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Hypervelocity impact simulations of DART on asteroid Dimorphos: Impact-generated porosity and gravity anomalies

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The impact processes are ubiquitous in the solar system, as one of the fundamental mechanisms driving the evolution of asteroids and comets[1]. From small meteorite impacts to gigantic Moon-forming collisions[2], the impact cratering formation holds key insights pointing out the dynamic history of our solar system from 4.5 billion years ago. Thanks to the rapid progress in numerical modeling and computational resources, high-resolution numerical models offer a powerful framework for expanding our knowledge of the impact cratering phenomena. Meanwhile, planetary defense missions have steeply advanced in characterizing Near-Earth Objects (NEO), such as NASA's upcoming DART mission[3], which will deflect the orbit of Dimorphos through a kinetic impactor. A few years after the DART impact, the Hera mission by European Space Agency (ESA)[4] will rigorously portray the consequences of the collision, from cratering to exploring the interior and dynamics. Several numerical efforts have recently provided significant insights on impact cratering and ejecta dynamics in response to the DART impactor. Raducan et al. (2019)[5], for example, have comprehensively reported several factors that affect the Dimorphos' response, from target layering and strength[6] to the projectile obliquity[7]. In the present study, after verifying our results using the impactor/target constraints[5-7], we have further examined the consequences of DART impact, focusing more on the impact-generated porosity and gravity anomalies. To accomplish this, we performed hypervelocity impact simulations by the iSALE2D shock physics code[8-10] set up for a variety of target scenarios, ranging from low-cohesion gravity-dominated to high-cohesion stress-dominated regimes. Our simulation results shed new light on the detailed picture of cratering formation in the aftermath of the DART impact.

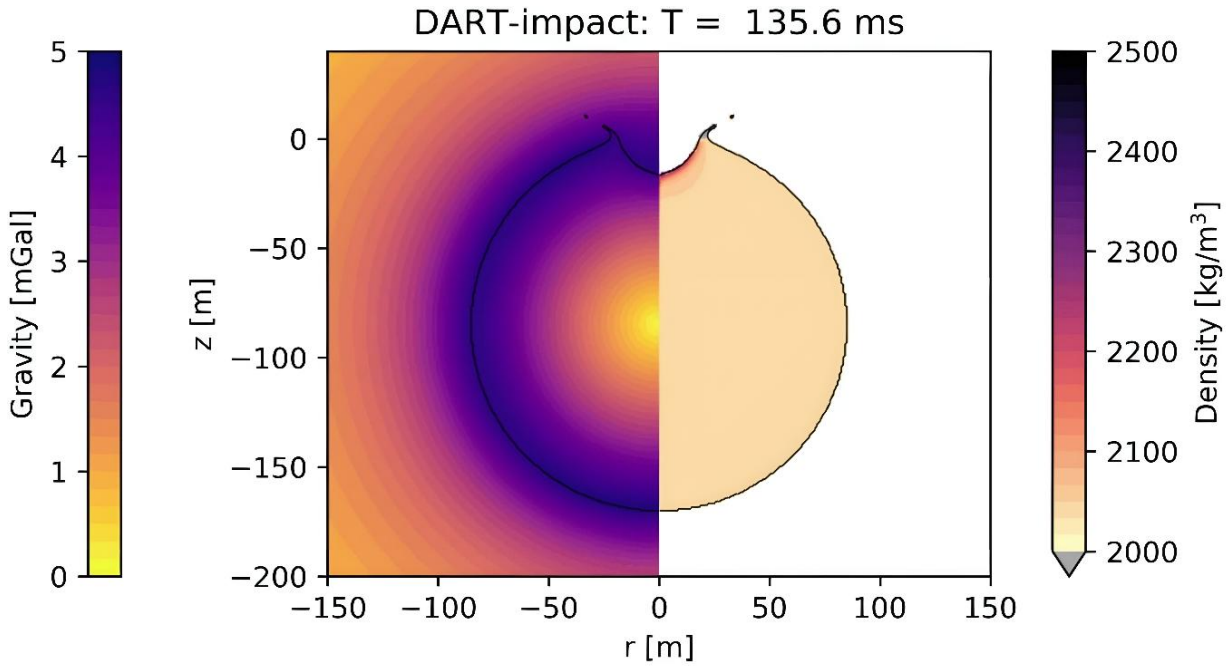

Figure 1: DART impact-generated gravity and density distribution on asteroid Dimorphos.

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