Polar Mesosphere Winter Echoes (PMWE), meteoric metal layers, dust and ion layers, airglow and mesospheric inversion layers. These layers are frequently used as tracers for dynamical processes in the MLT. Furthermore, they give insight into coupling processes from below and above on scales from seconds to decades. This includes but is not limited to gravity wave generation, propagation and dissipation in the middle atmosphere. The session gives an forum for questions like middle atmosphere energy amp; momentum budget, waves, instabilities, coupling, trends, solar cycle variations as well as distribution of aerosols and other minor constituents in the middle atmosphere. Current and future satellite missions (e.g. MATS), rocket or balloon projects as well as ground based instruments or instrument clusters (e.g. ARISE2) have currently or will in future adress the layered phenomena in unprecedented detail. Also modeling the microphysics, dynamics and atmospheric coupling processes affecting the MLT has improved significantly. The purpose of the session is to discuss the physics, dynamics and chemistry of the MLT through papers describing observations, laboratory studies and modeling.

C2.2 Wave Coupling Processes and Consequences in the Whole Atmosphere and Ionosphere

MSO/DO(s): Erdal Yiğit (George Mason University, Space Weather Lab, United States), Christopher Heale (Embry-Riddle Aeronautical University, United States)

Organizing Committee: TBA

Event Information: This symposium focuses on troposphere to thermosphere-ionosphere multi-scale wave coupling. New measurements, computational modeling and theoretical results, and analysis techniques are encouraged, including electrodynamical and chemical studies. In particular, studies in the following areas are most welcome: Global structure, variability, sources of gravity waves, planetary waves, Kelvin waves, and tides. Ion-neutral coupling Ionosphere-thermosphere-mesosphere response to lower and middle atmosphere variability. Wave generation (primary amp; secondary) and propagation effects in the neutral and ionized atmosphere.
C2.3 Advances in External Forcing Studies for the Middle Atmosphere and Lower Ionosphere

MSO/DO(s): Yvan Orsolini (Norwegian Institute for Air Research (NILU), Norway), Alessandro Damiani (Chiba University, Japan)

Organizing Committee: Dan Marsh (NCAR, USA), Bernd Funke (Instituto de Astrofísica de Andalucía, Spain), Katya Georgieva (Bulgarian Academy of Science, Bulgaria)

Event Information: The event has a focus on new results concerning the middle atmosphere and lower ionosphere response to a variety of external forcings such as (but not restricted to) energetic particle precipitation (EPP) and solar UV variability during the solar cycle. Results comparing the solar forcing importance relative to other external forcings arising from natural variability (such as volcanic forcing) or to anthropogenic forcing are also welcome. Contributions related to the inter-comparison of coupled climate model responses to solar forcings are also invited. This event is particularly relevant for the international SPARC initiative SOLARIS-HEPPA investigating the solar influence on the middle atmosphere and climate (http://solarisheppa.geomar.de/), for the SCOSTEP VarSITI program (2014-2018) (Variability of the Sun and its Terrestrial Impact: http://www.varsiti.org/) and for SCOSTEP’s new upcoming scientific program “Predictability of the Solar-Terrestrial Coupling” (PRESTO). Of special interests are the long and deep minima of 23rd solar cycle, the treatment of EPP in chemistry-climate models, and the climate system response to solar forcing and other natural variability forcings. Analyses of ground-based or satellite observations and of
model simulations are welcome.

C2.4 Small Satellite Missions for Aeronomy and Ionosphere Studies

MSO/DO(s): Amal Chandran (Nanyang Technological University, Singapore, Rep. Of Singapore), Loren Chang (National Central University, Academy of Sciences Located in Taipei, China)

Organizing Committee: TBA

Event Information: This session will focus on current, near-term approved and conceptual small/micro and nano-satellite missions to observe the Earth’s upper atmosphere, ionosphere and for monitoring space weather. The cubesat approach to low earth orbit Space missions combined with recent advances in cubesat technologies offer innovative cost-effective solutions for addressing fundamental scientific questions in these fields. Other focus areas include advances in scientific instrumentation for cubesat platforms, the use of distributed platforms for instruments, nano-satellite constellations, using small satellite technologies for space capacity building and innovative ride sharing opportunities for access to space.

C3.1 Planetary Atmospheres

MSO/DO(s): Dmitrij Titov (ESA/ESTEC, Netherlands), Larry W. Esposito (University of Colorado, United States)

Organizing Committee: TBA

Event Information: This COSPAR symposium addresses the physics of the atmospheres of terrestrial and outer planets. The symposium will be open for presentation of results of space missions, ground-based observations, numerical modeling and theoretical studies. The symposium will consist of invited and contributed talks and posters.

C3.2 Planetary Upper Atmospheres, Ionospheres and Magnetospheres

MSO/DO(s): Syed A. Haider (Physical Research Laboratory, Ahmedabad, India), Frederick Menk (University of Newcastle, Australia, Australia)

Organizing Committee: Andy Nagy (University of Michigan, USA), Stephen Bougher (University of Michigan, USA), Anil Bhardwaj (Physical Research Laboratory, India)

Event Information: This session covers the study of planetary atmospheres, ionospheres, magnetospheres and exospheres of inner and outer planets with special emphasis on observations, modelling and theoretical interpretations on recent and ongoing missions on Mercury, Mars, Venus (Messenger, ExoMars, Mars Express, Venus Express, Mars Odyssey, MRO, MAVEN and Indian Mars mission etc.) and Cassini missions as well as results from most recent Juno data. The comparative measurements of planetary upper atmospheres and ionospheres, their physical and chemical processes and numerical methods to interpret these datasets are especially encouraged. Papers highlighting a comparison of Cassini at Saturn and Juno at Jupiter results are also welcome. Both solicited talks and contributed presentations are welcome in this symposium which encompasses all solar system bodies.
C3.3 Imaging the Planets in X-rays

MSO/DO(s): Michael Collier (Goddard Space Flight Center, United States), C. Philippe Escoubet (ESA-ESTEC/RSSD, Netherlands)

Organizing Committee: 1. David Sibeck, NASA/GSFC, United States 2. Chi Wang, NSSC/CSA, China 3. Yoshizumi Miyoshi, Nagoya University, Japan

Event Information: All space science disciplines, heliophysics, planetary, and astrophysics, have an interest in understanding the complex nature of solar and stellar winds interacting with obstacles. Within recent decades, observations, modeling, and theory have shown that these interactions can be imaged in X-rays. Within our solar system, Earth, Earth’s moon, comets, Mars, Venus, Jupiter, and Pluto are known to emit X-rays resulting from their interactions with the solar wind. Furthermore, the solar wind itself emits soft X-rays when it interacts with interstellar neutrals entering the heliosphere to create a background emission for solar system objects. Similarly, stellar winds interacting with exoplanets emit soft X-rays outside our heliosphere. All these emissions are superimposed upon and must be separated from the cosmic soft X-ray background, which is itself of great interest to astrophysicists. We encourage all session submissions addressing or related to solar and/or stellar winds generating X-ray emissions. Possible topics include, but are not limited to, observations, modeling, theory, instrument concepts, and missions in both formulation and implementation, particularly the ESA/CAS SMILE mission.
C4.1 Improving the Description of Hemispheric Differences in Ionospheric Models

MSO/DO(s): David Altadill (Observatori de l’Ebre, Universitat Ramon Llull, Spain), Dieter Bilitza (George Mason University, Fairfax, Virginia and NASA, GSFC, United States)

Organizing Committee: Vladimir Truhlik (ASCR Institute of Atmospheric Physics, Czech Republic) Shigeto Watanabe (Hokkaido University — Hokudai, Japan) Bodo Reinisch (University of Massachusetts Lowell, USA) Ivan Galkin (University of Massachusetts Lowell, USA) Andrzej Krankowski (University of Warmia and Mazury in Olsztyn, Poland) Phil Richards (George Mason University, USA)

Event Information: The session is organized by the COSPAR/URSI IRI Working Group. Hemispheric differences have been observed for many ionospheric parameters including, the seasonal variation of electron and ion densities and temperatures. For example, the well-known Winter Anomaly exhibits a much stronger amplitude in the Northern hemisphere while the semianual anomaly is stronger in the Southern hemisphere, and the Northern hemisphere counterpart to the Weddell Sea anomaly in the Southern Hemisphere is much weaker. We invite presentations that investigate how well models describe the structure of these hemispheric differences with special emphasis on the IRI model, which is the ISO standard for the ionosphere. Because empirical models may have an inherent bias due to differences in data coverage, it is important to verify that models like IRI correctly represent hemispheric asymmetries well. Talks covering all aspects of the IRI modeling effort including model improvements, comparisons with new data, IRI extensions, and IRI applications are encouraged. Presentations that investigate the causes of hemispheric asymmetries are particularly welcome.

C4.2 Development of Models Related to the COSPAR International Reference Atmosphere and to ISO Standards for the Atmosphere

MSO/DO(s): David Rees (The Paradigm Factor, United Kingdom), W Kent Tobiska (Space Environment Technologies, United States)

Organizing Committee: TBA

Event Information: Development of Models Related to the COSPAR International Reference Atmosphere and to ISO Standards for the Atmosphere. This event will consider the further development of atmospheric models related to the COSPAR International Reference Atmosphere (CIRA). The issue of systematic changes of the thermosphere during the "Space Era" has been a topic of considerable interest that will also be discussed. The exploitation of well-known and highly-developed atmospheric models in the formulation of international standards of the atmosphere will also be presented and discussed. The meeting will consist of a set of solicited papers, supported by poster presentations.

C4.3 Venus International Reference Atmosphere, VIRA Update

MSO/DO(s): Ludmila Zasova (Space Research Institute (IKI), Russian Academy of
Organizing Committee: TBA

Event Information: Session is devoted to development of the COSPAR Venus International Reference Atmosphere model, VIRA. Published in 1985, it is used by many scientists and engineers in their studies, preparing future space missions and for analytical and numerical (global circulation models) studies as referent standard of atmospheric data. The first VIRA was based on Mariner, Venera and Pioneer Venus missions. Partial update on the middle atmosphere, VIRA II, was published in 2006, it includes also VEGA, Venera, Galileo and Magellan missions. As a results of Venus Express (2006–2015) a lot of new unique data were obtained, which allow to improve VIRA, in parts of as structure, composition, chemistry of the atmosphere, clouds, dynamics, radiative balance, solar wind interaction etc. The other sources of data is Akatsuki JAXA successfully working on orbit around Venus and also ground based observations. The event will consist of a set of solicited papers, contributed papers and poster presentations.

C5.1 Active Space Experiments

MSO/DO(s): Björn Gustavsson (University of Tromsø, Norway), Haiyang Fu (Fudan University, China)


Event Information: Geospace can be considered as a plasma lab. Active space experiments play an important role in the exploration of natural phenomena. Active probing of natural geospace phenomena may include the injection of particle and electromagnetic beams into geospace from ground and space. Contributions are solicited focusing on ground- and satellite-based active experiments, observations, theoretical, and numerical modeling techniques. Topics covered in these sessions may include but are not limited to: (1) Ground-based and in-situ observations of ELF/ VLF phenomena and their applications for diagnostics of space plasmas, (2) Linear and nonlinear properties of wave generation and propagation, (3) Ionospheric interactions by high-power HF heating facilities and associated processes, including ionospheric turbulence, artificial irregularities, airglow, stimulated electromagnetic emissions, artificial aurorae, artificial ionization layers, etc., (4) Ionospheric and magnetospheric studies using injections of particle and wave beams from spacecraft, and ground- based active radar facilities and nbsp;from natural sources, and (5) Other laboratory and active experiments pertaining to space plasma.

C5.2 Dust Detection and Observation in Space and Laboratory Experiments

MSO/DO(s): Jiri Pavlu (Charles University, Czech Republic), Sanjay Limaye (University of Wisconsin - Madison, United States)
Event Information: The session covers dust-plasma interactions and dust detection in space, including the investigation of naturally occurring phenomena in the Solar System (and beyond) and relevant laboratory investigations. This session is interdisciplinary by nature and its goal is to provide an overview of recent advances in the understanding of dust-involved processes in the interstellar medium, planetary environments, near the surfaces of airless bodies, or in the upper atmospheres of bodies with atmospheres. Dust can be studied also experimentally in simulated space-like environments, e.g., under microgravity conditions, in laboratory facilities that are capable of simulating relevant processes (as a strong coupling, dust charging, or dust impacts). The session is open to presentations concerning ongoing and future space missions on related topics. Sharing findings and ideas across various dust-plasma experiments regardless of the magnitude of gravity)(D) "Space Instruments and laboratory experiments"; (i.e., dust detectors, antenna observations, dust accelerator studies, charging of dust, light scattering on dust, destruction and growth of dust...)

D0.1 Overview Talks

MSO/DO(s): Klaus Scherer (Ruhr-Universität Bochum, Germany)

Event Information: In this session the recent developments and highlights of solar magnetospheric and heliospheric science are presented and summarized. The session consist of invited talks exclusively, one for each of the subcommissions (the heliosphere, transition from the Sun to the heliosphere, and magnetospheres), followed by a survey of the entire commission. The session will be scheduled on a single half-day with no other commission D sessions in parallel. Please submit an abstract to this session only when invited by the MSO or one of the DOs.

D1.1 Acceleration and Transport of Energetic Particles in the Heliosphere and Beyond

MSO/DO(s): Stefan Ferreira (North-West University, South Africa), Agnieszka Gil-Świderska (Siedlce University, Poland)

Organizing Committee: TBA
**Event Information:** The heliosphere and surrounding local interstellar medium is filled with several populations of energetic particles such as Galactic cosmic rays, anomalous cosmic rays, accelerated pickup ions and suprathermal solar wind particles. They interact with plasma and magnetic fields with embedded turbulence, leading to particle drift, diffusion, and acceleration. These processes are fundamental to energetic particle production and intensity modulation by solar activities. In some cases, energetic particles can play an important dynamic role in the formation of heliospheric structure. Various space-borne or ground-based observations of particle intensity, spectrum and anisotropy contain valuable information about the mechanisms of particle acceleration and transport through the heliosphere. This session is designed to bring together observers and theoreticians studying acceleration, transport, and emission from energetic particles in order to discuss the progress and challenges in understanding the underlying physics of particle acceleration and transport at in the heliosphere and local interstellar medium.

**D1.2 Large-Scale Heliospheric Structure: Theory, Modelling, and Data**

MSO/DO(s): Jens Kleimann (Ruhr-Universität Bochum, Germany), John Richardson (MIT, United States)

Organizing Committee: TBA

**Event Information:** The heliosphere is the circumsolar structure which is formed by the non-linear interaction of the solar wind and the interstellar medium (ISM) through which the Sun moves. Its properties are modulated by magnetic field influences, particle-based interactions, and hydromagnetic instabilities of the interface, the interface, to name but a few. Recently, data from new observational channels, notably remote satellite instruments such as IBEX (measuring energetic neutral atoms) and Earth-based detectors such as IceCube and the Tibet air shower array, have shifted the focus of modelling efforts from the upwind direction – for which the two Voyager spacecraft continue to provide valuable in-situ data – to include also the extended tail region. This session will focus on observational data from various sources that may serve to constrain the physical properties of the heliosphere as a whole (or large parts thereof), and numerical and analytical modelling efforts aiming at the physical interpretation of such data, or otherwise suitable to render our present concepts of the heliosphere’s large-scale structure and dynamics more consistent and complete. This includes, in both cases, the study of so-called astrospheres, heliosphere-like structures around nearby stars, which have recently been observationally confirmed and are being theoretically investigated. Furthermore, contributions addressing the heliosphere’s embedding into the ISM, and especially the recent heliopause crossing of the Voyager 2 spacecraft, are particularly encouraged.

