



Scientific rationale and concepts for in situ probe exploration of Uranus and Neptune

Olivier Mouis (1), David Atkinson (2), Thibault Cavalié (3), Leigh Fletcher (4), Michael Amato (5), Shahid Aslam (5), Francesca Ferri (6), Jean-Baptiste Renard (7), Thomas Spilker (8), Ethiraj Venkatapathy (9), Peter Wurz (10), Karen Aplin (11), Athena Coustenis (3), Magali Deleuil (1), Michel Dobrijevic (12), Thierry Fouchet (3), Tristan Guillot (13), Paul Hartogh (14), Tilak Hewagama (15), Mark Hofstadter (2), and the Icy Giants in situ exploration team

(1) Aix Marseille Université, CNRS, LAM (Laboratoire d'Astrophysique de Marseille) UMR 7326, 13388, Marseille, France, (2) Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA, (3) LESIA, Observatoire de Paris, PSL Research University, CNRS, Sorbonne Universités, UPMC Univ. Paris 06, Univ. Paris Diderot, Sorbonne Paris Cité, 5 place Jules Janssen, 92195 Meudon, France, (4) Department of Physics & Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, UK, (5) NASA Goddard Space flight Center, Greenbelt, MD 20771, USA, (6) Università degli Studi di Padova, Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" (CISAS), via Venezia 15, 35131 Padova, Italy, (7) CNRS-Université d'Orléans, 3a Avenue de la Recherche Scientifique, 45071 Orléans Cedex 2, France, (8) Solar System Science & Exploration, Monrovia, USA, (9) NASA Ames Research Center, Moffett field, California, USA, (10) Space Science & Planetology, Physics Institute, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland, (11) Department of Physics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH, UK, (12) Laboratoire d'astrophysique de Bordeaux, University Bordeaux, CNRS, B18N, allée Geoffroy Saint-Hilaire, 33615 Pessac, France, (13) Observatoire de la Côte d'Azur, Laboratoire Lagrange, BP 4229, 06304 Nice cedex 4, France, (14) Max-Planck-Institut für Sonnensystemforschung, Justus von Liebig Weg 3, 37077 Göttingen, Germany, (15) University of Maryland, College Park, MD 20742, USA

Uranus and Neptune, referred to as ice giants, are fundamentally different from the better-known gas giants (Jupiter and Saturn). Exploration of an ice giant system is a high-priority science objective, as these systems (including the magnetosphere, satellites, rings, atmosphere, and interior) challenge our understanding of planetary formation and evolution. The importance of the ice giants is reflected in NASA's 2011 Decadal Survey, comments from ESA's SSC in response to L2/L3 mission proposals and results of the 2017 NASA/ESA Ice Giants study. A crucial part of exploration of the ice giants is in situ sampling of the atmosphere via an atmospheric probe. A probe would bring insights in two broad themes: the formation history of our Solar System and the processes at play in planetary atmospheres. Here we summarize the science driver for in situ measurements at these two planets and discuss possible mission concepts that would be consistent with the constraints of ESA M-class missions.