SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (4)

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DAWN'S EXPLORATION OF VESTA

Abstract

On 16 July 2011, after completing nearly four years of interplanetary flight during which the spacecraft spent 70% of the time thrusting with its ion propulsion system, Dawn entered orbit around (4) Vesta, the second most massive body in the main asteroid belt. The orbit insertion was unlike that of typical planetary missions because of the gradual nature of the trajectory change inherent in the use of electric propulsion. Thrusting was no different from any other time in the mission. Following orbit insertion, Dawn continued spiraling to its first circular science orbit at an altitude of 2700 km and initiated the ambitious campaign of acquiring panchromatic and narrowband images in the visible and near-infrared; visible, near-infrared, gamma-ray, and neutron spectra; and extensive radiometric tracking to map the gravity field and hence interior structure. The use of ion propulsion provides the flexibility and capability to tailor the orbit altitudes and planes for the various scientific investigations. After completing its initial observations, Dawn spiraled down to a second science orbit at 680 km and later to a third orbit at 210 km mean altitude. Although the transfers to progressively lower orbits presented significant challenges, all were executed smoothly. Unlike at higher altitudes, in the lowest orbit the effects of the irregular gravity field and occasional attitude control thruster firings required Dawn to implement regular maneuvers to maintain the desired orbit. The 15-month Vesta operations plan included 40 days of margin, but as none of the margin was consumed by the time of the arrival in the lowest altitude orbit, it was all applied to acquiring additional science data. In April 2012 Dawn will begin spiraling back to higher altitudes. It will map Vesta's surface again at 680 km altitude, observing newly illuminated terrain as the Sun moves north, before initiating the gradual departure to travel to dwarf planet (1) Ceres for a 2015 rendezvous. Dawn's exploration of Vesta has shown it to be geologically complex and fascinating, resembling terrestrial planets more than typical asteroids. Among the principal features is a 500-km-diameter impact basin within which is the second tallest mountain known in the solar system, exceeded only by Olympus Mons. This paper will describe Dawn's approach to Vesta, including the observations and the orbit insertion, the major activities of the science orbits, and the flights between orbits. It also will summarize some of the principal findings.