**D1.3 Pickup Ions in the Heliosphere and Beyond**

MSO/DO(s): Nikolai Pogorelov (University of Alabama in Huntsville, United States), Ming Zhang (Florida Institute of Technology, United States)

Organizing Committee: Heather Elliott (Southwest Research Institute, USA)

**Event Information:** The Local interstellar
medium (LISM) is partially ionized, the density of neutral hydrogen (H) atoms exceeding the density of protons by about three times. As a result, charge exchange between neutral atoms (mostly H and He) and ions of the same type (mostly H+ and He+) substantially affects both the microphysical processes in the LISM and solar wind (SW) and the global structure of the heliosphere. This session will discuss the fundamental properties of the SW-LISM caused by the presence of non-thermal, pickup ions (PUIs). We will follow a broad, integrative approach based on a variety of observational data, simulation tools, and theoretical methods. As charge exchange of PUIs with neutral atoms gives birth to energetic neutral atoms (ENAs), we will also address observational and simulation results related to ENA fluxes. Therefore, the session will address both in situ measurements of PUIs by ACE, Ulysses, New Horizons, and Voyager, and remote observations of ENA fluxes from IBEX, Cassini/INCA, and SOHO/HSTOF. The proposed session will address microscopic and macroscopic phenomena related to PUIs, and especially their combination. It will particularly focus on the following scientific questions:

1. Where are PUIs produced and how do their distribution function evolve throughout the heliosphere?
2. How do the distribution functions of non-Maxwellian ions, and PUIs in particular, behave at collisionless shocks?
3. What are the physical mechanisms and consequences of turbulence generated by PUIs in the SW and LISM?
4. What is the effect of PUIs and anomalous cosmic rays on the global structure of the heliosphere?
5. What are the mechanisms to accelerate PUIs in the supersonic solar wind and in the inner heliosheath?
6. What is the correlation between observations and model predictions for the bulk properties of PUIs?
7. What are the physical mechanisms responsible for the IBEX ribbon and distributed ENA fluxes?
8. How to improve the energy resolution of ENA models?
9. What is the effect of He atoms and ions, and charge exchange between them, on the heliospheric structure?

We invite observational, theoretical, and simulation papers relevant to the session topics.

**D1.4 Propagation of Solar Energetic Particles in the Heliosphere**

MSO/DO(s): Nina Dresing (University of Kiel, Germany), Du Toit Strauss (North-West University, South Africa)

Organizing Committee: TBA

**Event Information:** The distribution of solar energetic particles (SEPs) in the inner heliosphere depends on many factors: On the hand, the nature of the acceleration and injection processes can lead to very different observations in the interplanetary medium such as impulsive, gradual, narrow- or wide-spread events. On the other hand, the transport processes can also influence the spreading of the particles, the observed anisotropies, time profiles, and other key characteristics of SEP events. To disentangle these different processes, a comprehensive approach combining (multi-spacecraft) observations, modeling, and theory is needed. Furthermore, the presence of large-scale structures such as Coronal Mass Ejections (CMEs) or Corotating Interaction Regions (CIRs), modifying the
nominal Parker magnetic field, may lead to completely different SEP distributions. However, even in an undisturbed heliosphere, the physics of SEP transport is not yet completely understood: The functional form of the diffusion coefficients, their species and energy dependence, the real nature of cross-field transport, and spatial changes of the transport conditions are still subject to ongoing investigations. We encourage contributions employing observations of single or multiple spacecraft, modeling, and theory or a combination of these addressing the propagation of energetic particles in the inner heliosphere at different radial, longitudinal, or latitudinal positions with respect to the solar source region.

**D2.1 Space Climate**

**MSO/DO(s):** Kalevi Mursula (University of Oulu, Finland)

**Organizing Committee:** Sarah Gibson (HAO/NCAR, USA), Natalie Krivova (Max-Planck Institute, Germany), Ilya Usoskin (Sodankylä Geophysical Observatory, Finland)

**Event Information:** Space Climate is a multi- and cross-disciplinary field of space physics, which studies the long-term (solar cycle to multimillennial) variation of solar activity and solar magnetic fields, and their effects to the solar wind, cosmic rays and to near-Earth environment, including atmosphere and climate. Accordingly, Space Climate Session joins experts from several scientific communities, including solar, heliospheric, cosmic ray, magnetospheric, space weather, ionospheric and atmospheric researchers and climatologists to work on the acutely interesting and versatile topic of the long-term evolution of the solar-terrestrial environment. Space Climate Session addresses not only our understanding of the history and current state of the solar-terrestrial environment, but also makes predictions for its future based on various scientific arguments. One important aspect of Space Climate is to better understand different long-term datasets. Thus, Space Climate Session also includes presentations on long-term datasets available for space climate studies, and their modeling and analysis using, e.g., pattern recognition, statistical and other methods relevant to large data bases.

**D2.2 Solar Probe and SolO**

**MSO/DO(s):** Angelos Vourlidas (Applied Physics Laboratory, United States), Karl-Ludwig Klein (Observatoire de Paris, France)

**Organizing Committee:** Silvano Fineschi (INAF, Italy), Americo Gonzalez-Esparza (UNAM, Mexico), Louise Harra (UCL, UK), Tim Horbury (Imperial College, UK), Kanya Kusano (ISEE, Japan), Nour-Eddine Raouafi (JHUAPL, USA), Alexis Rouillard (IRAP, France), Sami Solanki (MPS, Germany), Prasad Subramanian (IISER, India), Linghua Wang (Peking University, PRC)

**Event Information:** Parker Solar Probe (PSP) and Solar Orbiter are the space missions that will drive much, if not most, of the solar-terrestrial physics research in the coming years. As COSPAR-20 takes place at a key period for the two missions, it provides an excellent opportunity to discuss their early science results. Solar Orbiter will be checking out its remote sensing payload, having accumulated in-situ measurements for almost 6 months. PSP, having gradually reduced its perihelion from its initial 35 Rs
to 30 Rs; during its first two years of operations, will be readying for a plunge through the coronal Alfvénic point to 20 Rs; its 6th perihelion in September 2020. The multiple PSP passes through the outer corona will be producing a wealth of new results and leading to many new questions. Observing campaigns with ground and space-based telescopes, necessary in several domains to establish the solar origin of processes observed aboard the spacecraft, or to complement the spacecraft measurements, are already under way. Consequently, our session is organized along three themes: Take stock of the first two years of PSP observations and related theoretical developments to identify areas where progress has been made and more importantly areas that need further attention. Introduce Solar Orbiter science and science plans and assess the early results and performance. Bring together the different communities to present and discuss the results from the coordinated observations. This exchange of ideas could sharpen the observing plans for both PSP, as it (likely) crosses the Alfvénic point, and Solar Orbiter, as it deploys its formidable arsenal of remote sensing instruments and optimize the systems science from the global array of Heliophysics instruments.

D2.3 Thermal and Dynamic Plasma Instabilities on Multiscales: From Laboratories to Planets, the Sun/Stars, Galaxies, and Beyond

MSO/DO(s): Patrick Antolin (University of St Andrews, United Kingdom), Wei Liu (Bay Area Environmental Research Institute / Lockheed Martin Solar and Astrophysics Laboratory, United States)
cross-disciplinary topics concerning physically similar processes or phenomena in laboratory plasmas, planetary ionospheres and magnetospheres, stellar atmospheres, interstellar medium and galaxies; (3) current or future observing capabilities and instrumentation (e.g., ALMA, DKIST, Parker Solar Probe, Solar Orbiter) pertinent to addressing outstanding questions on these phenomena.

D2.4 Sun-Heliosphere Connection Events: Origin, Propagation, Impact and Prediction

MSO/DO(s): Jie Zhang (George Mason University, United States), Miho Janvier (Institut d’Astrophysique Spatiale, France), Manuela Temmer (Institute of Physics, University of Graz, Austria)

Organizing Committee: Alessandro Bemporad (INAF Turin Astrophysical Observatory, Italy)

Event Information: The study of solar transients (CMEs-ICMEs, flares, shocks, SEPs, SIRs/CIRs) and how they impact on the Earth and other planets have made significant progress in the last decade, thanks to a suite of heliospheric spacecraft observations and high performance numerical MHD simulations and modeling. These advances enable to study the global evolution of CMEs and CIRs starting from the solar surface into interplanetary space and to planets. Data-driven 3D numerical simulation of solar transients has become a powerful tool for improving our understanding in the physical processes that can be used for event prediction. In this session we invite contributions based on models and/or observations of solar transients, covering the initiation of CMEs and flares, CME driven-shock formation, CME propagation in the heliosphere, interaction with the solar wind, the link between CMEs and SEPs, prediction of their characteristics (Bs, hit/miss, arrival times, impact speed, etc.) on Earth and other planets. This session particularly focuses on events and studies that address geo-effectiveness.

D2.5 Nonthermal Particles in the Inner Heliosphere: Origin and Consequences

MSO/DO(s): Nat Gopalswamy (NASA Goddard Space Flight Center, United States), Iver H. Cairns

Organizing Committee: Nina Dresing (University of Kiel, Germany), Olga Malandraki (National Observatory of Athens, Greece), Shrikanth Kanekal (NASA/GSFC, USA), Divya Oberoi (NCRA/TIFR, India), Kaman Kozarev (Institute of Astronomy, Bulgaria), Ming Zhang (Florida Institute of Technology, USA), Timo Laitinen (University of Central Lancashire, UK)

Event Information: Nonthermal particles in the inner heliosphere are accelerated in flares and shocks driven by coronal mass ejections. Energetic electrons are responsible for various types of radio bursts that provide information on the source of the nonthermal electrons as well as the ambient medium into which they propagate. They also produce X-rays and gamma rays to high energies. It is a recent realization that shock-accelerated protons can also lead to extended gamma rays from the Sun. Solar energetic particle events and energetic particle events have important space weather consequences. The origin of the energetic particles poses important physics is-
sues on particle acceleration and propagation. We invite contributions observations, models, and prediction aspects of energetic electrons, protons, and heavy ions that utilize the wide variety of data from ground and space based instruments.

**D3.1 Highlights of Magnetospheric Plasma Physics**

MSO/DO(s): Michael A. Balikhin (University of Sheffield, United Kingdom), Lev Zelenyi (Space Research Institute of RAS, Russia)

Organizing Committee: Michael W. Liemohn (University of Michigan Ann Arbor, USA), David G. Sibeck (NASA Goddard Space Flight Center, USA), Xiao-Jia Zhang (University of California Los Angeles, USA)

**Event Information:** The period during the late 70s and 80s represents a golden era of space plasma and magnetospheric physics. Data gained by ISEE, AMPTE, INTERSHOCK, and other missions led to breakthroughs in studies of many fundamental phenomena such as collisionless shocks, magnetopause etc. It was expected that the combination of a somewhat higher time resolution, complemented by measurements of closely separated spacecraft, would lead to a comprehensive understanding of the solar wind-magnetosphere interaction. Now, 40 years later, data from fleets of multi-spacecraft missions such as Cluster, THEMIS, MMS are available, exceptional time resolution increase has been achieved by MMS. The purpose of this symposium is to summarise the advances in magnetospheric and fundamental plasma physics resulting from these mission; identify major unsolved problems, and to answer the question: Are the data already gained sufficient to achieve the ultimate understanding of magnetospheric physics; or if not; what data from future missions are necessary?

**D3.2 Cross-scale Coupling and Multi-point Observations in the Magnetosphere**

MSO/DO(s): Katariina Nykyri (Embry-Riddle Aeronautical University, United States)

Organizing Committee: Maria Stepanova, University of Santiago, Chile Thomas E. Moore, NASA Goddard Space Flight Center, USA Bertrand Lembege, LATMOS, IPSL/CNRS/UVSQ, France Anatoly Petrukovich, Space Research Institute, Russian Academy of Sciences, Russia

**Event Information:** One of the most compelling problems in near collisionless space plasmas is to understand how energy is being transferred between different spatial and temporal scales. Great progress has been made in understanding the physical mechanisms that allow the solar wind energy and plasma transport and circulation through the magnetosphere-ionosphere system. The main mechanism, allowing plasma and energy transport across the magnetopause and release in the magnetotail during substorms, is magnetic reconnection. While the micro-physics of reconnection is actualized in the ion and electron diffusion regions, the resulting field configuration has global effects on the magnetosphere. Also, other processes can affect the external boundary conditions that drive reconnection. These include velocity shear driven Kelvin-Helmholtz Instability (KHI), high-speed jets, or other processes that can create a thin current sheet. KHI
is a multi-scale process that can lead to development of shocks, secondary instabilities, plasma wave mode excitations, as well as reconnection. These processes heat and accelerate plasma affecting the global state of the magnetosphere. This session invites studies of cross-scale processes in the magnetospheric system using space or ground based data and simulations. We also invite papers on multi-spacecraft mission concepts targeted for understanding the remaining science questions in the magnetospheric system.

**D3.3 Non-thermal Distributions in Space Plasmas and their Role in Wave Generation, and Heating and Acceleration of Particles**

MSO/DO(s): Gurbax Singh Lakhina (Indian Institute of Geomagnetism, India), Ioannis Kourakis (Sorbonne University Abu Dhabi, United Arab Emirates)

Organizing Committee: George Livadiotis (Southwest Research Institute, San Antonio, Texas, USA. Email: glivadiotis@swri.edu), Viviane Pierrard (Royal Belgian Institute for Space Aeronomy, Space Physics and STCE, 3 av. Circulaire, B-1180 Brussels, Belgium. Email: viviane.pierrard@oma.be), Frank Verheest (Sterrenkundig Observatorium, Universiteit Gent (WE05), Krijgslaan 281 (S9), B-9000 Gent, Belgium. Email: frank.verheest@ugent.be)

**Event Information:** Nontehrmal particle distributions occur commonly in space plasmas, for example, solar and stellar coronas, solar wind and planetary magnetospheres. Nonthermal distributions are characterized by Cairns, Kappa, Lorentzian and Tsallis q-extensive distributions. Since such distributions have excess of energetic particles, over and above that of Maxwellian, the extra free energy can give rise to various kinds of plasma waves and instabilities and nonlinear coherent solitary waves, double layers and supersolitons. We solicit papers on the role of nonthermal distribution in exciting plasma wave modes and solitary structures and their effects on plasma heating and acceleration in the planetary magnetosphere, solar/stellar coronas, solar wind and in other astrophysical plasma context. All papers based on observations, modeling, theory, and simulations are welcome.

**D3.4 Plasma Transport across Magnetospheric Boundaries**

MSO/DO(s): Zdenek Nemecek (Charles University, Faculty of Mathematics and Physics, Czech Republic), Steven Petrinec ()

Organizing Committee: David G. Sibeck (GSFC NASA, USA), Jih-Hong Shue (National Central University, Taiwan), Andrey Samsonov (University College London, UK),

**Event Information:** This session will discuss all aspects of plasma transport across magnetospheric boundaries and related phenomena; e.g., the influence of boundary processes on geomagnetic activity in a general sense. Magnetic reconnection, Kelvin-Helmholtz instability and diffusive processes have been identified as the primary physical mechanisms by which energy, momentum, and mass are transported across the magnetopause. However, their relative importance under given conditions is still a matter of debate. In addition to processes occurring at the magnetopause, attention will be devoted to the
role of foreshock effects (turbulence, foreshock cavities, energetic particles) on these phenomena, leakage of magnetospheric particles into the magnetosheath, and the role of these processes in relation to the cusps. Contributions dealing with the location of boundaries and the influence of magnetosheath parameter profiles in response to changes of upstream conditions, and auroral and/or ground based observations as related to boundary plasma transport processes are also solicited.

D3.5 Particle Acceleration and Loss in the Earth and Planetary Magnetospheres

MSO/DO(s): Maria Usanova (University of Colorado, United States), Yuri Shprits (German Research Centre for Geosciences, Germany)

Organizing Committee: TBA

Event Information: Since the discovery of the Van Allen radiation belts, understanding of the acceleration and loss processes in the Earth’s magnetosphere and magnetospheres of the outer planets has been a central topic of research in the space physics community. Observations from the Van Allen Probes, ARASE, MMS, Cluster, Double Star, THEMIS, NOAA POES and GOES, Lomonosov, and a number of CubeSat missions provided a vast amount of data. New planetary missions such as Juno and JUICE will provide additional information about the radiation environments of the outer planets, which will lay the foundation for quantitative comparative studies. In this session, we invite modeling and observational contributions that focus on the physics of acceleration and loss of particles in the Earth and planetary magnetospheres.

