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The Small Carry-on Impactor from the Hayabusa2 Mission: models of jet formation, penetration and crater creation

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We simulate the formation of a small artificial crater on the near-Earth asteroid Ryugu resulting from the impact by a small copper explosively formed projectile. The projectile, the Small Carry-on Impactor (SCI) arrived at Ryugu on June 27, 2018 via the Hayabusa2, a sample return mission of the Japan Aerospace Exploration Agency (JAXA) launched December 3, 2014. The SCI is scheduled for detonation in March/April of 2019. The goal of the explosively formed kinetic impactor is to create a small artificial surface crater which will allow for an investigation of the asteroid's internal properties beneath the regolith, such as chemical composition and structure. Once the artificial crater is formed, Hayabusa2 will attempt to observe the crater through the resulting ejecta and debris field. The spacecraft will then confirm it is safe for touchdown and maneuver into the crater. Subsurface samples will be collected in and around the crater and returned to Earth in late 2020. It will mark the world's first sample return from a C-type asteroid.

In our models, we focus on the formation, performance, and impact of the explosively formed projectile, and the resulting artificial crater and debris field. We model the formation and performance of the 2km/s 2kg copper explosively formed projectile using Arbitrary Lagrangian-Eulerian radiation/hydrodynamics (ALE rad/hydro) [1] and Adaptive Smoothed Particle Hydrodynamics [2] simulations, and compare to experiment. Next, using a variety of C-type asteroid surface compositions, we explore the projectile impact and artificial crater formation, and the resulting distribution of debris and ejecta for a range of surface porosities and compositions. These results will be compared to Hayabusa2 images of the formed crater to provide insight into the internal chemical and physical properties of Ryugu.

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