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A strategy for exploring the Asteroid Belt with Ion propulsion

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The largest asteroids are survivors from the earliest days of the formation of the solar system and by and large have escaped the heavy bombardment period largely unscathed. Moreover, these largest bodies 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 much lower density. However, since it orbits at a high inclination it is quite inaccessible. The fourth most massive asteroid is 10 Hygiea at 3.12 AU. Much less is known about Hygiea than the other three asteroids but it is sufficiently further out that we might expect as much a difference between Hygiea and Ceres as we see between Ceres and Vesta, perhaps indicating how organic molecules were radially distributed. Another significant body in this region is 16 Psyche that appears to be the iron core of a much larger original body. This too would make an attractive target for an asteroid mission. In fact it is possible using the latest advances in ion engines to design a mission like Dawn that could visit both these bodies.