

Report of Division F “Planetary Systems and Astrobiology” 2021

1. Discussion among the members

The Div. F SC has participated or is participating in the Selection Process of the following IAU calls :

- Approval of new members
- Symposia 2021
- PhD Prizes 2021

Discussions among Division F and their commissions are ongoing.
Organization of the GA Division Day 2022.

Participation to the virtual meeting of Minor Planet Center User’s Group (MPC MUG) on Dec 2021.

A new Commission has been created as part of the Division F and organisation discussions are ongoing. Commission F4 – Asteroids, Comets and Transneptunian Objects started in August 2021 in a very active way.

2. Conference participation & diffusion

Due to the coronavirus many of meetings and workshops in this period of activity were virtual: the accessibility offered by this format has enabled much greater levels of participation than otherwise would have been allowed, even if a particularly detrimental effect was allocated on early-career researchers reducing personal changes and rich discussions.

Few to be quoted among many others:

-2021 Sagan Summer Workshop: Circumstellar Disks and Young Planets: 19 - 23 July 2021, Pasadena, CA/Virtual <https://nexsci.caltech.edu/workshop/2021/>

-Planet-forming Disks: From Surveys to Answers: 13 - 17 September 2021; Lorentz Center @ Oort, Leiden, NL <https://www.lorentzcenter.nl/planet-forming-disks-from-surveys-to-answers.html>

-Spatially Resolved Spectroscopy with Extremely Large Telescopes: 20 - 24 September 2021, Oxford <https://elt2020.web.ox.ac.uk/>

-Gaps, Rings, Spirals, and Vortices: Structure Formation in Planet-Forming Disks: 4 - 29 October 2021 Munich, Germany <https://www.munich-iapp.de/planet-forming-disks21>

-Modern trends in studies of physics and dynamics of the Solar system bodies, 4 - 5 October 2021 Shamakhy Astrophysical Observatory of ANAS <https://shao.az/en/news/638>

-PLATO Conference 2021: Exploring exoplanets in the habitable zone of solar-like stars_11 - 15 October 2021, Virtual <http://platomissionconference2021.iaa.es>

-The Star-Planet Connection: 25 - 28 October 2021, virtual <https://www.eso.org/sci/meetings/2021/StarPlanetConnection2021.html>

-Hayabusa symposium 2021 Nov. 15-16, 2021 virtual <https://curation.isas.jaxa.jp/symposium/2021/index.html>

3. Highlights

- The discovery of a 5 planet Laplace chain around TOI-178 <https://doi.org/10.1051/0004-6361/202039767> selected as a target for JWST <https://www.stsci.edu/jwst/science-execution/program-information?id=2319> the best laboratory for testing planetary formation theories
- The confirmation of the very large size of the comet Bernardinelli-Bernstein: <https://arxiv.org/abs/2201.13188>
- The discovery of the atoms of iron and nickel in the cold coma of Solar system comets <https://www.nature.com/articles/s41586-021-03435-0> and the first interstellar comet 2I/Borisov <https://www.nature.com/articles/s41586-021-03485-4>.
- First analysis of the sample back to Earth of Ryugu <https://www.nature.com/articles/s41550-021-01551-5>
- Discovery of approximate, but general, analytical solutions for albedos and reflected light phase curves of celestial bodies.: <https://www.nature.com/articles/s41550-021-01444-7>
- The series of [20 different MAPS papers](#) all released simultaneously which provide "deep, high-resolution ALMA observations of molecular lines to explore the chemistry that affects and probes planet formation in disks"
- The book "The Pluto System after New Horizons" (2021, University of Arizona Press).
- The successful launches of two asteroid missions by NASA: Lucy to Trojan asteroids and DART to the binary asteroid Didymos. https://www.nasa.gov/mission_pages/lucy/overview/index; <https://www.nasa.gov/planetarydefense/dart/dart-news>
- NASA & ESA selects 3 missions to Venus <https://www.nasa.gov/press-release/nasa-selects-2-missions-to-study-lost-habitable-world-of-venus> & https://www.esa.int/Science_Exploration/Space_Science/ESA_selects_revolutionary_Venus_mission_EnVision
- Launch on December 2021 of James Webb Space Telescope <https://webb.nasa.gov/content/about/launch.htmlon>
- The selection Solar System objects and exoplanets, disks for JWST observations is also an important achievement: <https://www.stsci.edu/jwst/science-execution/approved-programs/cycle-1-go> <https://www.stsci.edu/jwst/science-execution/approved-ers-programs> <https://www.stsci.edu/jwst/science-execution/approved-programs/cycle-1-gto>

Annexes

Reports:

Commission F1: Meteors, Meteorites and Interplanetary Dust

Commission F1 has organized a series of conferences every three years since 1991. In 2022, the Meteoroids meeting was to have been held in Huntsville, Alabama, USA, with Dr. W. Cooke of NASA Marshall Space Flight Centre the chair of the Local Organizing Committee. Because of the ongoing difficulties in travel caused by the pandemic, Meteoroids 2022 will be held virtually from June 13-17. Oral presentations will be pre-recorded by participants, and conference sessions will involve live discussions. Nearly 250 scientists have expressed interest in attending the conference, which is open for registration and abstract submission until March 30, 2022. The Scientific Organizing Committee consists of the members of the Organizing Committee of Commission F1, with additional members nominated by members of the committee. In spite of the pandemic, we are looking forward to discussing important recent advances in the field, including recovered meteorites on unusual orbits, new meteor showers predicted and observed (the Arids), the growth of global meteor camera networks (CAMS, GMN, DFN and AMOS) and connections with our colleagues working on comets and asteroids. Members of our Commission have also been participating in virtual meetings: the International Meteor Conference, organized by the International Meteor Organization, held meetings in September 2020 and 2021. The IMO is an amateur organization, but for decades there have been close ties between amateur and professional meteor astronomers. Our members have also participated in the June 2021 and February 2022 EUROPLANET Fireball workshops. Our Working Group on Meteor Shower Nomenclature has been very active recently, and are working on revising the procedure for moving meteor showers from the working list (with over 800 candidate showers) to the list of established showers (currently 112 showers). A list of criteria are being drawn up to increase the rigor required for this procedure, which should result in a much more robust list of established showers.

Margaret Campbell-Brown
Commission F1 President

Commission F2 : Exoplanets and the Solar System

The disciplines covered by this Commission have been growing rapidly. As a consequence, our membership has increased to 423.

Exoplanets have attracted considerable attention, and the public has wanted popular names for some of their favored planets. The IAU has responded with two public naming campaigns, organized by the WG Exoplanets for the Public. Both campaigns were well-received by the public, but the exoplanet scientists in general have not adopted public names in the research literature. To facilitate future efforts on this topic, at the request of Division F and Commission F2, the WG Exoplanets for the Public has been dissolved and replaced by a more broadly chartered Functional WG Exoplanetary System Nomenclature under Division F.

IAU Symposium 370: Winds of Stars and Exoplanets and other conferences endorsed by Comm. F2 have been postponed from 2021 to 2022 due to the coronavirus pandemic.

Commission President Jack Lissauer and Past President Alain Lecavelier des Etangs (and president of the WG Exoplanets for the Public), have written an article explaining the new working definition of an exoplanet that was adopted by the members of the Commission in 2018. This article was accepted for publication in the journal *New Astronomy Reviews* in early 2022.

Jack Lissauer
Commission F2 President

Commission F3 : Astrobiology

Meeting sponsored by Commission

Before the advent of COVID, we had planned to hold an Astrobiology Meeting in South Africa in November 2020. Needless to say, this meeting never occurred. It was postponed several times before being cancelled by the local organizing committee. The F-3 Organizing Committee now intends to co-sponsor a meeting in 2023 in Quito, Ecuador in collaboration with the International Society for the Study of the Origin of Life (ISSOL). The planning is being led by Dr. Herve Cottin, the Vice President of Commission F-3 in collaboration with Dr. H. J. Cleaves, President of ISSOL. We will send more information to commission members as details become available.

Standards of Evidence for Life Detection.

Over the last few years there has been quite a bit of debate on what standards should be applied to claims for the detection of life, either by in-situ probes such as those currently operating on the surface of Mars or via remote observations such as those used to study extra solar planetary systems. In response to the interest in this topic a community workshop was convened, Co- Chaired by Dr. Victoria Meadows (University of Washington) and Dr. Heather Graham (Catholic University of America/NASA-GSFC). This workshop produced a Draft Report “Community Report From the Biosignatures Standards of Evidence Workshop” that is available for review at the following website:

https://www.nfold.org/files/ugd/c2389f_d081d7f5fcfc455cbe0bb560a900ecb6.pdf

This is an extensive and comprehensive attempt to recommend standards for the Astrobiology Community as we seek evidence for the existence of Life beyond the Earth. While the official comment period on the report has ended, I expect that the debate concerning the suggested standards will continue into the indefinite future and that members of Commission F-3 should become familiar with the arguments and concepts presented in this report.