D3.6 Magnetotail Dynamics and Substorms during Storm and Non-storm Time

MSO/DO(s): Ian Mann (University of Alberta, Canada), Elena Grigorenko (Space Research Institute (IKI), Russian Academy of Sciences, Russia)

Organizing Committee: TBA

Event Information: Substorms are a fundamental component of magnetospheric dynamics which encompasses various processes of energy transformation and transport, evolving at different spatial and temporal scales, and in different magnetospheric regions encompassing the magnetotail plasma sheet, its boundary layer, and the auroral ionosphere. During recent years, the observations performed in the magnetotail by MMS, Cluster, THEMIS, Geotail and other missions, along with the observations in the inner magnetosphere and on the ground, have generated a unique opportunity for multiscale studies of tail dynamics and substorm-related plasma phenomena. In combination with advanced modelling, these observations have improved our understanding of this highly coupled system and begun to provide a system-wide perspective. However, many fundamental challenges still remain. This session seeks contributions on recent advances in the studies of tail dynamics and substorm-related phenomena enabled by modern multi-point spacecraft and ground-based measurements and/or related modelling. Contributions addressing progress in the understanding of i) substorm onset triggering and the relative timing of substorm-related phenomena; ii) the processes of energy transformation and particle energization in the magnetotail, and their impact on the substorm dynamics
at macroscales, are especially encouraged. The session is motivated by ongoing multi-spacecraft observations in the magnetotail, which together with geosynchronous and ground-based monitoring provide a potent tool for studying of interplay between the magnetotail dynamics and substorm activity. Recent observations of the system-level interplay between night-side reconnection, tail flows, the dynamics of the near-Earth transition region, and related magnetosphere-ionosphere coupling will be a particular focus. Contributions addressing the comparative impact of tail processes during storm and non-storm times are also welcome.

D3.7 Imaging of the Magnetosphere

MSO/DO(s): Yaireska (Yari) Collado-Vega (NASA/GSFC Heliophysics Science Division, United States), David Sibeck (NASA Goddard Space Flight Center, United States)

Organizing Committee: Harald Frey (UC Berkeley, CA, USA) Jerry Goldstein (Southwest Research Institute, TX, USA)

Event Information: Past studies provide evidence for a host of fundamental processes, including reconnection and particle acceleration, that govern the solar wind-magnetosphere interaction. These processes sculpt the global plasma structures that define the Earth’s magnetosphere. Consequently, global observations of the locations, motion, and densities of the bow shock, magnetopause, cusps, auroral oval, plasmapause, ring current, plasma sheet, outer exosphere, and other regions provide crucial information that can be used to diagnose proposed interaction modes. Recent technological advances make it possible to globally image the Earth’s neutral atmosphere and the plasma structures that comprise the Earth’s magnetosphere in Lyman-alpha, soft X-rays, far ultraviolet, extreme ultraviolet, energetic neutral atoms, and Thomson-scattered sunlight, and other signatures. These technological advances go hand-in-hand with the development of increasingly sophisticated global numerical simulations that encapsulate the fundamental physical processes and predict their diagnostic signatures. Presentations describing results from past/current/future simulations, imaging concepts, and imaging observations are welcome.

D4.1 Active Space Experiments

D4.2 Dust Detection and Observation in Space and Laboratory Experiments

E1.1 Fast Spinning Neutron Stars

MSO/DO(s): Sudip Bhattacharyya (Tata Institute of Fundamental Research, India), Duncan Galloway (Monash University, Australia)

Organizing Committee: Edward van den Heuvel (UvA, The Netherlands); Graham Woan (Univ. of Glasgow, UK); Tadayasu Dotani (ISAS-JAXA, Japan); Anna Watts (UvA, The Netherlands); Sharon Morsink (Univ. of Alberta, Canada); Marta Burgay (Cagliari Observatory, Italy); Antonia Rowlinson (UvA, The Netherlands); Paul Lasky (Monash Univ., Australia)

Event Information: Rapidly-rotating neutron stars are observed in multiple electromagnetic wavebands, and may also emit
gravitational waves detectable with current-generation interferometric detectors. These objects can be utilised to probe fundamental physical theories in extreme environments; the disk-magnetosphere interaction; and the properties of matter under extreme conditions. Significant progress has been made in this field in recent years, including the first detection of transitional objects bridging the gap between rotation- and accretion-powered pulsars, and the recent discovery of a neutron star - neutron star merger. The possible constraints on the neutron star equation of state from such mergers, as well as from X-ray timing and spectral observations, are likely the most stringent available, provided the many systematic effects can be quantified. This event will cover the current status, including new theoretical and multi-wavelength observational results, and future directions of this rapidly-developing field.

**E1.2 The Remnants of Supernova Explosions**

MSO/DO(s): Daniel Castro (), Tea Temim ()

Organizing Committee: Brian Williams (Chair, NASA GSFC, USA), Aya Bamba (University of Tokyo, Japan), Joseph Gelfand (NYU Abu Dhabi, United Arab Emirates), Katie Auchettl (University of Copenhagen, Denmark), Lorenzo Sironi (Columbia University, USA), Marianne Lemoine-Goumard (University of Bordeaux, France)

**Event Information:** Supernova remnants (SNRs) and pulsar wind nebulae (PWNe) have great impact on the energy density and evolution of galaxies. SNR shocks compress and heat the surrounding medium, and accelerate particles to cosmic ray energies. The ejecta from supernovae seed the cosmos with heavy elements, and their abundance patterns and distributions can be used as a clue to the nature of their progenitors. Thus, the study of SNRs allows for understanding issues of broad relevance in astrophysics, such as how stars evolve. Furthermore, some supernovae leave behind rapidly spinning neutron stars that create relativistic particle nebulae. PWNe studies address topics such as particle acceleration at relativistic shocks and the evolution of the pulsar spin down. The objective of this event is providing a forum for discussing the status of SNR/PWNe science, where the current questions being addressed are outlined and the role of current/future space observatories in resolving these is illustrated.

**E1.3 Astronomy from Space and the Ground: Synergies and Challenges**

MSO/DO(s): Alvaro Giménez Cañete (Consejo Superior de Investigaciones Científicas (CSIC), Spain), Pietro Ubertini (INAF - IAPS Rome, Italy)

Organizing Committee: Matt Mountain (AURA, US) Saku Tsuneta (NAOJ, Japan) Fabio Favata (ESA, NL)

**Event Information:** Astronomy is developing today with a combination of data provided by space platforms across the electromagnetic spectrum and ground-based observatories in the optical and radio domains as well as, more recently, by means of high energy particles and gravitational waves. It is important therefore to review the synergies and the need for cooperation, but also to identify the challenges to advance further and mitigate potential difficulties. Examples of the challenges to be addressed by multi-messenger astronomy are, exchange of infor-
information, open data access, use of Big Data platforms, response to alerts, time allocations or joint proposals. On the other hand, facilities in space are currently large and expensive, but also new ground-based large observatories demand important public resources. The identification of the big scientific questions to be addressed and how they can be better addressed, should thus involve both space and ground based projects in their roadmaps. The discussion of new elements and the establishment of long-term plannings have to be formulated taking into account the ideas and implementation of both type of scientific infrastructure in order to fully exploit their complementarity and show to decision-makers an efficient use of available resources. The meeting will put together the perspective of the scientific community and the agencies developing the different tools, both ground and space based.

E1.4 Black Hole Astrophysics: Observational Evidence and Theoretical Models

MSO/DO(s): Sandip Kumar Chakrabarti (Indian Centre for Space Physics, India), Andrew Melatos (University of Melbourne, Australia)

Organizing Committee: TBA

Event Information: Event Description: The history of black hole astrophysics, including stellar mass and super-massive black holes, has often been the study of different phenomena on a case by case basis. Disk or jets were being studied separately, hydrodynamics of one component ignored the other, spectral properties ignored timing properties or vice versa. With the advent of very good satellite observations, it is possible to look at the problems holistically. Such an approach will lead to ways for new and specific measurements. Most recently, LIGO/VIRGO detections of binary mergers and simultaneous observations in electro-magnetic radiation has opened up a completely new window in this subject. Furthermore, the Event Horizon telescopes (EHT) view of the photonsphere of a black hole paved the way for science in the strong gravity limit. We wish to gather experts to discuss various outcomes of theoretical models which are either observed or observables. Similarly, observers will describe measurements for testing our theoretical understanding. Results of numerical simulations (both hydrodynamic or magneto-hydrodynamic) are most welcome. Another important aspect is to estimate intrinsic parameters, such as, mass, distance, spin, inclination angle, etc. of the black hole systems using methods which rely on theoretical models. We also have to look into observed emission line properties. We expect to have sufficient time for discussions after every talk. We will cover the following topics: Theoretical models of stellar, extragalactic, intermediate mass black hole accretion flows; Spectral and timing properties of these black holes across the nine decades of mass range; Multi-wavelength spectra ranging from radio to very high energy gamma-rays; Numerical simulations (hydro, MHD, Monte-Carlo) of disk-jet connection, spectral and timing properties; Observational evidences of black holes in the Universe (Stellar, Intermediate, Massive, Super-massive); Jets / Outflows: Discussion on disk-jet connections in various observed spectral states; Estimation of intrinsic parameters (mass, spin, distance, inclination, etc.) black hole Line emission profiles and study of their spectral broadening; polarization properties, predicted and observed, if any; Time or phase lags: Theoretical understanding of positive or negative time lags; General observational peculiarities to be addressed by theorists; LIGO/VIRGO detections of binary mergers and implications on accretion flows; Multi-
messenger Astronomy Imaging of black holes by Event Horizon telescopes and the interpretations Anticipations and Expectations from New Space Missions, if any. WE ARE NOT dealing with THEORIES WHICH MAY OR MAY NOT PREDICT BLACK HOLES, PER SE. NEITHER ARE WE DEALING WITH QUANTUM BLACK HOLES, ALTERNATE THEORIES OF GRAVITY ETC. nbsp;

**E1.5 Accretion on All Scales**

MSO/DO(s): Simone Scaringi (Texas Tech University, United States), Christian Knigge (University of Southampton, United Kingdom)

Organizing Committee: Phil Uttley (Amsterdam), Retha Pretorius (SAAO/UCT), Brad Peterson (Ohio State), Tom Maccarone (Texas Tech), James Stone (Princeton), Rob Fender (Oxford), more TBA...

**Event Information:** Accretion is the process that regulates the growth and evolution of most astrophysical objects in the Universe, from still-forming proto-stars to supermassive black holes in active galactic nuclei. Remarkably, essentially all accreting objects – across 10 orders of magnitude in accretor mass and size – share a common set of complex observational characteristics. For example, almost all accreting systems drive collimated jets and powerful disk winds, and almost all display similar periodic and aperiodic brightness variations. Moreover, regardless of setting, accretion often takes place in distinct bursts, during which systems undergo dramatic changes in their broad-band spectral energy distributions (SEDs). The purpose of this Scientific Event is to bring together researchers investigating accretion physics across the full range of astrophysical environments in order to explore and exploit the apparent universality of accretion on all scales. Members of the scientific community studying the following topics are most welcome to join and contribute: young stellar objects, computational astrophysics (including radiation/magneto-hydrodynamics), interacting compact binary systems (WDs, NSs, BHs), active galactic nuclei, time-domain and multi-wavelength astronomy. The main topics to be addressed during this Scientific Event will be: the disk-wind-jet connection across all scales, periodic and aperiodic accretion-induced variability, accretion physics in the presence of magnetic fields (both disk and accretor), state-of-the-art simulations of astrophysical accretion flows.

**E1.6 X- and Gamma-ray Counterparts of New Transients in the Multimessenger Era**

MSO/DO(s): Lorenzo Natalucci (Istituto Nazionale di Astrofisica, Italy), Marica Branchesi (Gran Sasso Science Institute, INFN, Italy)

Organizing Committee: TBA

**Event Information:**

**E1.7 Observations and Prospects for X-ray Polarimetry**

MSO/DO(s): Herman Marshall (Massachusetts Institute of Technology, United States), Christian Baumgartner (University of Graz, Austria)

Organizing Committee: TBA
**Event Information:** With observations of a few targets by AGILE, PoGO+, and X-Calibur at high energies and the upcoming and planned missions of IXPE and eXTP, X-ray polarimetry can provide insights to various physical phenomena that are not currently possible. The main topics of the event would be current and upcoming instrumentation, observational results from existing missions, scientific principles and theoretical considerations relating to X-ray polarization, and models of possible observations.

**E1.8 Evolution of Disk and Corona in X-ray Binaries: Intersection of Observations and Modeling**

MSO/DO(s): Eda Sonbas (Adiyaman University, Turkey), Kalvir S. Dhuga (George Washington University, United States)

Organizing Committee: Tomaso Belloni (INAF, Italy); Javier Garcia (CALTECH, USA); Thomas Maccarone (Texas Tech University, USA); Barbara De Marco (N. Copernicus Astronomical Center of the Polish Academy of Sciences); Mariano Mendez (Kapteyn Astronomical Institute, Netherlands); Phil Uttley (University of Amsterdam, Netherlands)

**Event Information:** While significant progress has been made over the years in establishing the role of accretion disks and/or the hot corona in the production of spectral and temporal observations in X-ray binaries, detailed understanding of these important emission regions still remains elusive. With the advent of new and superior observational facilities and more physically motivated analysis techniques coupled with sophisticated simulation methods, the field of X-ray binaries stands to make considerable headway in the very near future. In this event, we focus on observations and modeling of accretion processes in X-ray binaries across the entire luminosity range i.e., ranging from the quiescent through the traditional accretion states to the newest states identified in super-accreting systems.

**E1.9 Multi Wavelength Studies of Compact Objects - into the 21st Century**

MSO/DO(s): Dipankar Bhattacharya (Inter University Centre for Astronomy and Astrophysics, India), Tomaso Belloni (INAF, Italy)

Organizing Committee: Angela Bazzano (INAF-IAPS Roma, Italy), Geoff Bicknell (ANU Canberra, Australia), David Buckley (SAAO, South Africa), Piergiorgio Casella (INAF, Rome, Italy), Poshak Gandhi (Univ. Southampton, UK), Kristin Madsen (Space Research Lab, CalTech, USA), Sara Motta (Oxford Univ, UK), David Russell (NYU Abu Dhabi, UAE), K.P. Singh (IISER Mohali, India), Gregory Sivakoff (U. Alberta, Canada), Anna Watts (API, Univ of Amsterdam, The Netherlands), Shuang-Nan Zhang (IHEP Beijing, China)

**Event Information:** Compact objects, such as isolated and accreting neutron stars and accreting black holes, are among the most wide-band emitters of electromagnetic radiation. The emission also happens to be extremely variable. Both intensity and spectral variations are known to occur at sub-second time scales. Studies of physical processes in and around such objects thus demand simultaneous, high time resolution, multi-wavelength observations.
poses a technical challenge which is only recently being addressed, with broad-band timing capabilities of some space missions like AstroSat, and also strong, organised efforts for coordinated observations involving multiple facilities. The event intends to provide a forum to present the results from multi-wavelength observing campaigns for compact object research, and also to brainstorm on the effective utilisation of the capability enhancements and coordination opportunities offered by upcoming facilities.

