Exploration of water resources in the lunar polar region

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Observations by multiple lunar exploration missions and their data analysis have suggested that water ice might be widely present in the lunar polar region [e.g., 1, 2]. For example, neutron spectrometer data indicates that hydrogen is abundant at latitudes above 85 degrees in both north and south poles compared to low latitudes. Moreover, the estimated water equivalent hydrogen in the top ~1m layer of the lunar regolith is up to ~0.5 wt. % [3]. With the possibility that water exists in the lunar polar regions, there is growing interest in using water ice as an in-situ resource. Specifically, if the water on the lunar surface can be used as a propellant, the mass of the spacecraft for the lunar landing mission at launch from the earth can be reduced, which will have a great impact on future exploration scenarios and activities. However, currently, the actual origin, abundance, condensation mechanism, and lateral and vertical distribution of water remain unclear. So, to assess the abundance and distribution of water in the lunar polar region, the Japan Aerospace Exploration Agency (JAXA), in collaboration with the Indian Space Research Organisation (ISRO), is planning the lunar polar exploration mission (LUPEX)[4, 5]. In this presentation, we report on the current status of examination on mission scenarios for water exploration using selected payload instruments.
In early 2020, JAXA has selected three candidate instruments for the LUPEX. In addition, it has decided to receive several types of candidate instruments form India and the international collaborators. We are considering two types of operational scenarios, one is "course observation" that observes water during the rover travers, and the other is "fine observation" that involves drilling by the rover system to collect and analyze samples. In course observation, during the rover traverse, radar observation ~1.5m underground by Ground Penetrating Radar (GPR), average hydrogen concentration measurement ~1m subsurface by Neutron Spectrometer (NS), and observation of exposed water ice on the lunar surface by Advanced Lunar Imaging Spectrometer (ALIS)[6] are performed. In fine observation, volatile gas leaking to the lunar surface excavation by the rover system is measured with a surface pressure gauge named Exospheric Mass Spectrometer for LUPEX (EMS-L), and excavated soil is observed with ALIS. The excavated and collected samples are analyzed by Resource Investigation Water Analyzer (REIWA). REIWA will be developed as an instrument package to conduct suites of direct volatile measurements of the surface/subsurface regolith samples. REIWA consist of mainly four subcomponents, namely, Lunar Thermogravimetric Analyzer (LTGA), Triple-Reflection Reflectron (TRITON)[7], Aquatic Detector using Optical Resonance (ADORE)[8], and ISRO sample analysis package (currently, this is a candidate instrument). LTGA has the function of measuring the concentration of volatile gas in the regolith by heating the sample to evaporate the volatile gas and measuring the weight difference. TRITON and ADORE are observation instruments that analyzes the mass spectrometry and trace moisture measurement of volatile gas generated by sample heating at LTGA. By performing these observations in multiple exploration areas (waypoints), ground truth data on water abundance and resource availability around the landing site will be obtained.

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