

IAF SPACE EXPLORATION SYMPOSIUM (A3)  
Small Bodies Missions and Technologies (Part 1) (4A)Author: Dr. Marc D. Rayman  
NASA Jet Propulsion Laboratory, United StatesDAWN'S SECOND AND FINAL EXTENDED MISSION:  
A NEW OPERATIONAL CAMPAIGN AT CERES**Abstract**

Dawn has been orbiting Ceres since March 2015. After exploring Vesta in 2011-2012, the spacecraft completed its prime mission at Ceres and then an extended mission at the dwarf planet as well. The expected lifetime at Ceres was short, because reaction wheels failed in 2010 and 2012, making the spacecraft increasingly reliant on the hydrazine-based reaction control system. For eight months in 2015-2016, Dawn operated in a circular orbit at 385 km (relative to the mean Ceres radius of 470 km), and subsequently maneuvered to higher altitudes for other science objectives. The current orbit is 5,000 x 39,000 km. A third reaction wheel failure in 2017 ended all wheel control and further increased the rate of hydrazine use. Thanks to extensive work to conserve it, however, Dawn has enough hydrazine left for a second extended mission, which will conclude when the hydrazine is exhausted, perhaps before the 69th International Astronautical Congress. Hydrazine consumption depends strongly on orbital altitude. There is insufficient hydrazine to return to and operate in the low orbit, but the project has developed new strategies to acquire data at low altitude. In April, the spacecraft will begin using its ion propulsion system to maneuver to two new science orbits. One month of thrusting will be needed to reach the first, at 400 x 4,800 km. The principal objectives there will be to acquire infrared spectra and visible images at high southern latitudes now that it is summer in that hemisphere. Some additional opportunistic color imaging will be conducted in the northern hemisphere where the altitude will allow better spatial resolution than color images already obtained. After about two weeks in the orbit, Dawn will thrust for another week to reach its final orbit, at 35 km x 3,985 km, with a period of 27 hours. The highest priorities will be the acquisition of neutron spectra, gamma-ray spectra, and localized gravity measurements. Images and infrared spectra will be acquired as well, but targeting specific features will be extremely challenging because of the orbit perturbations from the reaction control system. There may be enough hydrazine for three months of operations in this final orbit. Among the many constraints on the design of this orbit was the planetary protection requirement that Dawn not contact Ceres for at least 20 years. This paper will describe Dawn operations in its second extended mission, the nature of the orbits, and the scientific campaign.