E1.10 Accretion and Ejection in Galactic Compact Objects

MSO/DO(s): James Miller-Jones (ICRAR - Curtin University, Australia), Melania Del Santo (INAF - IASF Palermo, Italy)

Organizing Committee: Nathalie Degenaar (University of Amsterdam, the Netherlands); Barbara De Marco (Nicolaus Copernicus Astronomical Center, Poland); Maria Diaz Trigo (ESO, Germany); Rob Fender (University of Oxford, UK); Julien Malzac (IRAP/Universite de Toulouse, France); Teo Munoz-Darias (IAC Tenerife, Spain); Tom Maccarone (Texas Tech University, USA); Marc Ribo (Universitat de Barcelona, Spain); Patrick Woudt (University of Cape Town, South Africa)

Event Information: The last two decades have seen tremendous progress in linking the phenomena of accretion and ejection through time-resolved studies of Galactic compact objects, including accreting black holes, neutron stars and white dwarfs. The advent of new facilities, particularly in the X-ray and radio bands, is facilitating significant advances in our understanding of the accretion and ejection processes and the link between them. This session will review the latest advances in this field, aiming to bring together expert theorists and observers from across the electromagnetic spectrum. We seek to draw from both the X-ray binary and cataclysmic variable communities, aiming to use the similarities and differences between these various source classes to gain new insights into the physical process of accretion and its link to the formation of winds and jets.

E1.11 The Gravitational Wave Universe in the LIGO-Virgo Era

MSO/DO(s): Michel Boer (CNRS, France), Matthew Bailes ()

Organizing Committee: TBA

Event Information: The detections of gravitational wave sources by the LIGO and Virgo collaborations have shown the power of this new messenger for astrophysics and fundamental physics. In the coming years space and ground facilities such as the LISA space mission, pulsar timing arrays, and GW ground-based observatories will enable to explore the whole GW spectrum from nHz to kHz, accessing a wide range of astrophysical objects such as compact binaries at various stages of their life, stellar-mass to super massive black hole binaries, and stochastic backgrounds. GWs represent a unique tool to explore fundamental physics in the strong field regime, general relativity, alternative theories of gravity, and new physics. They prove to be an important tool to explore the Universe and its objects, as well as its dynamics. As Virgo and LIGO are about to reach their nominal sensitivity, with the new generation of ground based detector under study, it will be the right time to discuss the discoveries already made
and the new view of the Universe that has been opened thanks to gravitational waves.

**E1.12 LISA, the Next Window on the Universe**

MSO/DO(s): Nelson Christensen (Observatoire de la Côte d’Azur, France), Michel Boer (CNRS, France)

Organizing Committee: Nelson Christensen (Artemis, Observatoire de la Côte d’Azur, France), Michel Boer (Artemis, Observatoire de la Côte d’Azur, France)

**Event Information:** Event Description: The Laser Interferometer Space Antenna (LISA) will be a large-scale space mission designed to detect one of the most elusive phenomena in astronomy - gravitational waves. With LISA we will be able to observe the entire universe directly with gravitational waves, learning about the formation of structure and galaxies, stellar evolution, the early universe, and the structure and nature of spacetime itself. LISA will operate in the low frequency range, between 0.1 mHz and 1 Hz (compared to LIGO’s frequency of 10 Hz to 1000 Hz). The LISA proposal for the L3 mission slot was accepted by ESA in June 2017 and the mission is currently in the first planning stages. Presently the plan is for a launch in 2034. Completing its mission in July, 2017, LISA Pathfinder has shown that the low noise levels surpassed the original requirements, demonstrating that key technology for LISA is well underway. We will welcome talks pertaining to the following LISA Mission and LISA Science topics: - LISA Mission Status - LISA Pathfinder results - LISA Phasemeter - LISA Optical Bench - LISA Gravitational Reference Sensor - LISA Laser - LISA Diagnostics and Payload Processing - LISA Telescope - LISA scattered light studies - Analysis of joint gravitational wave and electromagnetic observations of galactic binaries (including verification binaries) - Population studies of galactic binaries - Studies of seed black holes and black hole formation mechanisms - Studies of supermassive black hole binaries and the connection to galaxy clustering - Analysis of joint gravitational wave and electromagnetic supermassive black hole binary events - Analysis of the extreme-mass-ratio inspiral population - Tests of general relativity and the nature of compact objects - Analysis of intermediate mass black hole binaries and intermediate mass ratio inspirals - Studies of stellar origin black hole populations - Estimation of cosmological parameters - Characterisation of backgrounds - Analysis of detected unmodelled events - Instrument performance analysis and instrument response modelling - Waveform modelling - Data analysis tools - Low-latency pipelines - Individual and global source identification - Source catalogues - Multi-messenger, multi-band - Interpretation of LISA Observations

**E1.13 High-energy Processes at the Galactic Center**

MSO/DO(s): Andrea Goldwurm (CEA/Saclay APC, France), Vladimir Dogiel (P. N. Lebedev Institute, Russia)

Organizing Committee: TBA

**Event Information:** Several complex and interconnected high-energy processes are currently taking place in the inner few square degrees of our Galaxy. They involve the super-massive black hole of the Galaxy, Sgr A*, but also a variety of other objects like compact stars, supernova remnants,
powerful stellar winds, hot gas and molecular clouds, non-thermal-filaments and intense magnetic fields, peculiar populations of stars and possibly dark matter. Understanding such processes, that are likely occurring in other galaxy centers, is a key for the comprehension of the mechanisms at work in local and active galactic nuclei and more generally of the interplay between super-massive black holes and their host galaxies. In this event we will discuss new results obtained from observation programs and theoretical modelling dedicated to the energetic processes in the Galactic Center (GC). At the time of the meeting new GC X-ray surveys with Chandra, XMM-Newton, NuSTAR and possibly SRG will be completed, new gamma-ray data of Fermi, HESS and possibly CTA will also be available or prospected along with those of infrared and radio ground-based observatories, in particular from the VLT/Gravity experiment and the Event Horizon Telescope. The main topics of the meeting will include: General Relativistic effects observed from Sgr A* and its close environment Persistent and flaring emission in X-rays, Infrared and Radio from Sgr A*Sgr A* past activity derived from X-rays reflection in the central molecular zone (CMZ) or from plasma emission revealing large outflows and possibly star formation events Non-thermal radio and X-ray emission from magnetic filaments, pulsar wind nebulae, supernova remnants and other peculiar sources of the GCCosmic-Ray acceleration and Gamma-ray emission in the GeV to PeV range from the CMZ and the galactic bulge and from the Fermi bubbles Prospects of GC observations with future instruments

Organizing Committee: TBA

Event Information: With Swift, Fermi, and MAXI, the high-energy sky has been monitored for 10 years or more in broad energy spectra. Results from this monitoring will be presented and discussed. The topics include long-term light curves of persistent bright binaries and AGNs, outburst history of recurrent transients, rare transient phenomena, and census of variable sources in the whole sky.

E1.14 Long-term All-sky Monitoring of High Energy Transient Sources

MSO/DO(s): Nobuyuki Kawai (Tokyo Institute of Technology, Japan), Jamie Kennea ()

E1.15 Cherenkov Telescope Array: the Ground-based Eyes to Observe the Gamma-ray Universe

MSO/DO(s): Tulun Ergin (TUBITAK Space Technologies Research Institute, Turkey), Pol Bordas ()

Organizing Committee: Gavin Rowell (The University of Adelaide, Australia), Miroslav D. Filipovic (University of Western Sydney, Australia), Stefan Funk (ECAP, Germany), Jamie Holder (University of Delaware, USA)

Event Information: Recent developments in gamma-ray astronomy have opened new astronomical windows for the study of our universe. By now, thousands of astrophysical sources have been discovered in this energy range with the help of both space-borne instruments, such as Fermi and AGILE, and ground-based observatories, such as H.E.S.S., VERITAS, MAGIC, ARGO, and HAWC. Gamma-ray astronomy is ripe for new discoveries due to the fact that more advanced observatories, such as the Cherenkov Telescope Array
(CTA), are currently being built to detect gamma rays between tens of GeV and about a hundred TeV. CTA will have an improved angular resolution and flux sensitivity with a larger field of view, which will allow to make large surveys and to investigate source morphology of very large extended sources. Furthermore, CTA will come with a much higher detection rate of transient gamma-ray sources, allowing as well for a deeper follow-up of flaring events triggered by other observatories. In this COSPAR Event 1.15, we welcome presentations about CTA Key Science Projects, Simulations and Detector Development, as well as presentations from experiments, such as H.E.S.S., VERITAS, MAGIC, HAWC, ARGO, Pierre Auger, Fermi, LOFAR, SKA, and IceCube. Contributions focused on multi-wavelength observations, analysis, and theoretical modeling of galactic and extragalactic gamma-ray sources are also very welcome.

**E1.16 Origin of Cosmic Rays**

MSO/DO(s): Igor Moskalenko (Stanford University, United States), Eun-Suk Seo (University of Maryland, United States)

Organizing Committee: TBA

**Event Information:** Cosmic rays (CRs) are the only pieces of matter available to us that come from Galactic and extragalactic distances. The spectra of their species, composition, and direction at the highest energies provide invaluable information about their origin and propagation history. The bulk of Galactic CRs is associated with the most energetic events such as supernova explosions, but some fraction may also come from pulsars and interstellar shocks, and perhaps from more exotic and less studied processes. The origin of extragalactic CRs is still a mystery with speculations ranging from nuclei of active galaxies to gamma-ray bursts and primordial shocks. Last decade was generous on discoveries in astrophysics of CRs, thanks to new experimental techniques and technological breakthroughs integrated into the instruments launched to the top of the atmosphere and into space. Among them PAMELA, Fermi-LAT, AMS-02, CALET, DAMPE, NUCLEON, and ISS-CREAM. Ground-based gamma-ray telescopes, such as H.E.S.S., MAGIC, and VERITAS, and water Cherenkov detector HAWC, proved to be able to probe CR fluxes in distant locations. Besides, we witnessed the birth of gravitational wave astronomy (LIGO and Virgo) and the first astrophysical neutrinos detected by IceCube. Meanwhile, instruments designed and built using the technology of 1970s, Voyager 1, 2 spacecraft, are also continuing to surprise us by beaming unique information from interstellar space. Spectacular recent discoveries in multi-messenger astrophysics and new measurements of spectra of CR species and their isotopic composition will be discussed during this event. Direct measurements of gamma-ray emission from a number of particle accelerators and from interstellar space, new CR results at very-high and ultra-high energies, as well as new controversies and alternative theoretical models will also be highlighted. This session encourages presentations of new experimental approaches and theoretical analyses directed towards answering questions related to the origins of cosmic messengers. Prospective invited talks will include highlights and presentations from all major collaborations. COSPAR Scientific Assembly and its proceedings Advances in Space Research are open to all bona fide scientists.
E1.17 The Space View of Radio Galaxies

MSO/DO(s): Francesca Panessa (INAF - IAPS Rome, Italy), Gabriele Bruni (INAF-IAPS, Italy)

Organizing Committee: Loredana Bassani (INAF, Italy), Yuri Kovalev (ASC, Russia), Eduardo Morganti (ASTRON, The Netherlands), Marek Jamrozy (Jagiellonian University, Poland), Dan Schwartz (Smithsonian Astrophysical Observatory, USA), Volker Beckmann (CNRS, France), Geoffrey Bicknell (Australian National University, AU), Lakshmi Saripalli (Raman Research Institute, India), Kazuhiro Hada (NAOJ, Japan), Zheng Weimin (Shanghai Astronomical Observatory, China), Manel Perucho (University of Valencia, Spain), Robert Laing (SKAO, UK)

Event Information: RATIONALEWith highly energetic relativistic jets that sometimes reach a few Megaparsecs, radio galaxies are fundamental actors in theories of black hole growth and downsizing, and in the evolution of their host galaxies. This event is designed to provide an overview of our knowledge of radio galaxies as obtained from space experiments, with a particular focus on the results obtained by RadioAstron and the X-ray/gamma-ray satellites. MAIN TOPICS X-ray and gamma-ray emission from radio galaxies RadioAstron results on jets launching and collimation Theory of accretion/ejection Theory of plasma physics Restarting nuclear activity Lessons from the multi-frequency approach Jet-medium interaction

E1.18 Probing Energy Extraction from Supermassive Black Holes

MSO/DO(s): Bindu Rani (NASA Goddard Space Flight Center, United States), Alexander Tchekhovskoy (Northwestern University, United States)

Organizing Committee: E. Meyer (UMBC, USA), R. Laing (SKA Organisation Jodrell Bank, UK), M. Petropoulou (Princeton University, USA), R. Nemmen (Universidade de Sao Paulo, Brasil), Y. Li (University of California, Berkeley), D. J. Thompson (NASA GSFC, USA), D. Giannios (Purdue University, USA), L. Kelley (Northwestern University, USA), D. Gabuzda (University College Cork, Ireland), P. Kharb (NCRA, India), C. Reynolds (Cambridge University, UK), I. Zhravleva (University of Chicago, USA), A. Philippov (CCA Flatiron Institute, USA), Laura Blecha (University of Florida, USA), R. Blandford (Stanford University, USA), A. Zensus (MPIfR, Germany), Shane Larsen (Northwestern University, USA)

Event Information: Powered by accretion onto supershady;massive black holes (SMBH), Active Galactic Nuclei (AGN) jets represent the extreme and largest members of a wide family of jetsy;-powered phenomena including gamma-shy;ray bursts, X-shy;ray binaries, young stellar objects, etc.. The beamed radiation from the jets pierces through the Universe and reaches us from billions of years in the past offering a unique opportunity to study the Universe when it was an order of magnitude younger than today. Understanding the microshy;- and macrosheym;physics of jet shy;launching and particle acceleration is one of the fundamental goals of modern astrophysics. This session focuses on how SMBHs generate ultrashy;-relativistic jets and powerful gammashy;-ray emission, including various aspects of SMBH lives including accretion, launching, collimation and termination
of relativistic jets, AGN feedback, high-energy acceleration and emission processes, and key advances in both theory and observations. Contributions are invited to review theoretical and observation advances, including observing strategies for future missions (SKA, JWST, IXPE, AMEGO, CTA, LISA, LSST, etc.).

E1.19 Early Results of Spectrum-Roentgen-Gamma Mission

MSO/DO(s): Rashid A. Sunyaev (), Peter Predehl ()
Organizing Committee: Eugene Churazov (IKI, Russia; MPA, Germany), Marat Gilfanov (IKI, Russia; MPA, Germany), Andrea Merloni (MPE, Germany), Kirpal Nandra (MPE, Germany), Mikhail Pavlinsky (IKI, Russia), Sergey Sazonov (IKI, Russia), Axel Schwope (AIP, Germany)

Event Information: The Spectrum-Roentgen-Gamma satellite carrying eRosita and ART-XC X-ray telescopes. The launch is scheduled for June 21, 2019. The primary goal of the mission is to provide an all-sky survey in the 0.3-15 keV band that surpasses the sensitivity of existing surveys by more than an order of magnitude. The science themes include Cosmology with a sample of some $10^6$ galaxy clusters; 3 million AGN, a record number of Galactic X-ray binaries and X-ray active stars. The survey will be synergetic with all-sky and wide-field surveys in radio, microwaves, IR, optical, and gamma-ray bands. By 2020 we expect to have a preview on the expected characteristics of the final all-sky survey and many results on individual objects, including supernovae remnants and the Galactic diffuse X-ray band. These results would be of interest for a wide astronomical community, both in terms of science topics.

