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POTENTIALLY HAZARDOUS ASTEROIDS DETECTION FROM SPACE-BASED NETWORK ON DISTANT RETROGRADE ORBITS

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ABSTRACT

Potentially Hazardous Asteroids (PHAs) have the potential to make a close approach to the Earth and a size large enough to cause significant regional damage in the event of an impact. If a Tunguska-class or smaller Near Earth Object (NEO) approaches the Earth from the Sun direction, its observation from ground is very difficult, this was the case of the meteorite fall in Chelyabinsk, Russia, in February 2013. Several search programs have been undertaken to map the entire population of NEOs, among them the Spaceguard Survey catalogued 90% of NEOs with diameter larger than 1 km. Because the sky region next to the Sun direction is difficult to observe, space-based systems can integrate ground-based observation for tracking NEOs from a location in between the Sun and the Earth.

This article assesses the detection capabilities of a network of space telescopes placed on Distant Retrograde Orbits (DROs) in the Sun-Earth system. DROs reaches a distance from the Earth larger than the Earth-L_1 distance; therefore, a spacecraft constellation on such orbit can detect PHAs incoming from the Sun direction, which could not otherwise be monitored from current Earth-based systems. Moreover, they allow increasing the warning time before a possible re-entry in the Earth's atmosphere, with respect to an L_1-based spacecraft.

A vast number of virtual Earth-impacting scenarios are built by homogenously distributing in orbital space a grid of 17,518 Earth impacting trajectories. The relative frequency of each trajectory is estimated by means Opik's theory and Bottkle's NEOs model. The relative frequency on which the different asteroid sizes occur can

be well estimated by a power law distribution. An analytical model for asteroid detection is then used to assess the observation capabilities from DROs in terms of smallest asteroid size as function of distance, solar phase angle, asteroid albedo.

A trade-off on the DRO amplitude and the number of spacecraft in the constellation is performed considering current visible sensor telescope technology and computing the percentage of PHAs that can be detected within a warning time threshold. Indeed, in case of a foreseen close encounter, a minimum time period is necessary to perform a detailed orbit determination of the asteroid for ground casualty reduction and air space closure.

The article demonstrates that a space-based telescope network on DROs would allow the detection of a large number of PHAs down to Tunguska-class size and can cover a wider space region compared to a ground-based telescope.

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