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IN-FLIGHT OPERATION OF THE DAWN ION PROPULSION SYSTEM THROUGH THE HIGH  
ALTITUDE SCIENCE ORBIT AT CERES

**Abstract**

ABSTRACT In-Flight Operation of the Dawn Ion Propulsion System Through the High Altitude Science Orbit at Ceres Charles E. Garner and Marc Rayman Jet Propulsion Laboratory California Institute of Technology Pasadena, CA Charles.E.Garner@jpl.nasa.gov John.R.Brophy@jpl.nasa.gov The Dawn mission, part of NASA's Discovery Program, has as its goal the scientific exploration of the two most massive main-belt asteroids, Vesta and Ceres. The Dawn spacecraft was launched from the Cape Canaveral Air Force Station on September 27, 2007 on a Delta-II 7925H-9.5 (Delta-II Heavy) rocket that placed the 1218-kg spacecraft onto an Earth-escape trajectory. On-board the spacecraft is an ion propulsion system (IPS) developed at the Jet Propulsion Laboratory which will provide a total  $\Delta V$  of 11.3 km/s for the heliocentric transfer to Vesta, orbit capture at Vesta, transfer between Vesta science orbits, departure and escape from Vesta, heliocentric transfer to Ceres, orbit capture at Ceres, and transfer between Ceres science orbits. Full-power thrusting from December 2007 through October 2008 was used to successfully target a Mars gravity assist flyby in February 2009 that provided an additional  $\Delta V$  of 2.6 km/s. Deterministic thrusting for the heliocentric transfer to Vesta resumed in June 2009 and concluded with orbit capture at Vesta on July 16, 2011. From July 2011 through August 2012 the IPS was used to transit to all the different science orbits at Vesta and to escape from Vesta orbit. Cruise for a rendezvous with Ceres began in August 2012 with orbit capture at Ceres planned in early March 2015. Ceres orbit operations using IPS include the Approach phase, Survey orbit phase, and high altitude and low altitude mapping orbits. Ceres orbit operations using IPS are scheduled for completion in the summer of 2016. To date the IPS has been operated for over 45,000 hours, consumed approximately 385 kg of xenon, and provided a  $\Delta V$  of over 10.5 km/s. The IPS performance characteristics are very close to the expected performance based on analysis and testing performed pre-launch. This paper provides an overview of Dawn's mission objectives and the results of Dawn IPS mission operations through the high altitude mapping science orbit at Ceres.