E2.1 Magnetic Flux Ropes in Solar and Stellar Environments

MSO/DO(s): Brigitte Schmieder (Observatoire de Paris, LESIA, France), Cristina H. Mandrini (Instituto de Astronomía y Física del Espacio, Argentina)
Organizing Committee: Pascal Petit, IRAP, Toulouse, France - Mark Cheung, LMSAL, USA - Teresa Nieves Chinchila, IACS/CUA, NASA Goddard Space Flight Center, USA - Kazunori Shibata, Kyoto University, Japan

Event Information: Topic: Magnetic flux ropes in solar and stellar environments. Magnetic flux bundles or ropes are the main building blocks forming active regions. Their destabilization can lead to the most violent events – flares, coronal mass ejections (CMEs), and energetic particle events. After eruption, they are observed over a wide range of spatial scales throughout the heliosphere. Specific configurations of these structures can produce the strongest geomagnetic storms as they impact the Earth’s magnetosphere. Stellar CMEs, which in analogy to solar CMEs could be caused by the eruption of large-scale flux ropes, may play an important role in mass and angular momentum losses of young Sun-like stars. It is also highly probable that observed superflares might be associated with very large stellar CMEs. Such powerful events may have significant implications for the physical conditions and the eventual habitability of orbiting exoplanets. The proposed event aims to shed light on the fundamental physics of different sets of flux rope structures, their genesis, escape of confinement, interaction, relevance for solar/stellar environments and plausible impact on their planets.
E2.2 Magnetic Structures of Solar Filaments

MSO/DO(s): P. F. Chen (School of Astronomy and Space Science, Nanjing University, China), Guillaume Aulanier (Observatoire de Paris, France)

Organizing Committee: TBA

Event Information: Solar filaments are among the most challenging phenomena of the solar atmosphere. Their eruptions are associated with coronal mass ejections and flares. Indeed filaments are generally believed to be supported by current-carrying magnetic fields that provide the magnetic free energy. Understanding them is therefore of prime importance for the development of future space weather applications. However, the detailed magnetic configuration of solar filaments before they erupt remains elusive. The main reason is that the full coronal magnetic field can still not be measured accurately. Over the past years, tremendous progress has been achieved on this challenging issue, using different but complementary methodologies: magnetic field extrapolations; thermodynamic models; morphological and dynamical behaviors (e.g., barbs, tornadoes, plumes, cancelling features); spectroscopy and polarimetry. The proposed event is aimed to gather experts at data analysis, modeling and instrumentation, so as to foster our understanding of the formation, structuring and dynamics of these fascinating objects.

E2.3 Driving Solar Eruptions

MSO/DO(s): Yuhong Fan (National Center for Atmospheric Research, United States), Piyali Chatterjee (University of Oslo, Norway)

Organizing Committee: Antonia Savcheva (CFA, USA) Bernhard Kliem (Univ. of Potsdam, Germany) Duncan Mackay (Univ. of St Andrews, Scotland) Etienne Pariat (Paris Observatory, France) Hiroaki Isobe (Kyoto Univ., JAPAN) Manolis Georgoulis (RCAAM Athens, Greece) Michael Wheatland (Univ. of Sydney, Australia) Nandita Srivastava (Udaipur Solar Observatory, India) Pengfei Chen (Nanjing Univ., China)

Event Information: This session will focus on the physical processes by which precursor structures for solar eruptions are developed and the mechanisms that lead to their eruptions. Increasingly more sophisticated interior-to-corona simulations of flux emergence have provided new insights into the formation of complex, flare productive active regions. Significant progress has also been made in observing and modeling the evolution toward eruption driven by converging flows and flux cancellation. Models of solar eruptions with increased realism have allowed a more direct comparison with multi-wavelength observations of the solar atmosphere. Data driven models on both local and global scales are being developed to study realistic eruptive events. This session will review and discuss recent advances in observations and modeling to understand the origin of solar eruptions. The 4 half-day sessions will address the following topics: 1) Overview: observation of solar and stellar flares/CMEs and the fundamental physics of explosive magnetic energy release 2) Magnetic flux emergence, flux cancellation, and build-up of precursor structures for solar eruptions (What is the subsurface origin of flare productive active regions? What are the relative roles of the Lorentz force and convective turbulence? What is the helicity transport? How are quiescent filaments formed? What are the signatures for readiness for eruption?) 3) Initiation mech-
anisms and dynamics of eruptions (What are the roles of magnetic reconnection vs. ideal instability? What conditions lead to fast, slow and confined eruptions? What is the role of prominence/filament mass? How do homologous and interactive CMEs form and develop?)
4) Realistic data driven and data constrained modeling of solar eruptions (How can data be used in construction of the initial state, driving lower boundary conditions, and validation of models? Possible applications of data assimilation and machine learning.)
5) Eruption propagation and geo-effectiveness of CMEs (What affect the geo-effectiveness of the outgoing CMEs?)

E2.4 New Views on the Solar Magnetic Atmosphere

MSO/DO(s): Anna Malanushenko (High Altitude Observatory, NCAR, United States), Silvano Fineschi (INAF, Italy)

Organizing Committee: Patrick Antoulin (University of St Andrews, UK)

Event Information: Establishing the 3D structure of magnetic fields in the solar corona is a critical yet challenging problem. Novel approaches to model-data fusion, combined with multi-wavelength observations from new telescopes, including the Daniel K Inouye Solar Telescope, will drive progress, and provide crucial context for new space missions, including Parker SolarProbe and SolarOrbiter.
robust genome sequencing and editing technologies. The session will present the current state of the field with a focus on the function of acceleration-sensitive structures and their role in the perception and transduction of the gravity signal and ensuing responses. The role of statoliths, the cytoskeleton, ion fluxes, and related molecular events such as light perception, gene transcription and expression, and physiological responses will be considered as well as the interaction among tropisms. In addition, ground-based and spaceflight experimentation results in unicellular systems and flowering plants will be presented in this session.

F2.1 Biological Effects of Space Radiation: a Controllable Challenge for Long-term Human Space Missions

MSO/DO(s): Christine Hellweg (DLR - Inst. of Aerospace Medicine, Germany), Guangming Zhou (Soochow University, China)

Organizing Committee: Christa Baumstark-Khan (DLR, Institute of Aerospace Medicine, Germany), Arif Ali Chishti (University of Karachi, The Karachi Institute of Biotechnology and Genetic Engineering, Pakistan)

Event Information: Space radiation is the ldquo;Number One Health Riskrdquo; (Chancellor et al., 2014) for long-term space missions beyond Low Earth Orbit (LEO). During space missions, astronauts are chronically exposed to galactic cosmic radiation (GCR) consisting of energetic protons, helium and heavier nuclei up to iron. This chronic exposure increases the risk for developing cancer and degenerative diseases (cataract of the eye lens, and possibly also decrements of the central nervous system (CNS) and other organ systems). Depending on dose, dose rate, radiation quality, affected tissue, genetic background and other factors, early, late and chronic effects might be induced after space radiation exposure. The extents of these risks and the underlying mechanisms have to be further elucidated. In addition to the baseline exposure to GCR, Solar particle events (SPEs) bear the risk of acute high dose exposure, and might even provoke the acute radiation syndrome. Mitigation of the space radiation risks necessitates a multidisciplinary approach, from understanding the nature of the space radiation environment, the development of relevant radiation dosimeter systems, having the relevant tools to model the radiation environment, elucidating the mechanisms of action leading to possibly deleterious effects of space radiation exposure in humans, other vertebrates, invertebrates and plants, including the interactions with other spaceflight environmental factors, understanding the influence of shielding on the biological effects of space radiation, understanding individual radiation response, including adaptive response, and predisposition for deleterious radiation effects and developing relevant physical, chemical and biological countermeasures. The objective of this session is to present and discuss the current status of this multidisciplinary approach based on data from physical interaction to biological response. The interdisciplinary session addresses researchers from the fields of biology, biotechnology, biochemistry, chemistry, physics and medicine dealing with the effects of space relevant radiation qualities alone or in combination with other spaceflight environmental factors such as microgravity on cells, tissues, organs and organisms. Radiation interaction with molecules and track structure geometry are important determinants for the biological outcome. On cellular and tissue level, the complex interplay of cellular responses, starting with DNA damage induction or damages to other cellular components (e.g. membranes, organelles, proteins) and leading to signal transduction, DNA repair, altered
Gene expression (including microRNA), cell cycle perturbations, cell death, chromosomal aberrations, genomic instability, senescence, differentiation and transformation will be elucidated. Damage escape strategies as well as adaptive responses and bystander effects will also be outlined. Also, cell-type, tissue and organ specific effects of protons and heavy ions resulting in dysfunctions are addressed (such as cataract and cardiovascular and central nervous system effects). The radiation effects on the immune system and its influence on the radiation response in other tissues are important topics in this session. On organismal level, the effects of space relevant radiation qualities not only on mammalian and other vertebrate animal models, but also on plants and invertebrate animals such as insects and nematodes, are topic of this session. This session also covers surveys with human subjects, e.g. detection of chromosomal aberrations in blood lymphocytes. Experiments performed in space and ground-based studies (e.g. at heavy ion accelerators) are discussed in this session. Up to 100 participants are expected. The session will include up to 25 oral presentations and 30 posters.

**F2.2 Space Radiation Risk, Quality of Radiation and Countermeasures: Physical and Biophysical Mechanisms, Modelling and Simulations**

MSO/DO(s): Andrea Ottolenghi (University of Pavia, Italy), Francis Cucinotta (University of Nevada Las Vegas, United States)

Organizing Committee: TBA

**Event Information:** The general objective of this session is to discuss the results of research activities that can improve space radiation risk assessment. This includes the design of biological and passive and active physical countermeasures in order to reduce cancer risk and understand if non-cancer risks will occur for specific space missions. Particular attention will be given to the mechanisms underlying the dependence of biological effects on the quality of radiation. The session will discuss physical and biophysical multi-scale modeling and simulations with the aim of integrating activities carried on by scientists of different disciplines (physicists, biologists, etc.), developing predictive models of the behavior of complex biological systems exposed to radiation, allowing a better understanding of the risks to health from exposure to radiation as well as evaluate countermeasures. Specific topics are:
- Physical interaction models and transport and track structure codes, code verification and validation with experimental data.
- Multi-scale mechanisms, modeling and simulations (at sub-cellular, cellular, tissue and organism levels) of the biological response to radiation.
- Systems radiation biology-“Omics” investigation of biological systems after radiation exposure.
- Development and implementation of countermeasures, in different mission scenarios.
- Advanced shielding materials and development of active shielding.
- Risk assessment for cancer morbidity and mortality, with emphasis on chronic exposures and non-targeted effects.
- Risk assessment of early onset effects that have the potential to impact performance during long duration missions, including CNS and cardiovascular diseases, and possible countermeasures.

**F2.3 Space Radiation: Dosimetric Measurements and Related Models, Radiation Detector Developments and their Ground-Based Characterization**
F2.4 Genetic, Epigenetic and Metabolic Changes in Spaceflight and Simulated Spaceflight Environment

MSO/DO(s): Yeqing Sun (Dalian Maritime University, China), Honglu Wu (NASA/Johnson Space Center, United States)

Event Information: The space radiation environment and the relevant radiation exposure from the various sources is one of the limiting factors for long duration human space missions. The event will present the newest radiation measurement results gathered on-board various manned space crafts as for example the International Space Station ISS. Further on it will provide information about the radiation field parameters measured in interplanetary missions as to the Moon and to Mars, being the precursor missions for future human exploration. These results shall be compared and benchmarked applying various radiation transport codes and newest results for model developments shall be discussed. Emphasize shall be further given to the development of new radiation detectors to be applied for long duration humans space missions and their ground based characterization applying various accelerator facilities and sources.

F2.5 Simulating the Deep Space Radiation Environment on a Journey to Mars-The NASA Galactic Cosmic Ray Simulator Project and Approaches to Risk Modelling and Mitigation

MSO/DO(s): Janice Huff (Universities Space Research Association, United States), Tony Slaba (NASA Langley Research Center, United States)

Organizing Committee: Lisa Simonsen (NASA Langley Research Center, USA)

Event Information: Given the technical challenges of studying radiation in the true space environment, ground-based research is performed at the NASA Space Radiation Laboratory where a beamline is dedicated to the study of the radiobiology of heavy ions. A major effort currently underway is the Galactic Cosmic Ray Simulator Project
(GCR), focused on development of the facility, hardware, and software tools needed for delivery of a shielded GCR environment with a mixed field, high-energy capability that accurately simulates the radiation environment astronauts will experience during interplanetary travel to Mars. The simulator project will address high priority research required for accurate risk modeling and validation of medical countermeasure for deep space and Mars missions. This session will cover topics related to dose-rate and mixed field exposures; the biological hazards of space radiation emphasizing cardiovascular disease, immune decrements and cancers; and best approaches for risk mitigation using medical countermeasures.

**F3.1 Chemical Evolution and Origin of Life**

**MSO/DO(s):** Ankan Das (Indian Centre for Space Physics, India), Maria Cunningham (University of New South Wales, Australia)

Organizing Committee: Paola Caselli (Max Planck Institute of Extraterrestrial Physics, Germany), Takashi Shimonishi (Tohoku University, Japan), Cristina Puzzarini (University of Bologna, Italy), Bhalamurugan Sivaraman (Physical Research Laboratory, India) (More names to be added soon)

**Event Information:** Pre-biotic Astrobiology (PBA) deals with the study of the chemical amp; dynamic behavior of the evolving universe with a view to synthesizing prebiotic matter in mind. Observational amp; experimental evidence suggest that PBA is taking place in the ISM. Recent advancement in theoretical, observational amp; laboratory studies opened up many new possibilities. The origin of amino acids through the PBA of the early earth has been a topic of long-standing interest. This session will provide a platform to revisit some of the new developments made on the subject. Here, we would like to discuss the following:

- a. Numerical simulation to study the collapse amp; fragmentation of star-forming regions.
- b. Chemical evolution during the process of star-formation.
- c. Delivery of the pre-biotic species in the proto-earth.
- d. Advancement in laboratory amp; observational aspects to address the most relevant astronomical issue.
- e. Earliest signature of life forms in Earth’s history and the influence of clay chemistry amp; ocean chemistry in origin of Life.
- f. Large astronomical molecular line surveys of the interstellar medium.
- g. Statistical analysis techniques for interpreting large molecular line surveys of the interstellar medium.

**F3.2 Astrobiology: Laboratory Experiments, Field Studies in Analogue Environments and Space Experiments in Low Earth Orbit**

**MSO/DO(s):** Petra Rettberg (DLR - Inst. of Aerospace Medicine, Germany), Nicolas Walter (ESF Space Sciences Unit, France)

Organizing Committee: TBA

**Event Information:** Astrobiology is an interdisciplinary research area aiming at the understanding of the origin and evolution of life on Earth to enable the search for life on other planets and moons in our solar system and beyond. Different complementary approaches are necessary to identify the physical and chemical limits of life as we know it and to obtain a better understanding of habitability in general. Laboratory studies allow the in depth investigation of biological
phenomena in a standardized and reproducible environment. Field studies are necessary for the analysis of natural communities adapted to their environment and the interactions and dependencies between the community members. Space experiments allow the investigations of the response of organisms and communities to the space environment and to the combined simulated planetary conditions, e.g., Mars. For this session, we invite contributions covering astrobiology research in the laboratory, in field studies, and in Earth orbit settings, including the ISS.

**F3.3 Habitability in the Solar System and Beyond**

MSO/DO(s): Rafael Navarro-Gonzalez (Universidad Nacional Autonoma de Mexico, Mexico), Javier Martin-Torres ()

Organizing Committee: Sushil Atreya (University of Michigan, Ann Arbor), Francois Raulin (University Paris-Est Créteil), Dirk Schulze-Makuch (Technische Universität Berlin), Jorge Vago (European Space Agency, Paris), Martin J. Van Kranendonk (University of New South Wales, Sydney).

**Event Information:** The session will be dedicated to review our knowledge on the possibility that life emerged on Mars and other planets and satellites of the Solar System excluding the Earth. A key environmental requirement for life, as we know it, is the presence of liquid water, which can exist in the atmosphere, surface and/or interior of a variety of planetary bodies. This implies that life forms could exist in the upper atmosphere in clouds and/or down to the surface or subsurface of planetary environments obtaining energy from photosynthesis or chemosynthesis. However, it has also been speculated that exotic life could exist in chilly, non-liquid solvents, such as a methane-ethane sea in Titan in a hydrocarbon driven metabolism. The session will consist of solicited and contributed papers dealing with laboratory studies, theoretical modeling, analog studies and observational studies on the possibility that life emerged on other planets and satellites of the Solar System. A key question is to identify an independent origin of life on Earth in the Solar system which could be resolved from future space missions.

