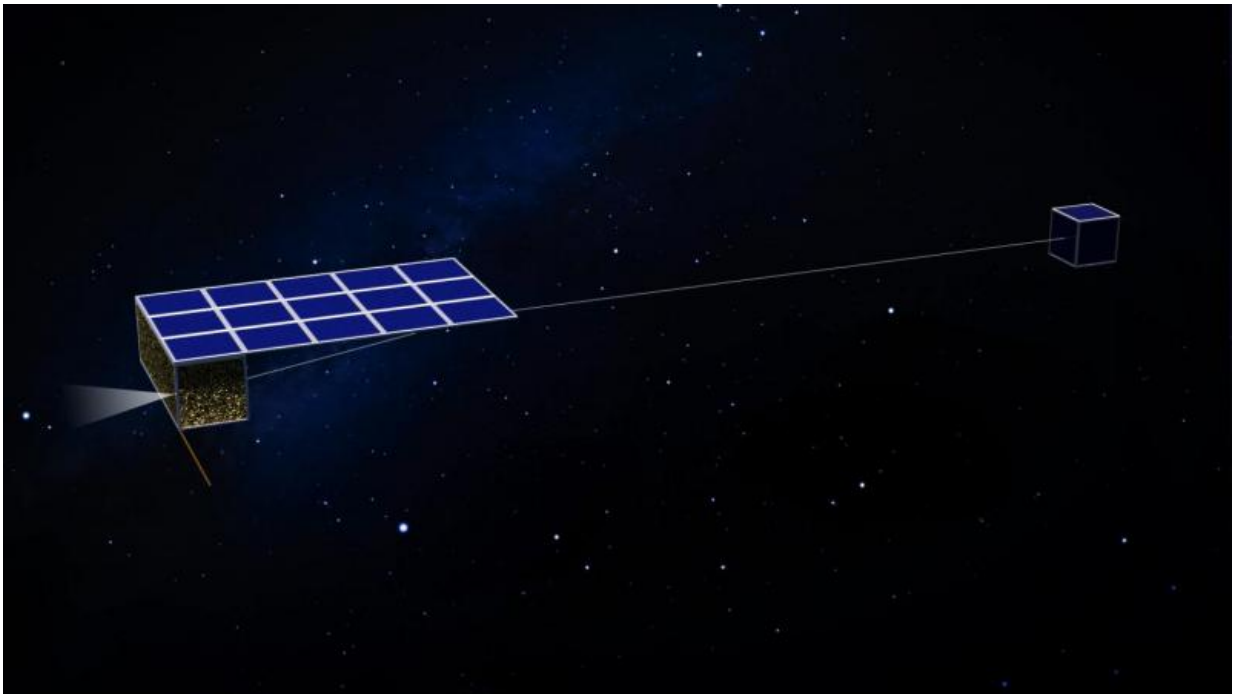
Nanosat fleet proposed for voyage to 300 asteroids

