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NEAR-EARTH ASTEROIDS SHORT-TERM EARLY WARNING AND DEFENSE BASED ON SUN-EARTH HALO ORBIT

Abstract

Near-Earth asteroids (NEAs) pose a major potential threat to the safety of the earth. Observing and cataloging NEAs is the basis and premise of asteroid defense. Limited by the current level of observation technology, the precise orbit determination requires decades of observation time. Besides, there are still plenty of NEAs that have not been discovered. Therefore, in addition to cataloging and establishing long-term defense strategies, when NEAs approach the Earth, short-term early warning and defense are also very important. Nowadays, asteroid observation and short-term early warning are mainly carried out by ground-based observation platforms, but the ground-based observation system cannot monitor asteroids that come from the direction of the sun. Besides, the short-term early warning time and distance are generally very short, which may lead to failure to defend against asteroids in time.

This study proposes to deploy a short-term early warning defense system, composed of the observation system and defense system, on the Sun-Earth L1 Halo orbits, which can provide short-term early warning and defense of NEAs from the direction of the sun. The observation system around the Sun-Earth L1 point can monitor the sky region next to the sun direction all the time because the Sun-Earth L1 point is between the sun and the earth and on the sun-earth line. Thus, the observation system around the Sun-Earth L1 point could ensure that all approaching asteroids from sun-direction could be warned. Moreover, the positional advantage of the Sun-Earth L1 point facilitates quick defense against asteroids and ensures that the defense of the asteroid is completed at a certain distance from the earth. In this study, we analyze the capabilities of the short-term early warning defense system. The impact of asteroid size on the short-term early-warning time and distance of the system is firstly studied. Then, we design the transfer trajectory for short-term defense, and the effect of the defense system is evaluated. The simulation shows that the system could provide effective early warning for asteroids from the direction of the sun. However, the diameter of the asteroid would affect the capabilities of the defense system, so we provide the defense effect of the system for asteroids with different diameters. The analysis of this study provides a feasible and valuable reference scheme for the NEAs defense.