**F3.4 Biosignatures and Biomarkers—Searching for Traces of Prebiotic Organic Compounds or Forms of Past or Present Life in the Solar System**

MSO/DO(s): Michel Viso (CNES, France), Petra Rettberg (DLR - Inst. of Aerospace Medicine, Germany)

Organizing Committee: TBA

**Event Information:** Mars Sample Return is almost in the starting blocks. The consortium iMost proposed a list of studies to be performed on such samples. Other ideas and proposals are arising to search for traces of prebiotic chemistry, biomarkers or biosignatures this samples, on Mars or on some icy satellites of the giant gaseous planets. This session will report on the hypotheses, chemicals or features to look for. A review of terrestrial analogs, chemicals or laboratory made artifacts which could be used as training for MSR or as template to specify and design instruments to be onboard future probes. Biomarker: an identified feature that you can measure (DNA, 2023-02-07T16:52:43.982000+00:00)
Sterane; Biosignature: a unique feature which can be explained only by a process induced by a potential form of life (microfossil, Stromatolite;)

F3.5 Pre-biotic and Complex Molecules in the Universe: Observational, Laboratory, and Computational Perspectives on the Evolution of Molecular Complexity

MSO/DO(s): Robin Garrod (University of Virginia, United States), Gianfranco Vidali (Department of Physics, Syracuse University, United States)

Organizing Committee: Arnaud Belloche (Max Planck Institute for Radioastronomy, Germany), Adwin Boogert (Institute for Astronomy/University of Hawaii, USA), Nanase Harada (AISAA, Taiwan), Eric Herbst (University of Virginia, USA), Mike McCarthy (Harvard Smithsonian Center for Astrophysics, USA), Tom Millar (Queens University, Belfast, UK), Dmitry Semenov (Max Planck Institute for Astronomy, Germany), Ians Sims (University of Rennes 1, France) Naoki Watanabe (Institute of Low Temperature Science, Hokkaido University, Japan)

Event Information: This event will bring together astronomical observers, laboratory researchers, theorists, and computational modelers, to discuss new perspectives on the origins of complex and pre-biotic chemistry, from our solar system to other galaxies. The ALMA telescope has now reached maturity, with major discoveries of gas-phase complex molecules in star- and planet-forming regions, while the JWST mission will soon bring a wave of complementary solid-phase data. The Rosetta comet mission has helped to tie recent galactic observations to the chemical origins of our own solar system, while extragalactic molecular detections are refining our view of chemistry outside the Milky Way. We will provide a forum for the discussion of recent observational detections of pre-biotic molecules in galactic and extragalactic sources, laboratory investigations of the interstellar production of sugars and amino acids, cometary abundance determinations, and computational simulations of astronomical regimes. We will strongly encourage participation by young researchers from under-represented countries.

F3.6 Climate and Astrobiological Potential of Icy Deposits on Mars

MSO/DO(s): Isaac Smith (York University, Canada), Jennifer Eigenbrode (NASA Goddard Space Flight Center, United States)

Organizing Committee: TBA

Event Information: The planet Mars contains numerous, massive deposits of water ice that are spread over the polar regions and the mid-latitudes in each hemisphere. The polar layered deposits (PLD) are primarily (gt;95

F3.7 Finding Life beyond Earth: Modern Methods for Technosignature Searches

MSO/DO(s): Danny C. Price (), Alice Gorman ()

Organizing Committee: TBA

Event Information: The galaxy abounds
with temperate rocky planets, water, and organic chemistry. But has life arisen elsewhere in the cosmos? And if so, has intelligent, technologically-capable life evolved in a similar manner to here on Earth? This session will explore modern methods to search for life beyond Earth (SETI - Search for Extraterrestrial Intelligence). The session will feature observational results, strategies for detection using modern algorithms and machine learning, and discussion of wide-field and wide-bandwidth techniques. Historical and societal aspects of SETI will also be considered.

F4.1 Bioregenerative Life Support – Past–Present–Future / Outlook and Ecological Aspects

MSO/DO(s): Klaus Slenzka (OHB-System AG, Germany), Susanne Peters (Airbus Defence and Space, Germany)

Organizing Committee: TBA

Event Information: Space Exploration is a challenge for science and engineering/technology. Exploration is closely linked to long-duration missions at a later stage of development including humans as the main explorers. Long-duration mission require new, alternative design and technology since a quick return to a home base is not possible. Refurbishment, re-modeling, of used systems at all levels is necessary. Based on these facts ecological, sustainable processes are necessary including ISRU; even Bio-ISRU. The adaptation of Life Support Systems to local environmental situations is another, new approach and should be addressed in this session. This session will focus on contributions from scientists, developers and engineers to sustainability in general and the implementation into Life Support Systems. However, also to the all-over design of Life Support Systems future; mainly a bio-regenerative one; going far beyond the existing theories.

F4.2 Advanced Life Support Test Beds and Facilities

MSO/DO(s): Raymond Wheeler (NASA/Kennedy Space Center, United States), Christophe Lasseur (ESA, Netherlands)

Organizing Committee: Alex Tikhomirov (Institute for Biophysics, Russia) Daniel Schubert (DLR German Space Agency, Germany)

Event Information: Advanced life support technologies will be needed to enable human exploration of space. This includes methods for regenerating breathable air, clean water, managing and recycling wastes, and providing food. To study the performance of different technologies or approaches for human life support, testbeds and facilities will be needed. Some of this could be done in space, such as on the International Space Station, but ground test facilities will also play an important role, particularly for long duration testing to assess costs and reliabilities. Session F4.2 will provide a forum for researchers to present information from past, present, and proposed life support testbeds and how their findings could be used to support human exploration of space.

F4.3 Influence of Spaceflight Environments on Biological Systems

MSO/DO(s): Galina S. Nechitailo (Inst. of...
Event Information: Orbiting spacecraft is a unique physical, chemical and biological environment, which affects living organisms in many different ways. Lack of gravity, temperature and chemical gradients, magnetic and electrical fields, spectral composition and intensity of light and high-energy cosmic radiation influence many important metabolic and physiological processes in animals, plants and microorganisms, as well as transfer phenomena in and around them. Success of future manned space missions depends on understanding the effects of these factors on biological organisms and developing appropriate countermeasures, aimed on improving growth, development and reproduction in microgravity. The program of the symposium will include presentations on the influence of the entire complex of physical factors associated with spaceflight on biological systems, including detailed analysis of the impact of the microgravity on the organism, as well as the effects of electric and magnetic fields. Both spacecraft and ground-based studies will be covered. The goal of this symposium is to bring together scientists interested in the above problems for a productive exchange of ideas.

F4.5 Space Food and Nutrition

Event Information: For long duration space travel by humans to destinations like Mars, humans will require a reliable and nutritious source of food. The conventional approach is to consider stored, preserved foods, but these

F4.4 Modelling and Control to Support Closure of Man-made Ecosystems and Biospheres

Event Information: Human space missions to Mars and exploration of other planets of our Solar system is impossible without creation of life support systems (LSS) with a high level of closure. Only such highly closed LSS can reach a high level of autonomy. Theoretical approaches to reliability and stability of Bioregenerative Life Support System closure for various space missions and planetary surface settings will be addressed. Physicochemical and biological methods for organic waste oxidation, oxygen and food production to increase closure of mass exchange processes will be considered. Closure technologies for materials recycling and their interactions with biosphere processes will also be addressed. System approach, deterministic modeling, static and dynamic analysis and strategy of control are the key points for a rationale and generic development of such systems.
stored foods can be enhanced and perhaps eventually replaced with in situ produced foods. The cultivation of farm products in space is a long studied approach for achieving this goal of growing food. Converting the farm products to prepare meals will also present challenges. In addition, producing the edible food stuffs will not be enough; nutritional balance is also important. Session F4.5 will examine various approaches and findings from controlled environment agriculture similar to what might be envisioned for space settings like Mars. In addition, the challenges of providing adequate nutrition for humans in these space settings, and dealing with food preparation challenges will be addressed.

F5.1 Molecular, Cellular and Physiological Changes in Response to Spaceflight and Ground-based Analogues

MSO/DO(s): Dieter Blottner (Charité Universitätsmedizin Berlin, Germany), Elizabeth Blaber (NASA Ames Research Center, United States)

Organizing Committee: TBA

Event Information: The symposium is open to original reports on the molecular, cellular and physiological changes in response to spaceflight (human, mice, rats), analog studies (short-arm centrifuge, bed rest, dry immersion) but also to any ground-based animal studies (unloading). Preference is given to major organ systems (e.g., muscle, bone, cardio-vascular, nervous; immune system, others) at cell-tissue-organ scale already known and/or newly identified to be sensitive and triggered by various loading conditions and microgravity including also recovery/reconditioning effects. Data from high resolution microscopy, functional image analyses, omics technologies, next generation sequencing, or any other up-to-date methods used in Space Life Sciences are highly welcome.

F5.2 There and Back Again - An Astronaut’s Tale: NASA

MSO/DO(s): Zarana Patel (NASA/Johnson Space Center, United States), Jeffrey Willey (Private Individual, United States)

Organizing Committee: Janice Huff (NASA Johnson Space Center, USA)

Event Information: The main objective of this session is to address the highest priority risks to human health and performance during long duration human exploration missions in deep space. The NASA Human Research Program classifies these as ‘red’ risks and these include inflight and post-mission risks due to hazards such as altered gravity fields, isolation/confined, hostile/closed environments, distance from Earth, and space radiation exposure. This session will include general overviews of the main risks as well as focused talks on innovative work to characterize and mitigate those risks. These will include: ground and flight analogs; Overview of the space radiation environment and health risks; Risk of spaceflight associated neuro-ocular syndrome; Risk of inadequate nutrition and food stability; Risk of inflight and late cognitive and behavioral decrements; Risk of immune decrements.
G0.1 Gravitational Effects on Physico-Chemical Processes

MSO/DO(s): Valentina Shevtsova (Université Libre de Bruxelles, Belgium), Jeff Porter (Universidad Politécnica de Madrid, Spain)

Organizing Committee: TBA

Event Information: This session is dedicated to research into the effects of gravity in fluid and material science. A wide range of basic processes and systems are of interest, including: transport, mixing, multiphase flows, solidification, miscible or immiscible layers, interfacial instabilities, bubbles, drops, evaporation, boiling, particle motion and accumulation, convection, thermocapillary flows, jets, electrocapillarity, Kelvin-Helmholtz, Rayleigh-Taylor, Rayleigh-Beacut6;nard, Marangoni-Beacut6;nard, etc. A complementary concern of this session is in practical and industrial applications such as material processing, separation methods, oil recovery and cleanup, life-support and propulsion systems, and biomedical engineering. The general aim is to provide a productive and stimulating forum where scientists from universities, industry, and other research institutions can discuss exciting new results and share their experience. Results from experiments carried out in any kind of microgravity platform are welcome.

G0.2 Drop Tower Days

MSO/DO(s): Marc Avila (ZARM, University of Bremen, Germany), Thorben Könenmann (ZARM Fab mbH, Germany)

Organizing Committee: Prof. Qi Kang (National Microgravity Laboratory, Institute of Mechanics, Chinese Academy of Sciences, China)

Event Information: The Drop Tower Days session is concerned with latest results of short-term microgravity experiments and displays an excellent platform to share experimental know-how from research under conditions of weightlessness. Ideas and proposals for microgravity experiments in drop towers or any further (ground-based) research platforms are also discussed. All scientific or technological subjects are treated to facilitate an interdisciplinary discourse among the participants. Accordingly, the Drop Tower Days session is addressed to all scientists who conduct microgravity research and those who operate and manage microgravity facilities.

G0.3 Influence of Free Space Environment on the Behaviour of Materials

MSO/DO(s): Alexey Kondyurin (University of Sydney, Australia), Joseph Minow (NASA Langley Research Center, United States)

Organizing Committee: Kim de Groh (NASA Gless Research Center, USA), David Edwards (NASA, USA), Lev Novikov (Moscow State University, Russia), Yugo Kimoto (JAXA, Japan)

Event Information: The free space environment is destructive for all materials used in the construction of space systems such as satellites, space stations, spaceships, and future space bases. The destructive factors of the space environment include high vacuum, large temperature variations and gradients, high energy ionising radiation,
ultraviolet radiation, meteoroids and orbital debris and atomic oxygen. These factors are significantly different from our experience on the surface of the Earth. The ability to replicate the effects of the space environment on material performance using ground based laboratory facilities is difficult. Space flight experiments that characterise the temporal response of material parameters during space exposure help to validate ground-based testing methodology. The understanding of physical-chemical processes in the construction of space materials is a key factor for our success in space exploration in the future.

The scientific event, Influence of Free Space Environment on the Behaviour of Materials, will include presentations on:
The composition of the free space environment, Modelling the free space environment, The influence of the free space environment on material behaviour including physical - chemical processes associated with the construction of space materials, Results of space flight materials experiments and ground-based testing capability to emulate the free space environment's influence on material behaviour, New material development demonstrating a high tolerance to space environmental effects.

H0.1 Commission H Highlight Talks

MSO/DO(s): Claus Laemmerzahl (ZARM, University of Bremen, Germany)

Organizing Committee: TBA

Event Information: The main purpose of this session is to give space for highlight talks from all sessions which are of general interest for all commission H. This covers gravitational physics including gravitational waves, condensed matter, space missions, enabling technologies and practical applications of space. With this event we plan to create mutual interest. These talks will be commission H plenary talks, that is, there will be no parallel event for these talks. The selection of the talks will be done in collaboration with the organizers of the events H.02 - H.06.

H0.2 Gravitation, Dark Energy and Dark Matter

MSO/DO(s): Orfeu Bertolami (Departamento de Física e Astronomia, Universidade do Porto, Portugal), Frederico Francisco (Universidade do Porto, Portugal)

Organizing Committee: TBA

Event Information: The purpose of this event is to discuss some of the most challenging questions of contemporary cosmology, namely the existence and the nature of dark energy and dark matter. Indeed, unraveling the properties and the nature of dark energy and dark matter are the main goals of recent and forthcoming space missions such as Euclid. An relevant related issue is to which extent the observations that are explained in the framework of General Relativity with dark energy and dark matter can be accounted by alternative theories of gravity.

H0.3 Space Missions for Fundamental Physics

MSO/DO(s): Paul McNamara (ESA-ESTEC, Netherlands)

Organizing Committee: TBA
**Event Information:** As the development of enabling technologies improves, in both performance and mass/power, the prospect for performing fundamental physics experiments in a space environment has become a reality. The space environment offers many advantages when it comes to precision measurements, such as low gravity, long baselines, and low seismic noise, as well as interesting regions of space such as the Sun-Earth saddle point which cannot be replicated in an earth-bound laboratory. Drag-free technologies are now well established and precision measurements can be done using a variety of techniques (laser interferometry, SQUIDs, capacitive sensors, matter wave interferometers). These techniques open up a wealth of physics tests which up until now could not be probed in conventional experiments, such as tests of quantum decoherence, dedicated tests of General Relativity, or tests of alternative theories of gravitation in the weak field environment that space offers. Examples of past, and current, fundamental physics missions are the European Space Agency’s LISA Pathfinder, and ACES, and the CNES mission, Microscope, a satellite test of the equivalence principle. This symposium aims to bring together a global community working in this field and to look to the future ideas coming from them.

**H0.4 Gravitational Wave Astro-physics**

**MSO/DO(s):** Michele Vallisneri (ESAC/ESAC, Spain), Michele Armano (ESA/ESAC, Spain)

**Organizing Committee:** TBA

**Event Information:** The LIGO/Virgo detections of gravitational waves from coalescing binaries of stellar-mass black holes and neutron stars marked the beginning of gravitational-wave astronomy. Gravitational waves open a new dimension for our understanding of the Universe, granting us access to the most dramatic astronomical events and the most extreme astrophysical conditions. Space-based gravitational-wave detectors such as LISA will complement ground-based programs by observing the low-frequency band ($10^{-5}$ to $10^{-1}$ Hz), replete with a bounty of sources: thousands of compact binary systems, the mergers of massive black hole binaries out to very high redshifts, extreme-mass-ratio inspirals, stellar-mass black hole systems that may be seen also from the ground, and precision tests of Einstein’s general relativity. This session will discuss the scientific payoff, technological implementation, and international context of space-based gravitational wave observatories, and it will stress the unity and complementarity of detection efforts across all frequencies. The ground-based, space-based, pulsar-timing, and cosmic microwave background programs have a strong history of cross-fertilization in theory, data analysis, and experiments, and.