September 19 2017



Artist's concept of the spacecraft. Credit: FMI

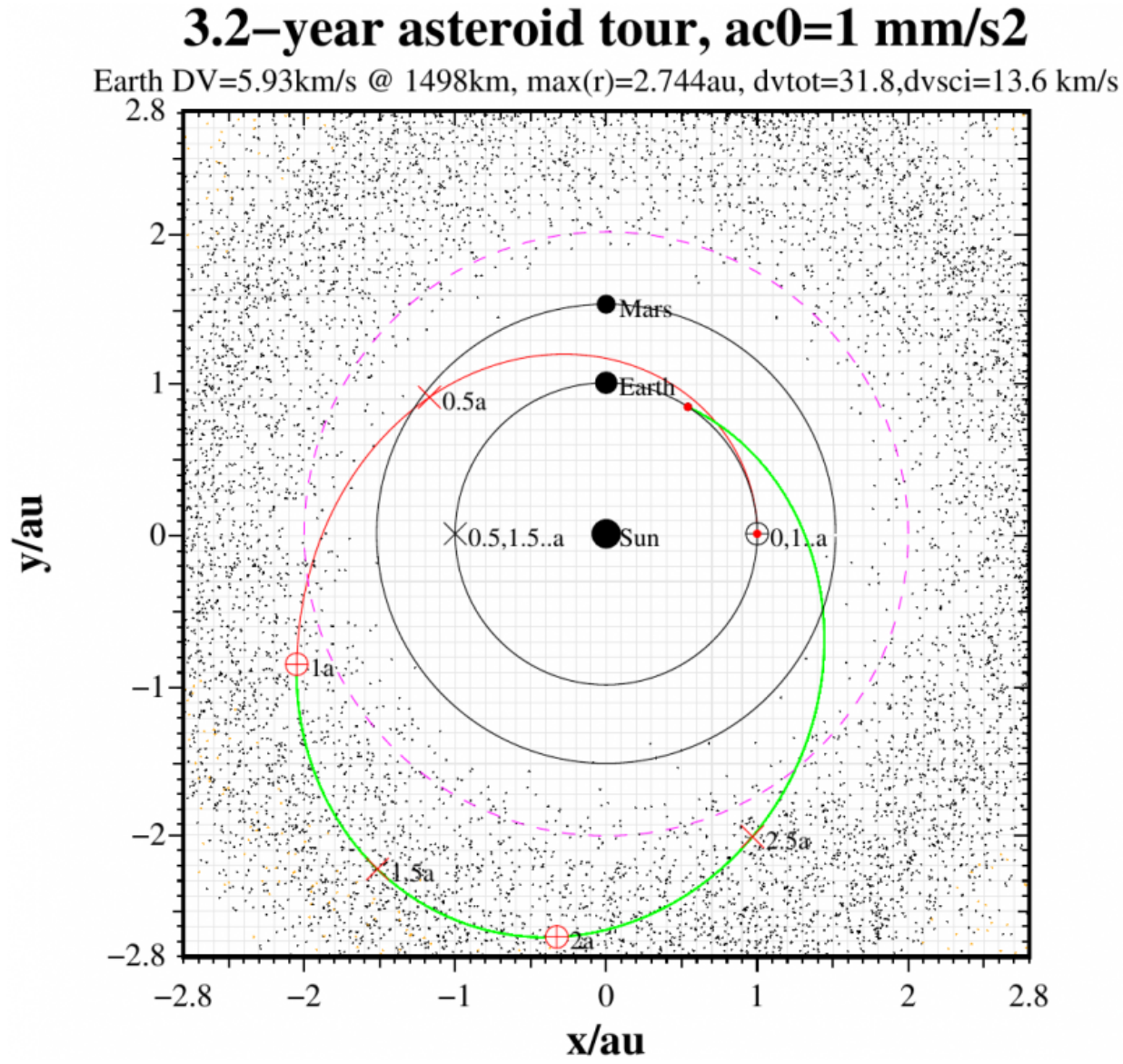
A fleet of tiny spacecraft could visit over 300 asteroids in just over three years, according to a mission study led by the Finnish Meteorological Institute. The Asteroid Touring Nanosat Fleet concept comprises 50 spacecraft propelled by innovative electric solar wind sails (E-sails) and equipped with instruments to take images and collect spectroscopic data on the composition of the asteroids. Each nanosat would visit six or

seven asteroids before returning to Earth to deliver the data. The concept will be presented by Dr Pekka Janhunen at the European Planetary Science Congress (EPSC) 2017 in Riga on Tuesday 19th September.

"Asteroids are very diverse and, to date, we've only seen a small number at close range. To understand them better, we need to study a large number in situ. The only way to do this affordably is by using small spacecraft," says Janhunen.

In the mission scenario, the nanosats flyby their target asteroids at a range of around 1000 kilometres. Each nanosat carries a 4-centimetre telescope capable of imaging the surface of asteroids with a resolution of 100 metres or better. An infrared spectrometer analyses spectral signatures in light reflected or emitted by the asteroid to determine its mineralogy. The instruments can be pointed at the target using two internal reaction wheels inside the nanosats.

"The nanosats could gather a great deal of information about the asteroids they encounter during their tour, including the overall size and shape, whether there are craters on the surface or dust, whether there are any moons, and whether the asteroids are primitive bodies or a rubble pile. They would also gather data on the chemical composition of surface features, such as whether the spectral signature of water is present," says Janhunen.



