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ACCESSIBLE AND RETRIEVABLE ASTEROIDS CONSIDERING LUNAR AND SOLAR GRAVITY ASSISTS

Abstract

Asteroids preserve pristine relics of the early solar system, and thus are the key to uncovering the formation of the solar system. Moreover, asteroids are considered as promising bonanza that may contain water and rare metals. The resources can be exploited to sustain astronauts' lives, fuel spacecraft, and power space bases, and thus to enable farther human exploration. On the other hand, near-Earth asteroids are also threats to the Earth. The Chelyabinsk meteor released atomic-bomb-level energy and injured thousands of people when it hit the Earth. It is time to "look up" and start tackling potential distasters.

Asteroid retrieval will not only mitigate the threat, but also allow easy and constant exploration and exploitation of the asteroid. As many themes, such as colonization of Mars, do not longer stay in the sci-fi but become more realistic, we can also forsee the technologies, techniques, and endeavors that realise asteroid retrieval. To retrieve an entire small near-Earth asteroid (NEA) – approximately 2-m diameter with a mass of order 10,000 kg, is believed to be possible by 2025 (J. R. Brophy et al., AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 2011).

In fact, the asteroids of high threat to the Earth, except for the PHA, are usually the easily accessible asteroids as well, for their small orbit energy difference relative to the Earth. As a small energy change can allow for reaching and capturing asteroids, such an energy change can be provided by the gravity perturbation of the Sun and Moon. The idea of using lunar and solar gravity assists to retrieve asteroids was proposed by the author a few years ago. This paper will clarify the key issues: 1) the mechanism of luni-solar gravity in retrieving and stabilizing asteroids to the vicinity of the Earth, and the capacity of the luni-solar gravity perturbation in asteroid retrieval (or in other words, the capacity of altering the orbital energy); 2) the trajectory design tehcnique employing luni-solar gravity assists for reaching and capturing asteroids; and 3) a list of easily retrivable asteroids with the proposed technique in the next 20 years.