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ASTEROID IMPACTOR SAMPLE RETURN MISSION CONCEPT

Abstract

In November 2021, the Asteroid Impact and Deflection Assessment (AIDA) mission launched an impactor spacecraft named Double Asteroid Redirection Test (DART). The mission attempts to demonstrate the ability of spacecraft to influence the trajectory of asteroids. The result will provide humanity with a better understanding in preventing catastrophic asteroid impacts. Beyond AIDA, various asteroid missions have successfully demonstrated asteroid flyby, orbit, landing, and even sample collection and return. These missions produce tremendous scientific knowledge and validify important technological advancement.

In this paper, we propose a novel asteroid sample return mission. This mission will launch a spacecraft to intercept and impact an asteroid in deep space. The spacecraft will impact the asteroid and both bodies will fragment. Due to the impact, the asteroid's trajectory will be affected to some degree. However, the spacecraft is constructed with a distributed operation network. Some fragments of the spacecraft will remain operational, and they will attempt to collect the asteroid fragments and signal to mothership for collection. We detail the concept of the distributed operation network and introduce several methods of implementation. The distributed network will widen the margin of the impact accuracy, as the spacecraft disregards the precise location of impact. We provide several asteroid candidates and our interception trajectories. Since the spacecraft is aimed to impact the asteroid directly, we hypothesize that the energy budget is significantly lower than a conventional sample return mission that may require rendezvous and orbit. We also estimate the probability of spacecraft fragmentation as opposed to burial within the asteroid, as well as the probability of returning the sample back to Earth with the fragmented spacecraft and its limited capability.

This mission concept merges the objectives of asteroid deflection and sample return with potentially reduced energy budget. However, we also identify the challenges of this concept and the technology advancements required to maximize success.