**H0.5 Applications (Geodesy, Metrology, Navigation, and Others)**

**MSO/DO(s):** Jürgen Müller (Leibniz University of Hannover, Germany), Roberto Peron (IAPS/INAF, Italy)

**Organizing Committee:** TBA

**Event Information:** In this Event, we will discuss new sensor measurement and mission concepts that apply advanced techniques for the study of the gravitational field on ground and in space. Terrestrial gravity anomalies will be determined by observing free-falling atoms (quantum gravimetry) instead of using falling corner cubes. This will open the door for a vast bundle of applications such as fast local gravimetric surveys and exploration, and
the observation of Earth system processes with high spatial and temporal resolution. This technique can also be applied for future gradiometric measurements in space. Other concepts are approaching a frontier that can be termed as "Relativistic metrology": the precise measurement of quantities (e.g., length and time) related to space-time dynamics. Frequency comparisons of highly precise optical clocks connected by optical links give access to differences of the gravity potential (relativistic geodesy). In future, relativistic geodesy with clocks might be applied for defining and realizing height systems in a new way, locally as well as globally. Moreover, accurate clocks help to improve the accuracy of the International Atomic Time standard TAI. They are important for all space geodetic techniques as well as for the realization of reference systems and their connections. One example of increasing importance is positioning and navigation with GNSS for terrestrial and space applications. In addition, laser interferometry between test masses in space with nanometer accuracy; which has been realized in the GRACE-FO mission; belongs to these novel concepts. For the latter, technology developed for gravitational wave detection and successfully tested in the LISA/pathfinder mission is being prepared for geodetic measurements. In future even more refined concepts (tracking a swarm of satellites) will be realized. We invite presentations to illustrate the principles and state of the art of those novel techniques and the application of the new methods for terrestrial and satellite geodesy (where local and global mass variations and surface deformations will be observed with unforeseen accuracy and resolution, variations that reflect changes in the Earth system), navigation and fundamental physics. We also welcome papers for further applications and invite contributions covering the theoretical description of the new methods, introducing novel theoretical concepts as well as new modelling schemes.

**H0.6 Enabling Technologies for Fundamental Physics Experiments and Missions**

MSO/DO(s): Ernst Maria Rasel (Leibniz Universität Hannover, Germany), Sven Herrmann (ZARM, University of Bremen, Germany)

Organizing Committee: TBA

**Event Information:** The fundamental physics program for space experiments offers a wide range of exciting topics. They range from quantum mechanics, to general relativity, gravity and gravitational waves, just to mention a few. This session should provide an overview and bring together the worldwide activities aiming at the advancement of key technologies enabling the ambitious missions in these fields. The state of the art of optical and cold-atom technology, atom interferometry, metrology and novel sensors, for example quantum sensors and novel clocks, and the related mission proposals will be presented.

**PCB.1 Capacity Building**

MSO/DO(s): Carlos Gabriel (ESA/ESAC, Spain), Mariano Mendez (University of Groningen, Netherlands)

Organizing Committee: TBA

**Event Information:** The COSPAR Capacity Building Programme (CBP) started in 2001 with the organisation of highly practical workshops in developing countries with the aim of encouraging (young) scientists from those regions to use scientific data from space
missions. In 2009 a Fellowship associated to the workshops has been added as a fundamental component of the CBP. The Programme today is covering a large number of disciplines related to space sciences, with a cadence of 3 workshops per year. A re-organisation of the Panel took place during the last COSPAR GA in July 2018. The new Panel started this period with the main aim of continuing the successful path of past years. The desire to reinvigorate the CBP, however, brought us to define three elements to be pursued: a) creation of Alumni – it should serve the purpose of better evaluate the effectiveness of the Programme, following the careers of COSPAR workshop participants; b) strengthening of the interaction between the different disciplines represented in the CBP – it should help us to homogenize the way the workshops are conducted, but also to learn from experiences from other areas; c) extension of the Programme with a new type of workshop, specifically in the area of small satellites, devoted to younger students and with a fundamental multi-disciplinary component. This half-day session should not only discuss the advances made with respect to these three elements in the 2 years between the General Assemblies but also include experiences from workshops and fellowships, particularly in this last period, but not necessarily restricted to. We invite all former participants in COSPAR workshops and/or those having received an associated fellowship to report on their experiences. Presentations from local and/or scientific organisers of workshops are also welcome.

Organizing Committee: TBA

**Event Information:** The Capacity Building Programme (CBP) is considered today one of the flagships of COSPAR activities. It started in 2001 as an unambitious project and has matured in these last 18 years to a well-established initiative, organizing around 3 highly practical CB workshops in almost all space science disciplines in developing countries, encouraging young researchers to use scientific data from space missions. The characteristics of the CB workshops are very similar, even if they are devoted to such different disciplines like for example Astronomy, Earth Observation, Space Weather or Space Crystallography. In a CB workshop 25-35 PhD students or young researchers from a certain world region participate, who hear lectures corresponding to the scientific field treated, and get to know the corresponding data and to learn related analysis techniques. The duration of a workshop is in the rule 2 weeks, during which the participants and the lecturers/data analysis supervisors (usually experienced and well-known scientists worldwide) share not only the specific workshop hours but also hotel and common meals, resulting in a high level of communication. We are aiming now to propose to COSPAR the creation of a new type of workshops, centered on Small Satellites, targeting younger students (undergraduates, even upper secondary school students). We think that the opportunity for attracting younger generations to space sciences in general through participating in projects around nanosatellites is unique and timely, especially in developing countries. The nature of such workshops is necessarily multidisciplinary, and we would be operating at project team level rather than on the level of individual researchers. Strong requirements on coordination arise from it. Also longer term project work would be necessary, following an initial workshop, which would constitute the stage of learning the basics.

**PCB.2 Small Satellites for Capacity Building**

MSO/DO(s): Carlos Gabriel (ESA/ESAC, Spain)
and defining the topics to be studied around a nanosatellite project. This will require that a team of say 5-6 students continue later to be guided by a lecturer/mentor for months, working on one of those topics (power supplies, detectors, command systems, data analysis methodshellip;). There is in-between a good level of experience gathered in institutes and universities, working in a similar pattern to the one described, which should help us to define a concrete way to go. Also the space industry should be very interested in such a Programme, and we hope on their support to fund it. The experience gathered in former ldquo;traditionalrdquo; CB workshops on Small Satellites (South Korea 2015, Israel 2019) is also of high value for establishing the characteristics of such a new initiative. We invite therefore especially people with experience in the field of Small Satellites, particularly those having dealt with young student teams around nanosatellite projects, to submit abstracts for sharing their experiences and thoughts, with the aim of discussing the establishment of a capacity building initiative around them.

PEDAS.1 The Science of Human-Made Objects in Orbit: Space Debris and Sustainable Use of Space

MSO/DO(s): Carolin Frueh (Purdue University, United States), Carmen Pardini (ISTI/CNR, Italy)

Organizing Committee: TBD

Event Information: The PEDAS1 sessions will address advances on the science of human-made objects in orbit with respect to space situational awareness and space traffic management. This includes active satellites and space debris in orbit around the Earth and in other regions of space, such as the Lunar and Martian region. Of interest are scientific advances concerning the following four areas: 1) information collection and their processing: active and passive sensing and observation collection, including astrometry and characterization information such as operational state, shape, attitude and materials, estimation, data fusion and inversion techniques; 2) environment models in their effect on the human-made objects: effects of natural perturbations on the orbit and attitude evolution, debris and micrometeoroid flux, hypervelocity impact models and shielding, astrodynamics; 3) end-of-life concepts: short-term and long-term sustainability, mitigation methods and their effectiveness, national and international debris mitigation standards and guidelines; and 4) solutions to pressing operational challenges: object identification and characterization, orbit determination, collision avoidance, methods for ranking critical objects and space debris indexes, criteria for assessing the environmental impact of new space systems, such as small satellites and large constellations, re-entry predictions and risk assessments. Selected papers are automatically recommended for publication in Advances in Space Research.

PEX.1 Establishing a Framework for Environmental Stewardship on Celestial Bodies

MSO/DO(s): Frances Westall (CNRS, France), John Rummel (SETI Institute, United States), Athena Coustenis (Paris Observatory, France)

Organizing Committee: TBA

Event Information: In the present climate
of scientific exploration and potential scientific/commercial exploitation of celestial bodies ranging the Moon, through asteroids and comets to, potentially larger icy bodies in a distant future, it is incumbent on mankind to consider their environmental stewardship in terms of "planetary sustainability." While accepting that future exploitation of celestial bodies may be essential for the survival of the human species, we need now to address potential irreversible changes resulting from human activities. There is, thus a growing need to establish a pathway towards an international environmental regime for space exploration. This situation calls for reflection on the scientific exploration of the celestial bodies together with the collateral economic aspects, coupled to legal considerations with discussion as to what can, realistically, be undertaken to assure sustainable stewardship of celestial bodies. We welcome contributions addressing any of these wide-ranging topics.

PEX.2 A Shared Scientific Vision for Global Space Exploration

MSO/DO(s): Frances Westall (CNRS, France)
Organizing Committee: TBA

Event Information: Efforts have been made to reiterate and reinforce the role of the scientific community in defining and fulfilling robotic and space exploration goals, including exploring the Moon, Mars and near-Earth asteroids. Exploration of the Earth-Moon-Mars space can provide answers to key questions of our existence: how our solar system formed, whether life exists beyond Earth, and what our future prospects may be. A shared vision is crucial to give overall direction and to unite stakeholders in sustaining a global space exploration programme. We welcome contributions addressing any of these wide-ranging topics.

PE.1 Teacher Training Workshop

MSO/DO(s): Rosa Doran (NUCLIO - Núcleo Interactivo de Astronomía, Portugal), Auriol Heary (University of Western Australia, Australia)
Organizing Committee: TBA

Event Information: According to the world bank, more than 85

PE.2 Current Trends, Initiatives and Research in Education and Outreach for Space Sciences

MSO/DO(s): Michel Boer (CNRS, France), Rosa Doran (NUCLIO - Núcleo Interactivo de Astronomía, Portugal)
Organizing Committee: TBA

Event Information: This session will address the issues in related to research in education for Space Sciences. It will feature also the various initiatives from teachers, educators and scientists engaged in education and public outreach in COSPAR related fields. We will also address the following topics: Current trends for education and outreach in space science Citizen space sciences Space literacy Use of small and nano satellites Use of Big Data in the classroom and for outreach Effective open access for schools User friendly software for education Space Sciences in the curricula Space in our modern life We call for research
studies and experiences from educators and researchers in the above mentioned fields.

**PIR.1 Near-term Exploration of the Interstellar Medium**

MSO/DO(s): Ralph McNutt (Johns Hopkins University Applied Physics Laboratory, United States), Robert Wimmer-Schweingruber (Christian-Albrechts-Universität zu Kiel, Germany)

Organizing Committee: Edmond C. Roelof (Johns Hopkins University Applied Physics Laboratory, USA), Steven R. Vernon (Johns Hopkins University Applied Physics Laboratory, USA), Michael V. Paul (Johns Hopkins University Applied Physics Laboratory, USA), Mike Gruntman (University of Southern California, USA), Richard A. Mewaldt (Caltech, USA), Pontus Brandt (Johns Hopkins University Applied Physics Laboratory, USA) Vladislav V. Izmodenov (Lomonosov Moscow State University, Russia), Mihir I Desai (Southwest Reserch, USA), Stamatios M. Krimigis (Johns Hopkins University Applied Physics Laboratory, USA) and (Academy of Athens, Greece), Leon Alkalai (Jet Propulsion Laboratory, USA), Gary P. Zank (The University of Alabama in Huntsville, USA)

**Event Information:** The scientific understanding of the interaction of the solar wind with the near interstellar medium has been a topic of significant discussion from the beginning of the Space Age. This Scientific Event builds upon relevant observations to date with a view to the next steps in our scientific study of our near neighborhood, including both in situ and remote observations relevant to planetary science and astrophysics from such a remote vantage point from the Sun. With the power supplies on the Voyagers nearing their end of life, the rapid pace of discovery of exoplanets in other stellar systems, and the evolution in our own understanding brought about results from the Voyager, Cassini, and Interstellar Boundary Explorer (IBEX) spacecraft, the time is right for looking at the next small steps we can make into our stellar neighborhood. This Event is divided into (1) science of the nearby interstellar medium, (2) instrumentation for making measurements of and from the nearby interstellar medium, and (3) near-term approaches for reaching the nearby interstellar medium. Papers discussing science traceability to measurement requirements and to instrument implementation requirements demonstrating science closure are especially encouraged. The focus is on new measurements and science, which can be accomplished in more than 50 years and be ready for launch no later than the year 2030. While the emphasis is on heliophysics science objectives, discussions of compelling astrophysics and planetary science objectives and their implementations are also sought.

**PPP.1 Planetary Protection Policy**

MSO/DO(s): Athena Coustenis (Paris Observatory, France), Akihiko Yamagishi (Tokyo University of Pharmacy and Life Science, Japan)

Organizing Committee: TBA

**Event Information:** This session will include reports on recent planetary protection studies, colloquia/workshops and agency
activities with relevance to the COSPAR Planetary Protection Policy and implementation guidelines. Recent adaptations and updates of the Policy proposed by the COSPAR Panel on Planetary protection and validated by the COSPAR Bureau following the Panel’s recent meetings and based on documented studies will be presented. Further revisions proposed by the current international space exploration context or new scientific discoveries will be discussed.

PPP.2 Planetary Protection Mission Implementation and Status

MSO/DO(s): Gerhard Kminek (ESA, Netherlands), Lisa Pratt (NASA, United States)

Organizing Committee: TBA

Event Information: This session covers reports on the planetary protection implementation and status of launched, ongoing and planned missions. The session will focus on techniques, measures and procedures applied to spacecrafts, payloads and ground facilities to meet and verify the respective planetary protection requirements.

PPP.3 Planetary Protection Research and Development

MSO/DO(s): Niklas Hedman (), Petra Retzbeg (DLR - Inst. of Aerospace Medicine, Germany)

Organizing Committee: TBA

Event Information: This session will report on planetary protection research and development activities, including in preparation for new mission concepts and taking into account more challenging scientific endeavors, including on life detection.

PRBEM.1 Missions and Data Sets for Radiation Belt Modeling

MSO/DO(s): Yoshizumi Miyoshi (Nagoya University, Japan), Paul O’Brien (The Aerospace Corporation, United States)

Organizing Committee: TBA

Event Information: The energetic electrons and ions in the radiation belts are often responsible for damaging satellites and pose a serious hazard to astronauts. Therefore modeling the radiation belts is important for societal activities in the space. Currently, several high altitude geospace satellites, such as Van Allen Probes and Arase measure space radiation. Moreover, a number of low-altitude satellite have continuously observed space radiation. These missions as well as past and future missions provide data sets for radiation belt modeling. PRBEM-1 will cover topics related to the past/present/future geospace missions to measure the radiation environment, data sets and their applications to radiation belt modeling.

PRBEM.2 Development of Global Physical, Empirical, and Data Assimilative Models of the Radiation Belt Environment

MSO/DO(s): Yuri Shprits (German Research Centre for Geosciences, Germany), Adam Kellerman (UCLA, United States)
Organizing Committee: TBA

**Event Information:** Particles trapped by Earth magnetic field and particles caring the ring current are hazardous to satellite electronics and can produce deep dielectric charging and surface charging. Several recent studies showed how physics based models can be combined with statistical models to reconstruct the radiation belt environment for the purposes of specification, now-casting and forecasting. The session will cover a broad range of topics related to the near-Earth radiation environment modeling with a goal of development of new specification models. We invite a broad range of contributions related to: specification of the radiation belt, ring current and SEP environments; describing the new data sources or tools for data processing and analysis; predictive modeling; that can be adopted for operations; describing the new data assimilation modeling; allowing to reconstruct the evolution in the past.

