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Gravitational Disturbances and the Asteroid Kinetic Impact Deflection Method were Connected

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Abstract

We will discuss the use of the kinetic impact technique to divert asteroids that might at any given time pose a threat of colliding with Earth. Using fluctuations in the asteroid 101955 Bennu's velocity (v) at various points during its orbital cycle and measuring close contacts with Earth, we propose to assess the feasibility of deflecting its orbit in more detail in the study that will be developed here. We will see that the asteroid has multiple close encounters with the planet over a reasonably lengthy period of time, causing it to experience a natural gravitational disturbance. As the impulses are applied, the relative distances shift, resulting in fluctuations in the asteroid's energy and a significant variation in the relative distance between the asteroid and Earth for a considerable amount of time after the impulse. We report findings on the applied impulse's intensity, which is crucial given the magnitude of the impactor that must be taken into account. To do this, we plotted the impulse placements over the course of the asteroid's orbit (M.I.O.A.). We conclude by describing what happens to the asteroid's orbit during times of gravitational perturbation since it experiences a number of "Swing Bys" that amplify variations in the relative distances between the bodies following impulses.

Introduction

Small rocky or metallic bodies known as asteroids are remains from the solar system's creation. Due of potential collisions with our planet, these bodies can pose a serious threat to life. Additionally, they can serve as a source for scientific research as well as for commercial and space exploration, and this issue has already been covered in a number of publications. The fact that these objects are typically very small in comparison to planets and moons and, as a result, have a weak gravitational attraction that accounts for their irregular shape, is another issue we encounter.

As a result, various ideas have been made over the years with various strategies to disrupt the asteroid's orbit and thereby deflect it. Techniques including using nuclear power, solar sails, solar radiation collectors, and laser systems were tested, as well as techniques like influencing the asteroid's velocity to change by an impulse and having an object contact the body. Ledkov et al. demonstrated that the planetary defence scenario can make use of asteroid-Earth gravitational motions. In this paper, they suggest that a larger asteroid can be guided to collide with a potentially hazardous asteroid by modest impulses in the orbit of a small asteroid along the approaches to Earth. Ahrens and Harris created a piece of work that connected the asteroid's deflection patterns

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to the fragmentation they caused. They demonstrated that velocity differences of no more than 1 m/s would be sufficient to cause the asteroid's orbit to alter noticeably for perturbations that may last decades. With this work, they demonstrated how asteroids near Earth can be diverted by changing their velocity in relation to the Sun, either up or down. However, they caution that in circumstances where it is necessary to deflect the body quickly, the variation should be hundreds of meters per second. In contrast, if an impulse is applied and the asteroid's energy output exceeds a certain threshold, a catastrophic fragmentation is likely to happen and could cause harm to Earth. The DART mission, whose primary goal is to assess the deflection capacity of an asteroid using this technique, is the first genuine asteroid deflect mission as a result of the kinetic impact deflection technique's increasing importance in the scientific community due to its practicality. A spacecraft will collide with the satellite known as "Didymoon," disrupting both its orbit and the orbit of the main body Didymos as a result. The AIDA mission, which will keep track of the orbital change, is backing the mission. Park and Ross demonstrated that an impulse's location in the orbit and its direction relative to the orbital velocity have a significant impact on the change it causes. The impulse applied during the perihelion is the best for alert times greater than one orbital period, they also claimed in their work. The goal of this research is to assess the kinetic impact approach used to divert potentially hazardous asteroids away from Earth while taking into account how this relationship changes over a period of about 100 years following the application of the asteroids' impulses. Therefore, we shall change the object's velocity during its orbital cycle. Similar to Negri and others the asteroid 101955 Bennu, which is a member of the class of asteroids with a close-to-Earth orbit, was selected for study. Because NASA's Osiris Rex mission recently targeted this asteroid, it has gained even more notoriety among scientists.

Conclusion

It Swings By becomes crucial in the asteroid deflection strategy over a considerable amount of time, where the approach must take into account where the impulse will be applied. Our results demonstrate that, given the numerous close encounters of the asteroid with the Earth, we do not actually need a large impulse to move the asteroid away—rather, we only need to choose the best positions to apply the impulses—which is feasible given that larger impulses require larger-mass impactors. We noticed that the asteroid may be moved away from the Earth by impulses directed against its motion and delivered during the perihelion of its orbit. When applying impulses in the perihelion of the orbit for the case under study, the impulse of 10 mm/s proved to be one of the most successful. However, some applications of impulse in the asteroid's aphelion showed good results as well, such as impulses of -10 mm/s and -20 mm/s that involve using smaller impactors.