Interplanetary Missions Enabled by CubeSats and Micro-satellites —Achievements and Future Plan in Japan—

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This paper introduces Japanese achievements and future plans of CubeSats and Micro-Sats for deep space exploration.

As the first step toward deep space missions by such tiny and low-cost spacecraft, University of Tokyo and Japan Aerospace Exploration Agency (JAXA) developed the world’s first deep space microspacecraft PROCYON. Its mission objective is to demonstrate a micro-spacecraft bus technology for deep space exploration and proximity flyby to asteroids performing optical measurements. PROCYON was launched into the Earth departure trajectory on December 3, 2014 together with Japanese asteroid sample return mission Hayabusa-2. PROCYON successfully completed the bus system demonstration mission in its interplanetary flight.

Currently, Japan is not only pursuing the improvement and utilization of the demonstrated micro-sat deep space bus system with a weight of tens of kg or more for more practical scientific deep space missions, but also trying to develop smaller spacecraft with a weight of less than tens of kg, namely CubeSats, for deep space exploration. We are developing two self-contained 6U CubeSats for the rideshare opportunity on the USA’s SLS EM-1 mission, one of which (EQUULEUS) will fly to a libration orbit around Earth-Moon L2 point and perform scientific observations of the Earth and the Moon, and the other (OMOTENASHI) is planning to perform "semi-hard" landing on the moon by using a solid rocket motor onboard.

We are also seeking the possibility of CubeSats which is carried by a larger spacecraft to the destination and supports the mission by taking advantage of its low-cost and risk-tolerable feature. As an example of such style of CubeSat missions, we are studying a CubeSat for close observations of a planetary body (e.g. asteroid), which will be carried to the target body by a larger mother spacecraft.

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