The European Astrobiology Network Association

The European Astrobiology Network Association (EANA) presented the following awards:

2021 Space Factor Students Contest

1st prize, Sebastian Victor Gfellner et al., Introducing the FORaminifera Rocket EXperiment (FORAREX)

2nd prize, Bárbara Soares et al., Composition of terrestrial planets orbiting M dwarfs

3rd prize, Marina Fernandez et al., Interstellar phosphorus chemistry as a complex system: a theoretical approach to the formation of the simplest building blocks of life

4th prize, Hector Palomeque et al., *Ignicoccus hospitalis* – understanding its extraordinary radiation tolerance and an unsolved archaeal repair system

EANA 20th Anniversary Presentation Award

Annemiek C. Waajen et al., How the presence of meteorites could have shaped microbial communities on early Earth

Kristina Beblo-Vranesevic et al., From Mars analogue environments to space: ground data evaluation of the survivability of *Buttiauxella* sp. MASE-IM-9 and *Salinisphaera shabanensis*
Lena Noack and Caroline Brachmann, Can plate tectonics lead to observational traces in (exo) planetary atmospheres?

EANA 20th Anniversary Outstanding Paper Award

Alberto G. Fairén, Javier Gómez-Elvira, Carlos Briones, Olga Prieto-Ballesteros, José Antonio Rodríguez-Manfredi, Raquel López Heredero, Tomás Belenguer, Andoni G. Moral, Mercedes Moreno-Paz, and Víctor Parro, The Complex Molecules Detector (CMOLD): A Fluidic-Based Instrument Suite to Search for (Bio)chemical Complexity on Mars and Icy Moons

Joseph A. Nuth
Commission F3 President

Commission F4: Asteroids, Comets & TNOs

Com. F4 is a new Commission which approved in Aug 2021. Currently it has 241 members. Members of Organizing Committee are Irina Belskaya, Ukraine (President), Ricardo Gil-Hutton, Argentine (Vice-President), Driss Takir, USA (Secretary), Jorge Carvano (Brazil), Masateru Ishiguro (Republic of Korea), Joseph Masiero (USA), Patrick Michel (France), and Flora Paganelli (USA).

One of the aims of the Commission is to promote progress on study the physical properties of small solar system bodies. Highlights of the main events and results on asteroids, comets and TNOs in 2021 were discussed and proposed by Commission members. These highlights will be posted at Commission's webpage to help larger public audience to get acquainted with the most significant results published in 2021 in more than 1600 peer-reviewed papers.

The OC activity included participation in organization of the Division Days on the GA in Busan; participation in the SC Division F virtual meeting and in the virtual meeting of Minor Planet Center User's Group (MPC MUG) on Dec 15-16, 2021. The latter meeting discussed MPC/SBN efforts and updates aimed to serve for small bodies community.

Irina Belskaya
Commission F4 President

Commission X2 : Cross-Division A-F Commission Solar System Ephemerides

During this period, optical observers and data processing centers (MPC, NASA, ESA, NEODyS) consolidated the adoption of the ADES format, which was approved by Commission 20 at the 2015 IAU General Assembly. The transition process is on-going, but important applications are already in place such as the NEO Confirmation Page targets data processing for JPL-Scout and NEODyS-NEOScan computations. The next major challenge is preparing to process the increased flow of astrometric data due to the start of big surveys such as the Vera Rubin Telescope, the NEO Surveyor mission, and the Fly-Eye Telescope. The data flow is expected to increase by up to two orders of magnitude relative to the current data flow, which

primarily comes from the operational surveys. In view of this increased data volume, the Minor Planet Center is making the necessary preparations and major software and data flow architecture reviews are undergoing. Similar adaptations are necessary for the other data processing centers. On the planetary side, the next-generation, general-purpose planetary and lunar ephemerides called DE440/DE441 were delivered in 2020 by JPL. Compared to the previous general-purpose ephemerides DE430, seven years of new data have been added with improved dynamical models and data calibration.

Since 2016, three new versions of INPOP planetary and lunar ephemerides have been delivered by the IMCCE team: INPOP17a, INPOP19, and INPOP21a. They benefit from an improved modeling of the Moon rotation and orbit (INPOP17a), the introduction of Bayesian methods for the asteroid mass determination and the regular inputs of Juno, Mars Express and ExoMars data (INPOP19a, INPOP21a). Perturbations by TNOs have been included since 2020 after the introduction of recently analyzed Cassini observations. Constraint on the size of the Moon core has been obtained, INPOP21a gave a better description of the distribution of the mass for the outer solar system and new constraints on dilaton and graviton theories have been published using INPOP19a and INPOP20a.

In 2021 the IAA - Russian Academy of Sciences released a new version of planetary ephemerides, EPM2021, after 4 years since last release.

In 2021 the JPL-Sentry team announced the implementation of a new impact monitoring method that replaces the Line-of-Variations method. This development is important because the new method is fully independent of the previous ones, thus improving the reliability of the results and of the cross-check validation with NEODYs and ESA.

Fabrizio Bernardi
Commission X2 President