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System of Observation of Daytime Asteroids: trajectory and orbit design

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ABSTRACT

System of Observation of Daytime Asteroids (SODA) is a future space mission, aimed at detection and monitoring hazardous asteroids approaching the Earth from the daytime sky. The system consists of two spacecraft placed into an orbit in the vicinity of the Lagrangian point L1 of the Sun-Earth system, about 1.5 million km from the Earth.

The SODA project is planned to use small spacecraft, with a weight less than 500 kg. Two spacecraft will be equipped with three small telescopes, with an aperture about 30 cm, and will constantly scan the near-Earth region. The mission is intended to detect at least 95% of hazardous celestial bodies larger than 10 m in size [1]. In addition, observations by two SODA satellites will allow the project to determine the object's trajectory and warn about a possible region of Earth's atmospheric entry.

In this work we present main aspects of trajectory and orbit design for the mission. An analysis of suitable operational orbits, covering station-keeping manoeuvres, cost, and solar inference exclusion zone avoidance, is discussed. The main goal of the transfer trajectory design is to achieve a suitable relative positioning of two

spacecraft in L1 orbits, while performing only one launch. For the mission scenario we consider opportunities of a launch by Soyuz 2.1b vehicle with a Fregat-SB upper stage. This configuration allows delivering about 2200 kg of payload into the vicinity of the L1 point. Therefore, besides two SODA spacecraft, an additional payload might be considered for the launch.
To ensure an accurate orbit determination of a hazardous object, two spacecraft must be spaced apart in L1 orbits. For this purpose, it is planned to use a lunar gravity assist, performed by one spacecraft, while the second one is directly transferred into the vicinity of the L1 point [2]. Such a scenario allows a delay of arrival of one spacecraft and achievement of a phase difference in the operational orbit.

The SODA project was inspired by the idea of Dunham et al. [3], and has been developing mission concepts. For the time being the SODA mission design is still in progress. The future realisation of the project might prevent the recurrence of damaging events such as the Chelyabinsk bolide of February 15, 2013.

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