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HAYABUSA2 ORBIT DETERMINATION

Abstract

The Hayabusa2 asteroid sample return mission was launched on December 3, 2014, and completed its nominal mission phase by landing its sample return capsule on the Woomera Prohibited Area (WPA) in Australia on December 5, 2020. Accurate deep-space navigation was the key to the successful completion of Hayabusa2's nominal mission phase. We developed a navigation software named Deep-space Multi-Object Orbit Determination System (DMOODS) and used it for the critical operations of Hayabusa2. In this paper, we discuss algorithms, propagation models, calibration models used for DMOOD. We also describe the significant achievements of the orbit determination team, which include the development of a precise navigation method for the ion-engine thrusting phase, successful rendezvous to its target asteroid Ryugu, and navigation result for the capsule Earth re-entry operation. Simultaneously with the orbit determination for Hayabusa2, the ephemeris and gravity field of Ryugu were estimated using the onboard navigation camera and LIDAR observation data and provided to the project during its 1.5-year asteroid proximity phase from June 27, 2018, to November 13, 2019. Such information was indispensable for the Hayabusa2's sample-collection operations of the surface materials of Ryugu. The observation methods and techniques for updating such data are also described in this paper.