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THE SUCCESSFUL CONCLUSION OF THE DAWN MISSION: IMPORTANT RESULTS WITHOUT A FLASHY TITLE

Abstract

Dawn completed its second and final extended mission in orbit around dwarf planet Ceres on 31 October 2018. The spacecraft had been operating in a 35 x 4,000 km orbit, enabling high resolution nuclear spectroscopy and gravity measurements to the end of the mission. Imaging plus infrared and visible spectroscopy concluded in September 2018 because Dawn's periapsis had moved to the nightside of Ceres. Because of the loss of three of the spacecraft's reaction wheels earlier in the mission, attitude control was accomplished exclusively with hydrazine. Thanks to an extensive campaign of hydrazine conservation, the propellant lasted longer than originally anticipated. When it was depleted, the spacecraft was unable to maintain attitude and mission operations concluded. The final orbit was chosen to ensure compliance with the planetary protection requirement that Dawn not contact the surface for at least 20 years to allow for a period of potential biological exploration. Dawn had found Ceres to be of astrobiological importance. The mission revealed evidence of a past global ocean as well as a crust presently containing volatiles, brines, and organics. The interior may still contain liquid. Dawn launched in 2007 and explored the two largest objects in the main asteroid belt, Vesta (in 2011-2012) and Ceres (2015-2018). This is the only mission ever to orbit two extraterrestrial destinations and was enabled by the use of ion propulsion, which provided 11.5 km/s over the course of the 11-year mission. This paper will describe operations through the conclusion of the mission, highlights of the scientific discoveries, and lessons applicable to subsequent missions.