Dawn mission to (4) Vesta and (1) Ceres

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The ion-propelled Discovery mission Dawn was launched in 2007, on a near decade-long odyssey to explore the two most massive asteroids in the main belt, 4 Vesta and 1 Ceres. Based on its mass and volume, its basaltic crust, and the chemistry of the associated HED meteorites, Vesta was expected to consist of a completely differentiated dry silicate body with an iron core in contrast to Ceres, whose much smaller density implied a much wetter body, perhaps with liquid water beneath the crust. Upon entering vestan orbit in July 2001, Dawn discovered that indeed the surface resembled the HED meteorites and the gravity data were consistent with a differentiated body with a 110-km radius core. The large southern basin seen from HST was found to consist of two ancient impact basins with associated planet-encircling rings of graben-like fossae, but no olivine mantle was uncovered. The OH that had been hinted at in reflectance spectra observed by terrestrial telescopes was seen more broadly over the surface by the VIR mapping spectrometer. Moreover, hydrogen was broadly detected with the GRaND gamma ray and neutron spectrometer. Dark rayed craters were found, as well as buried dark materials indicative of transport to Vesta of exogenic carbonaceous material. Moreover, some craters showed evidence for both running and standing water: gullies in the crater walls and pits in the crater floors. The presence of water, even if only transient, on the surface of Vesta, and the apparent lack of an olivine mantle were unexpected results. While these observations do not negate the earlier work based on the HED meteorites, they do add important new insight into the conditions under which Vesta formed and evolved.

Dawn is now approaching Ceres, about 0.1 au away, with arrival scheduled in late March. The recent remote observation of an intermittent 'plume' of water by the Herschel Space Telescope has heightened the community's interest in this largest of the main belt asteroids. The presence of water at Ceres is consistent with the body's low density and our expectation of the circumstances surrounding its formation. We expect to explore Ceres from a similar set of circular polar orbits as those used to explore Vesta: Survey, High Altitude Mapping and Low Altitude Mapping.