PDC2019
Washington, DC, USA

- ☐ **Key International and Political Developments**
- ☐ **Advancements and Progress in NEO Discovery**
- ☐ **NEO Characterization Results**
- ☒ **Deflection and Disruption Models & Testing**
- ☐ **Mission & Campaign Designs**
- ☐ **Impact Consequences**
- ☐ **Disaster Response**
- ☐ **Decision to Act**
- ☐ **Public Education & Communication**

Hydrodynamic Modeling of the Deep Impact Mission into Comet Tempel 1

Kya Sorli(1)**, Tané Remington**(2)**, and Megan Bruck Syal**(3)
(1) *Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA, +1(406)696-0495, sorli1@llnl.gov*
(2) *Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA, +1(925)424-2144, remington6@llnl.gov*
(3) *Lawrence Livermore National Laboratory, 7000 East Ave, Livermore, CA 94550, USA, +1(925)423-0435, syal1@llnl.gov*

Keywords: *Deep Impact, Spheral, Comet, Kinetic Impact, Hydrodynamic Modeling*

ABSTRACT

Kinetic impact is one of the primary strategies to deflect hazardous objects off of Earth-impacting trajectories. The only test to-date of a small-body impact is the Deep Impact mission, a massive experiment conducted at comet Tempel 1 in 2005, when a 366-kg mass collided at ~10 km·s^{-1}, liberating an enormous amount of vapor and ejecta. Code comparisons with observations of the event represent an important source of new information about the initial conditions of small bodies and an extraordinary opportunity to test our capabilities on a rare, full-scale experiment. Using an adaptive smoothed particle hydrodynamics code, Spheral, we explore how variations in target material properties such as strength, composition, and layering affect results, in order to best-match the observed evolution of crater size and ejecta.

Knowledge of comet and asteroid interiors are currently limited, and recent visits have highlighted the diversity of such objects. For the case of asteroids, the Hayabusa spacecraft found the asteroid Itokawa to be “rubble pile” in composition, made of pieces of rock that have converged under the influence of gravity [1]. The recent images taken of asteroid Ryugu by the Hayabusu 2 spacecraft suggest the absence of a dusty regolith-like layer [2]. The upcoming OSIRIS-REx mission to Bennu will offer another reference point for asteroid composition through sample return. To address the diversity of asteroid makeup and limited consensus on comet interiors, we test a range of compositions for the Deep Impact Mission, including 3D modeling of rubble-pile and monolithic makeup. Benchmarking against the Deep Impact experiment provides new constraints on our modeling uncertainties, and

provides an opportunity to gain insight into cometary interiors. This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. LLNL-ABS-762640-DRAFT.

[1] Fujiwara, Akira, et al. "The rubble-pile asteroid Itokawa as observed by Hayabusa." *Science* 312.5778 (2006): 1330-1334.
[2] Hayabusa2: The highest resolution image of Ryugu (resolution update: the highest resolution image to date), JAXA, October 26, 2018.

****