**PSB.1 Scientific Ballooning: Recent Developments in Technology and Instrumentation**

**MSO/DO(s):** Tetsuya Yoshida (Japan Aerospace Exploration Agency (ISAS/JAXA), Japan), Sandip Kumar Chakrabarti (Indian Centre for Space Physics, India)

Organizing Committee: João Braga (INPE, Brazil) Jessica A. Gaskin (NASA/MSFC, USA) Suneel Kumar (TIFR/Balloon Facility, India) Mark Pearce (KTH, Sweden) Steve Smith (SWRI, USA) André Vargas (CNES, France)

**Event Information:** Balloons are used in scientific research in the fields of astrophysics, solar and space physics, planetary and earth sciences and atmospheric science. They are designed and operated for a wide variety of mission types. They drift in the troposphere, in the lowermost or medium stratosphere for numerous efforts have been conducted in the past to develop dedicated tools and libraries to ease scientific research. Some are developed jointly such as IRBEM or SPACEPY, while others are developed at individual labs. One lesson learnt from COSPAR assembly 2018 was that today it is not easy for early career scientists, as well as others, to find and use the most appropriate tool quickly and easily. PRBEM 3 has the mission to provide a time for tutorials and discussions on what exists, what can be improved and what can be developed jointly. PRBEM 3 will host a review (solicited) of such tools and will provide tutorials (some solicited) dedicated to the most established ones. Contributed ideas for new or dedicated tools and libraries are welcome.
a duration ranging from hours to months. A research mission can be accomplished in a single or multiple coordinated balloon flights. As an example, a mission can be designed to test innovative space borne instruments or to complement space-borne systems, and to calibrate and validate satellite instruments by in-situ measurements in the atmospheric science field. It can also be designed as a self-standing experiment, taking benefit of the unique capabilities of the balloon flight profiles. The balloon borne experiments benefit from new technologies in the area of instrumentation, in particular on the aspects of miniaturization, as well as from the advances in the balloon system design. A dialog between scientists and balloon system designers is very helpful. One of the main goals of this panel is to help advance this dialog. The panel is organized according to the following topics: Presentation of national programs. Mission concepts (Earth and planetary). Scientific Instruments. Balloon system design, analysis and performance. Gondola design and service systems. Meteorological balloons for professional Atmospheric science and Astrophysics. Public outreach and education of new generation of scientists. Plans of scientific ballooning in Australia and New Zealand.

PSD.1 Satellite Dynamics - new Developments and Challenges for Earth and Solar System Sciences

MSO/DO(s): Heike Peter (PosiTim UG (haftungsbeschränkt), Germany), Adrian Jäggi (Astronomical Institute, University of Bern, Switzerland)

Organizing Committee: Jose van den IJssel (TU Delft, The Netherlands), Shuanggen Jin (Shanghai Astronomical Observatory, China), Stefano Bertone (GSFC NASA, U.S.)

Event Information: The aim of the Panel on Satellite Dynamics is to support activities related to the detailed description of the motion of artificial celestial bodies. This goal should be achieved by improving the current theories of motion and by evaluating their determining forces in a more sophisticated way. Detailed theoretical understanding of the dynamics of satellites should coincide with the results of precise tracking in order to obtain the most precise knowledge possible of the orbit and the corresponding orbital positions. The scope of the Panel on Satellite Dynamics entails the positioning of a wide range of objects in space, including Earth orbiting satellites for Earth observation such as GRACE-FO, Swarm, Jason-3, and the Copernicus Sentinels, and navigation satellite systems such as GPS, GLONASS, Galileo, Beidou, QZSS or tracking systems such as SLR and DORIS. In addition, positioning plays an important role in the success of the continuously growing number of today’s and tomorrow’s missions to explore the Solar System. Recent and future missions have to deal with complex trajectories and innovative propulsion and breaking techniques to visit multiple bodies (e.g., Cassini, Dawn, JUICE), small unconventional bodies (e.g., Rosetta, OSIRIS-REx, Lucy), and harsh and unknown environmental conditions challenging our technical capabilities (e.g., Messenger, Venus Express, BepiColombo, JUNO). Both advances in the modeling of spacecraft dynamics and the theoretical understanding of space observables (e.g., range, Doppler, VLBI, optical) are required to allow for a more efficient exploration and a deeper understanding of our Solar System. Limiting errors in Precise Orbit Determination (solar radiation pressure, time variable gravity fields, phase center corrections, attitude variations, etc...) are of critical interest for many stakeholders. Moreover, formations of satellites are being re-
alized and proposed for Earth observation and fundamental sciences, that impose very severe constraints on (relative) positioning and orbit and attitude control solutions (e.g. micro-propulsion). Mini-satellites and cubesats also represent a new frontier for both Earth and planetary exploration, posing new challenges as well as new opportunities. Satellite orbit determination requires the availability of tracking systems, well established reference frames and accurate station coordinate solutions, detailed force and satellite models, and high-precision time and frequency standards. Contributions covering all recent developments and plans in ground, satellite or probe positioning and navigation are solicited as well as contributions on current progress on establishment, maintenance and improvement of reference systems in Geosciences. The event will be organized as a joint event together with sub-commission B2 corresponding to IAG (International Association of Geodesy) Commission 1 on Reference Frames.

**PSW.1 Quantitative Assessment of Current and Emerging Space Weather Modelling Capabilities for Improved Space Weather Services**

MSO/DO(s): Alexi Glover (European Space Agency, Germany), Maria Kuznetsova (NASA Goddard Space Flight Center/Heliophysics Science Division, United States)

Organizing Committee: Vladimir Kalegaev (MSU, Russia), Mike Terkildsen (BOM, Australia), Piers Jiggens (ESA, Netherlands), Suzy Bingham (Met Office, UK), Stefaan Poedts (K U Leuven, Belgium), Joe Minow (NASA, USA), Clezio De Nardin (INPE, Brazil), Terry Onsager (NOAA, USA)

**Event Information:** Within the space weather community, prototype services frequently operate as capability demonstrators and a full verification of their ability to reproduce/predict elements of the space environment under a range of space weather conditions, from the moderate to the extreme, has yet to be completed. In addition, as new modelling capabilities emerge, information on the operational use case for a given model can provide valuable information to the developer, facilitating transition from the research domain into operations at a later stage. Underpinning model accuracy is being addressed by numerous international activities, but as yet a community-wide consensus on how to address accuracy and suitability for transition into operations for the wide range of models and domains involved has not been reached. This event builds on the successful related event held during the 42nd COSPAR Scientific Assembly. It encourages dialogue between modellers, application developers and service providers in order to review current model and service validation activities, to build upon successes, to identify challenges, and to develop a strategy, supported by actions, for continuous assessment of space weather predictive capabilities as recommended in the COSPAR Space Weather Roadmap. Presentations from International Space Weather Action Teams focusing on capability assessments are encouraged as are all presentations addressing both coordinated validation frameworks and individual case studies. This event will also include a discussion panel focussing on techniques to characterise progress towards operational readiness and on enabling feedback from operations to the research domain.

**PSW.2 Planetary and Interplanetary Space Weather**

MSO/DO(s): Manuel Grande (Aberystwyth
Event Information: Space Weather effects are significant throughout the solar system and the ability to predict and design around them is essential for planetary exploration. We welcome descriptions of measurements of space weather effects made in planetary environments or interplanetary space, as well as models, comparisons and methods for improved prediction. We will also explore the way that the space weather environment at other solar system bodies modifies the design criteria for instruments and missions. We particularly welcome presentations which consider the topic of planetary space weather in the context of the recent COSPAR space weather roadmap.

PSW.3 Nowcast and Forecast on Ionospheric Indices and Related Scales for Space Weather Services

MSO/DO(s): Norbert Jakowski (Deutsches Zentrum fuer Luft-und Raumfahrt (DLR), Germany), Tim Fuller-Rowell (University of Colorado, United States)

Event Information: Discussion of ionospheric indices having a high potential to fulfill user requirements in particular in safety of life (SoL) and precise positioning applications shall be continued in a more concretized form than we could do at the 42nd COSPAR assembly. Initiated studies shall be reviewed and conclusions shall be drawn which indices are considered as potentially applicable for selected use cases. In order to judge the suitability, specification of user needs for various applications are required from customers. Therefore, intensification of the dialog between ionospheric scientists and customers is encouraged. Best practice experience obtained in weather/ionospheric weather services should be presented. Being aware that forecasts of the expected behavior of indices used by customers require intensive scientific research in the context of overall space weather processes, related scientific work should be discussed to enable or further improve forecasting of ionospheric indices. Therefore, contributions from SW experts covering all other fields of space weather are encouraged. Progress on the development of an Ionospheric Scale related to the indices is also encouraged.

PSW.4 Space Weather Information Architecture and Its Roles in Enhancing Data Access and Utilization

MSO/DO(s): Arnaud Masson (European Space Agency, Spain), Shing Fung (NASA Goddard Space Flight Center, United States)

Event Information: The Space Weather
community has entered the era of big data for almost a decade now. Research analysis and modelling efforts to understand and forecast the space weather impact of solar eruptive events rely largely on the availability, accessibility and usability of diverse (space-based and ground-based) heliophysics and space weather data products. The growing data complexity and volume imply the need for a coherent information architecture that uses data standards to support data and information flows effectively. Standards for data models, metadata and data access protocols can enhance data distribution and support data mining and data-model comparison. Several standards are already in use in the heliophysics and space weather community, e.g. Space Physics Archive Search And Extract (SPASE), Heliophysics API (HAPI), Common Data Format (CDF) or the Open Geospatial Consortium (OGC). The use of different standards raises further issues about interoperability and compatibility. For this session, we invite submissions describing current or planned usage of data model standards from space weather or more generally heliophysics data providers. We welcome contributions on standardised data access and exchange tools that will also enable international coordination and collaboration. Applications of these tools in supporting data-model comparison, data mining and machine learning are strongly encouraged.

PSW.5 International Space Weather Action Team - a Global Network of Research Teams Targeting Improvements of Resilience to Space Weather

MSO/DO(s): Maria Kuznetsova (NASA Goddard Space Flight Center/Heliophysics Science Division, United States), Mario M. Bisi (Rutherford Appleton Laboratory, United Kingdom)

Organizing Committee: Hermann Opgenoorth (Umea University, Sweden), Ian Mann (University of Alberta, Canada), Manuela Temmer (University of Graz, Austria), Bruinsma Sean (CNES, France), Anna Belehaki (NOA, Greece), Alexi Glover (ESA, Germany), Sophie Murray (Trinity College Dublin, Ireland), Daniel Heynderickx (DH consultancy, Belgium), Jon Linker (Predictive Science Inc., USA), Manuel Grande (Aberystwyth University), Sharafat Gadimova (UNOOSA), Robert Wimmer-Schweingruber (University of Kiel, Germany)

Event Information: Modern society has become increasingly dependent on complex technological environment that is highly susceptible to space weather effects caused by the temperamental nature of our dynamic Sun. Understanding and predicting space weather and its impact on society is acknowledged as a global challenge. To address the need to join forces and to maximize return on investments thenbsp; COSPAR Panel on Space Weather coordinates an activebsp; network of Internationalnbsp; Space Weather Action Teams (ISWAT). An action team choses to address a specific focused task, thus providing a building block of the ISWAT initiative. Action teams are organized into clusters grouped by domain, phenomena or impact and work in coordinated effort to improve resilience to space weather. The initiative is building upon established efforts, engages existing international groups and facilitates emergence of new teams and ideas. We solicit contributions from teams focused on different aspects of space weather including advancing understanding, collecting user requirements, assessment and improvement of predictive capabilities, utilization of available observations, transition of research ideas to applications, and inputs for future missions planning. We welcome submissions from ISWAT teams as
well as from teams that are interested to join the ISWAT. We particularly encourage submission on space weather community-wide initiatives and campaigns and invite discussions on community coordination in space weather and approach to Global Space Weather Roadmap updates.

**PSW.6 Global Coordination in Space Weather. Interfacing with User Groups**

MSO/DO(s): Ian Mann (University of Alberta, Canada), Hermann Opgenoortn (Sweden)

Organizing Committee: Richard Marshall (Australian Bureau of Meteorology, Australia) Masha Kuznetsova (Goddard SpaceFlight Center, USA)

**Event Information:** Space weather is and will remain a challenge to space and planetary sustainability and will become increasingly important to deal with in the future as we become more reliant on technologies that are susceptible to our variable space environment. Recognizing the need to understand the solar origin of space weather, characterize its impacts on space- and ground-based technologies and human space-flight programs, and develop reliable forecasting services for end-users, COSPAR commissioned an international space weather roadmap study for 2015-2025 (Advances in Space Research, 2015: DOI: 10.1016/j.asr.2015.03.023). Under the coordination of the COSPAR Panel in Space Weather (PSW), the Roadmap is now in the process of being updated. Ensuring that future updates to the roadmap appropriately reflect user needs are critical to this process. This event will consist of invited discourses and panel discussions focussing on the needs of the users of space weather services. It offers a forum for interactions between scientists and the user community with a view to facilitating improved space weather services, underpinned by appropriate observational and modeling capabilities and their transition from research to operations. The goal is to create an information-sharing environment that brings together international scientific, engineering and operational communities, and impacted societal groups and users, towards the goal of an improved global resiliency against the adverse impacts of space weather.

**PSW.7 Hands-on Education in Space Weather**

MSO/DO(s): Dibyendu Nandi (Center of Excellence in Space Sciences India, IISER Kolkata, India), Alexi Glover (European Space Agency, Germany), Nat Gopalswamy (NASA Goddard Space Flight Center, United States)

Organizing Committee: Hermann Opgenoorth (Uppsala University, Sweden) Robert F. Wimmer-Schweingruber (University of Kiel, Germany)

**Event Information:** This session will focus on global coordination in space weather education and capacity building. Solicited speakers will highlight currently ongoing space weather capacity building activities by their respective organizations. This will be followed by a round-table discussion on strategies for coordination and collaboration among various organizations and space agencies in delivering integrated space weather education through workshops and schools around the world. Leveraging of both expertise and finances for such activities would be discussed among the
stakeholders. Individual submissions highlighting space weather education and outreach efforts from around the world are encouraged; these will be scheduled as a poster session and will be highlighted through a flash-poster summary during the oral session. This session is organized under the aegis of the International Space Weather Action Teams (ISWAT) initiative of the COSPAR Panel on Space Weather. https://ccmc.gsfc.nasa.gov/iswat/

S.1 You are COSPAR!

MSO/DO(s): Michel Viso (CNES, France), Jean-Louis Fellous (COSPAR Secretariat, France)

Organizing Committee: TBA

Event Information: COSPAR is your science organisation to explore space related activities in a wide range of fields. This event is dedicated to new-, or not so new, comers at a Scientific Assembly. A few presentations will describe the history and the future of COSPAR as well as the various ways for any Associate to participate and proudly support the Science and the Committee. Associates are invited to take the floor or to present in posters how they discovered COSPAR, how COSPAR helps them in their science career or to foster cooperation and initiate new projects. This event will help everyone to acknowledge the new stance of COSPAR. We will demonstrate the importance of publishing in Space Research Today, Life Sciences in Space Research, and Advances in Space Research. We will answer to Everything You Always Wanted to Know About Cospar* (*But Were Afraid to Ask)!

S.2 Deep Space Science Enabled by Daughter Nanosats

MSO/DO(s): Steven E. Matousek (), Pierre W. Bousquet (Centre National d’Etudes Spatiales, France)

Organizing Committee: TBA

Event Information: This session will present possible future planetary science return using daughter nanosats. Technology is rapidly advancing to reduce the power, mass, volume, and cost of science instruments for small platforms (smallsat, cubesat, and nanosat). One particularly promising mode to return unique science is to have one or more daughter platforms deployed from a main spacecraft at the destination. The increase in temporal and/or spatial measurements leads to new ways to explore. We will present new planetary science enabled by the use of one or more daughter nanosats emphasizing the science measurements and required techniques.