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Electric solar wind sail nanospacecraft fleet for multi-asteroid flyby touring

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We propose a fleet of nanospacecraft that tour the main asteroid belt, each making 5-7 flybys of main belt asteroids. The spacecraft are propelled by a single-tether electric solar wind sail (E-sail). After launch to a marginal escape orbit from Earth, the E-sail is used to raise the aphelion to the main belt. Upon entering the main belt, the E-sail is used to make orbital corrections to maximise the number of flybys. At the end, the spacecraft makes an Earth flyby to return the gathered data, nominally 10 GB per spacecraft. This strategy allows a low-cost retrieval of the science data by using only a few hours of deep-space network time per spacecraft. The science instruments include a few centimetre diameter optical telescope and a near infrared (NIR) spectral instrument. The telescope is also used for optical navigation. Autonomous optical navigation was demonstrated 20 years ago by DeepSpace-1. The flyby distance is nominally 1000 km. This level of orbit accuracy is possible to reach by using optical navigation based on the well-known orbits of nearby asteroids. Target-based optical navigation could be implemented to reach a shorter flyby distance, if deemed beneficial.

Our baseline is to launch 50 spacecraft, each weighing 5-6 kg and 10 kg when including mass of the separation device. Such mission is possible by launching 500 kg to marginal escape orbit by a launch vehicle such as PSLV or equivalent. The mission returns detailed flyby imagery and spectra of more than 300 main belt asteroids, thus resulting in more than tenfold increase in the number of asteroids from which in situ data are available. The mission concept is scalable in the number of spacecraft. For example, one or a few spacecraft could be launched as a piggyback of some other mission.