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Deflection / Disruption Modeling & Testing

Origin of the Didymos binary system: Insights from SPH simulations

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ABSTRACT

Recently, NASA's Double Asteroid Redirection Test (DART) [1] has impacted Dimorphos, the moon of Didymos, and successfully changed its orbital period. The change in period was more than 32 minutes [2] and this orbital change could give us insights on the properties of Dirmorphos and its origin. Previous studies [3-7] showed that asteroid binary system formation could result from the following sequence of events: the primary asteroid with a fast spin rate and near-spherical shape experiences rotation-induced structural failure that leads to surface mass shedding and produce a circum-asteroid disk; the disk rapidly spreads and disk particles accrete/reaccrete to form a moon orbiting around a top-shaped asteroid.

Previous studies used DEM codes [5, 6] to study the interior structures and stability of spinning rubble-pile asteroids, indicating disk-induced moon formation scenarios.

Here we use Bern SPH code [8, 9] to study the moon formation scenario by considering the Didymos' stability for different material properties and interior structures. The Bern SPH code includes realistic rheological models which makes it accurate when studying changes in the geophysical structure and material properties of the asteroid. By investigating the possible parameter space, we can get a better understanding of both the formation process and the material properties of the binary system. Furthermore, we are able to use these simulations to investigate the structural stability of both Didymos and Dimorphos given their current shapes and rotation states.

Our results can help constrain the moon formation mechanism from a kinematic and a material perspective and can also help constrain the properties of the 65803 Didymos binary system.

References: [1] Cheng et al., 2018, PSS [2] Thomas et al., submitted [3] Hyodo et al., 2022, ApJL [4] Sugiura et al., 2021, Icarus [5] Zhang et al., 2021, Icarus [6] Ferrari & Tanga, 2022, Icarus [7] Walsh et al. 2008, Nature [8] Jutzi et al., 2008, Icarus [9] Jutzi, 2015, PSS

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