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Preface

Preface to the special issue of PSS on "Surfaces, atmospheres and magnetospheres of the outer planets, their satellites and ring systems: Part XII″

This issue contains six articles on original research and review papers presented in the past year in sessions organized during several international meetings and congresses including the European Geosciences Union (EGU), European Planetary Science Congress (EPSC) and others. The manuscripts cover recent observations and models of the atmospheres, magnetospheres and surfaces of the giant planets and their satellites based on ongoing and recent planetary missions. Concepts of architecture and payload for future space missions are also presented. The six articles in this special issue cover a variety of objects in the outer solar system ranging from Jupiter to Neptune and the possibilities for their exploration. A brief introductory summary of their findings follows.

In the paper *"Longitudinal Variability in Jupiter's Zonal Winds Derived from Multi-Wavelength HST Observations"* Perianne Johnson and co-authors apply a sliding-window correlation method to recent HST imaging data to identify spatial variations in zonal winds, in particular in two equatorial jets.

In their study "*Scientific rationale for Uranus and Neptune in situ explorations*" Oliver Mousis and co-authors discuss mission concepts for possible future exploration of an important, but poorly understood class of the outer planets, the ice giants, Uranus and Neptune. The authors argue that essential aspects of the physical processes and properties of these bodies remain unknown and future spacecraft missions are needed to address them. In particular, such missions with an orbiter and entry probe as minimum essential elements will focus on the formation of ice giants, composition and dynamics, of their atmospheress, satellites and ring systems, magnetospheres and internal structure.

Bonnie Buratti et al. summarize in their review paper *"Cold Cases: What we don't know about Saturn's moons"* the remaining questions concerning the satellites in the Saturnian system, based on results from the Cassini mission. The icy moons around Saturn - Rhea, Dione, Mimas, Enceladus, Hyperion, Tethys, Iapetus, and Phoebe – still have unknown characteristics on various aspects concerning the surface composition, geology, thermal budget and other properties relating to their origin and evolution, as well as to their interactions with their environment. For example, the composition of minor constituents detected on the surface of the moons remains to be characterized and the mechanism driving Enceladus' heat production remains a mystery. The authors establish a list of nine priority questions that might be considered in the definition of future missions to the Saturnian system.

Building on the more general outstanding inquiries of the previous article, Conor Nixon and co-authors present a more detailed case for Saturn's Titan in the wake of the Cassini-Huygens mission. In "*Titan's Cold Case Files - Outstanding Questions After Cassini-Huygens*" they describe the space mission's discoveries, with the amazing results obtained during the 13 years from 2004 until 2017. They then go on to identify the unanswered scientific questions and the new ones that originated after the Cassini era exploration, which comprise all aspects of this complex world, from the interior to the outer atmosphere and its interactions with the surrounding environment. This review is very helpful for future investigations of this unique satellite in the solar system.

"*Explorer of Enceladus and Titan (E^2T): Investigating Ocean Worlds' Evolution and Habitability in the Solar System*" by Giuseppe Mitri and co-authors presents a mission concept to investigate some of the aspects highlighted in the previous paper, in particular the origin and evolution of volatile-rich ocean worlds with focus on the evolution and habitability of Enceladus and Titan. The baseline scenario for the E^2T mission is a solar electric powered spacecraft, in orbit around Saturn, performing multiple flybys of Titan and Enceladus. The payload is conceived to perform in-situ composition investigations and high-resolution imaging of these bodies. Mass spectroscopy in the state of the art would characterize the composition of Enceladus' plumes and Titan's atmosphere, while infrared imaging would reveal Titan's surface geology with unprecedented resolution (50–100m) and would bring robust constraints on Enceladus' heat budget via meter-scale imaging of its south polar terrain.

In "*0.2 to 10 keV electrons interacting with water ice: radiolysis, sputtering, and sublimation*", André Galli and co-authors present new laboratory work on water samples looking at radiolysis results after irradiation with electrons. The results bear strong relevance to oxygen-rich atmospheres around icy moons such as Europa and Ganymede.

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