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Hydrogen chemistry in Space Exploration: *In-situ* resource utilization

Although hydrogen is the most common element on the universe, having access to large amounts of it in space and transforming it in a way that it can be useful for exploration is a challenge. The development of *in-situ* resource-utilization (ISRU) methods for space exploration is a new research activity which is being supported both by NASA and ESA. The Exploration Roadmap of ESA and NASA to fulfil: 1) the Human and Robotic exploration of the Moon; 2) the Deep Space Gateway and 3) the human exploration of Mars has been defined, and the first steps are now being implemented. However, the requirements on propellant mass do not allow for large landed missions. The future Mars Ascent Vehicle for humans will require about 7.0 mT of methane and 22.7 mT of oxygen to lift-off from Mars, back to Earth, with 4 crew members. This represents about 80% of the weight of the spacecraft, and this is to date one of the most critical problems that inhibits the human exploration of Mars. Methane, CH_4, has been observed on the Martian surface by the Curiosity rover, however only at trace-amount levels. The chemistry of methane production and destruction on Mars is to date not understood. New emerging space companies as SpaceX have declared their intention to investigate propellant production for Mars exploration. In addition to propellants, such as CH_4, water, H_2O, is another critical product, both for life- support systems and for its possible transformation into hydrogen, H_2, and oxygen, O_2, for propulsion or again for life-support systems. In this talk we will review where are the main sources of hydrogen in the form of water on Mars and the Moon and how can this water be captured and transformed to facilitate the human and robotic exploration of space. We will review a few options for the sustainable production of methane on Mars, and the ISRU concentration and purification of water. Some of these processes may also have an industrial application on Earth.

Speaker Biography

María-Paz Zorzano is a researcher at the Centro de Astrobiología (CAB), of the National Institute of Aerospace Technology (INTA, Spain) and a Professor in Atmospheric Science at the Luleå University of Technology (LTU, Sweden). She is a planetary physicist, investigating space exploration and astrobiology. She is involved in multiple NASA and ESA missions of exploration of the Earth, Moon and Mars, including the Curiosity rover of the Mars Science Laboratory mission (NASA), the Exomars Trace Gas Orbiter (ESA), the ExoMars Rover (ESA) and the ExoMars Surface Platform (Roscosmos / ESA), as well as on proposals for the future international exploration of the Moon through the ESA Moon landers missions or the Deep Space Gateway. She is member of the COSPAR Planetary Protection Panel. She has received multiple awards related to space, such as the 2018 finalist award of the Space Exploration Masters Challenge and 2nd prize of the InnoSpace Masters call of 2018. She was also awarded in 2013 with a NASA Group Achievement for her contributions to the instrument REMS on board the Curiosity Rover. She is author of 85 refereed articles and several book chapters.

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