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SPACE EXPLORATION SYMPOSIUM (A3)
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A CASTAWAY SPACE-TELESCOPE: OPPORTUNITIES FOR ASTEROID BELT FLY-BY TOURS FOR MEDIUM AND DISCOVERY CLASS MISSIONS

Abstract

CASTAway Space Telescope is a mission conceived to explore our Solar System's main asteroid belt (MAB). The MAB contains a huge medley of objects of different pasts and at evolutionary stages; from solar nebula nearly pristine material to metallic cores of differentiated protoplanets. Thus, a comprehensive exploration of the MAB provides a unique window into the formation and evolution of our Solar System. The Comet and Asteroid Space Telescope Away in the asteroid belt (a.k.a. CASTAway) envisage a small telescope with relatively straightforward remote sensing instrumentation. The telescope would enable a point-source spectroscopic survey of over 10,000 objects. The composition of these objects could then be inferred, by their spectral information, and variations in composition across the MAB would provide a tracer for the dynamical evolution of the Solar System. CASTAway is launched into a trajectory that loops multiple times through the MAB. The trajectory is carefully designed to fly-by 10 to 20 main belt asteroids, allowing for a morphological and geological study of a large sample of objects. Finally, modified star tracker cameras would perform a serendipitous search of very small objects ($\sim$10m) during main belt crossings. The paper will first present the preliminary system design for CASTAway (i.e. spacecraft and payload), and some potential alternatives which are subject to launch performance and cost cap. The baseline design has however been prepared to fit within the programmatic and cost caps of both European Space Agency's medium class and NASA's Discovery class mission. An extensive account of trajectory opportunities for the timeframe of 2029-2030 is then provided. The trajectory requirements derived from the science objectives converge on the need for CASTAway's trajectory to spend as long as possible within the MAB. However, the operational costs involved on a survey mission constrains the mission lifetime to less than 7 years. Furthermore, only medium-lift launchers are considered in order to comply with the cost cap of medium size missions. These definitively limits the available Δv to reach the MAB and manoeuvre to encounter the 10-20 asteroids at a sufficiently close distance to spatially resolve them to a sufficient resolution. Despite the challenge, a numerous catalogue of solutions is found that allocate sufficient survey time and encounter $\geq$10 asteroids of a wide range of characteristics. The set of solutions found allows a visiting asteroids within the Hungaria family, Inner, middle and outer belt.