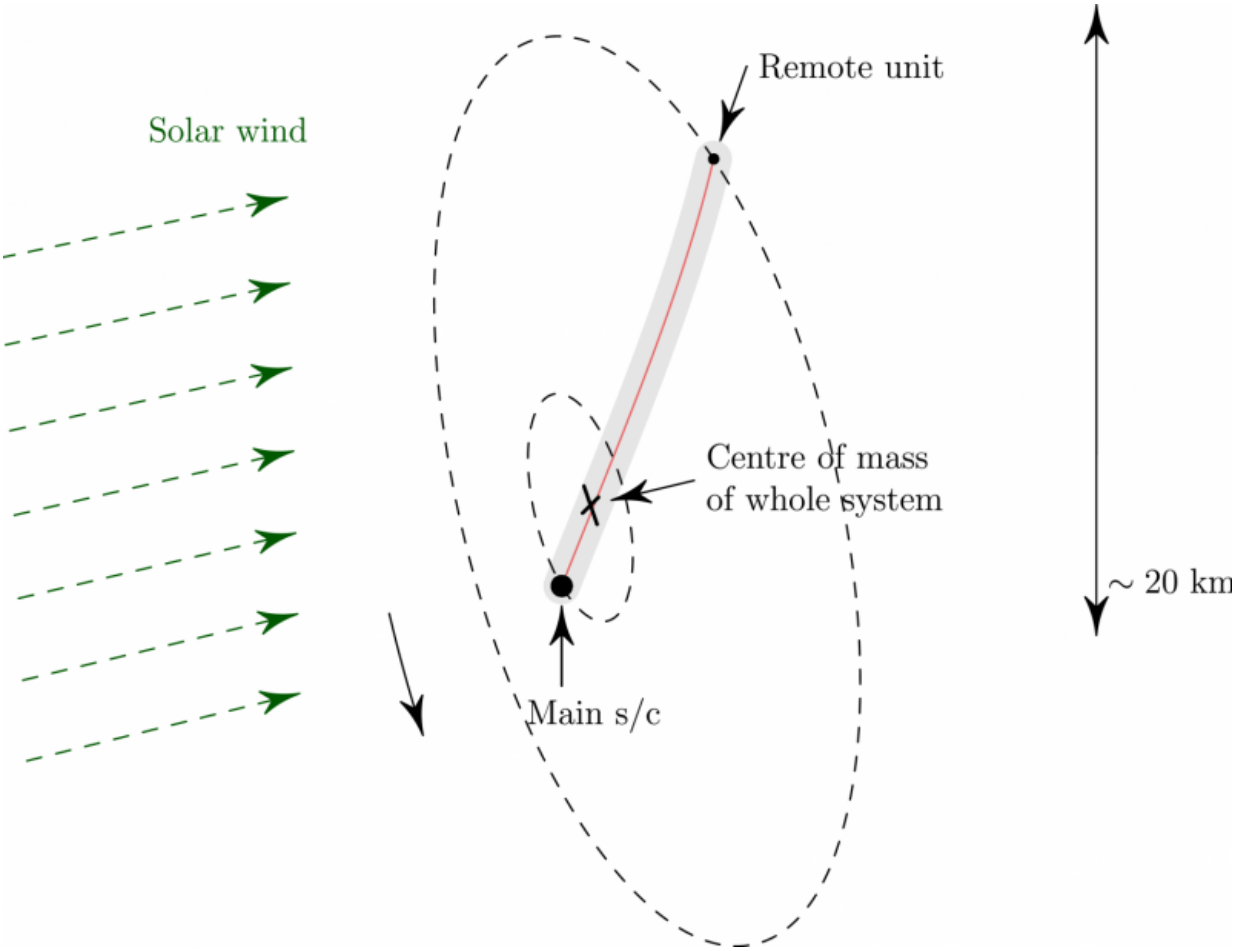
The orbital trajectory of the 3.2 year mission tour. Credit: Janhunen et al

E-sails make use of the solar wind – a stream of electrically charged particles emitted from the Sun – to generate efficient propulsion without need for propellant. Thrust is generated by the slow rotation of a tether, attached at one end to a main spacecraft carrying an electron emitter and a high-voltage source and at the other to a small remote unit. The

spinning tether completes a rotation in about 50 minutes, tracing out a broad, shallow cone around a centre of mass close to the main spacecraft. By altering its orientation in relation to the solar wind, the nanosat can change thrust and direction.

The thrust generated by E-sails is small; a 5 kilogramme spacecraft with a 20-kilometre tether would give an acceleration of 1 millimetre per second at the distance of the Earth from the Sun. However, calculations show that, on top of the initial boost from launch, this is enough for the spacecraft to complete a tour through the asteroid belt and back to Earth in 3.2 years. Nanosatellites do not have the capacity for a large antenna, so the concept includes a final flyby of Earth to download the data. The overall mission would cost around 60 million Euros, including launch, giving a cost of about 200,000 Euros for each asteroid visited.

"The cost of a conventional, state-of-the-art mission to visit this number of asteroids could run into billions. This mission architecture, using a fleet of nanosats and innovative propulsion, would reduce the cost to just a few hundred thousand Euros per asteroid. Yet the value of the science gathered would be immense," says Janhunen.



The single-tether E-sail spacecraft. Credit: Janhunen et al

More information: Abstract, European Planetary Science Congress 2017: Asteroid touring nanosat fleet with single-tether E-sails, meetingorganizer.copernicus.or … 7/EPSC2017-215-1.pdf

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