A mission proposal for understanding the origin of the lunar water: Scientific concept of the SELPHIE Mission

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We are approaching a new era of space exploration: Utilization of our Moon for Human Beings. Intensive international efforts targeting human activities on the Moon have been initiated, and developed drastically in this decade. The revolution enabling the activities was the discovery of water at the Moon. We envisage utilizing the water for Lunar surface activities, as well as for explorations to farther Deep Space destinations.

Although multiple datasets have revealed the existence of Lunar water, fundamental scientific questions remain unanswered: Where has the surface and cold trap waters come from? What are the relative roles between solar wind protons and delivery from space for the Lunar surface water? What is the role of transportation of surface water to cold traps? This is the problem area that the SELPHIE (Surface, Exosphere, and Lunar Polar Hydration with Impact Experiments) mission is to reveal. The top-level science question of SELPHIE is "How is the lunar surface water delivered or produced, transported, and accumulated in cold traps?"

The baseline design of the SELPHIE mission is composed of six scientific sensors (three remote sensing and three in situ sensors) together with two impact experiments: An infrared spectrometer, visible camera, energetic neutral atom telescope, neutral mass spectrometer, solar wind monitor, and dust detector. These sensors are operated from a 3-axis stabilized SELPHIE orbiter to reveal the comprehensive picture of the lunar water cycle. Two impact experiments (two identical systems, enabling two independent experiments) will be executed to reveal the source of water under cold traps. Each impact experiment contains a 6U cubesat and a small impactor (4 kg). The impactor will impact to a permanently shadowed crater to make ejecta. The cubesat will sound the plume by mass spectrometer and camera.

The nominal mission period is for 8-12 months, under the quasi-stationary polar orbit of the Moon (30-200 km altitudes). The pericenter is above the South Pole. The total mass of 600 kg (dry mass) with 61 kg payload mass is the baseline, while a further mass reduction could also be foreseen. The total cost, without payload development, is within the ESA's F-class mission cost cap (150 MEuro).

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