A strategy for exploring the Asteroid belt with ion propulsion: EVE and Dawn

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The largest asteroids are survivors from the earliest epoch of the formation of the solar system that have escaped the heavy bombardment period largely intact. Moreover, these minor planets should have remained closest to their points of origin. Thus a strategy of visiting the largest bodies in the main belt could tell us much about the original compositional gradient in the solar system and hence the temperature and pressure gradient that produced it. The Dawn mission explores the two most massive main belt asteroids 4 Vesta and 1 Ceres at 2.34 and 2.77 AU respectively. These bodies are very different: Vesta has an equatorial diameter of about 520 km and is covered with basaltic flows whereas Ceres is close to 1000 km in diameter and has a shape and density consistent with a rocky core covered by a thick ice (˜100 km) shell. The third most massive main belt asteroid, 2 Pallas, lies at the same distance as Ceres with the same size of Vesta but a lower density. However, since it orbits at a high inclination it is quite inaccessible. The fourth most massive asteroid is 10 Hygiea at 3.14 AU. Much less is known about Hygiea than the other three asteroids, but enough is known that we expect to find a much different body than either Vesta or Ceres including a more primitive composition. Further, upon completing an orbital exploration of Hygiea, using simply a duplicate of the Dawn spacecraft, there is an extensive dynamical family that is readily accessible.