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- **Deflection and Disruption Models & Testing**

Calculating the Momentum Enhancement Factor for Simulations of Kinetic-Impacts in Asteroid Deflection

Tamra Heberling, Galen Gisler, Catherine Plesko, and Robert Weaver
Los Alamos National Laboratory, Los Alamos NM, USA
theberling@lanl.gov, galengisler@mac.com, plesko@lanl.gov, rpw@lanl.gov

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ABSTRACT

Near-Earth asteroids pose a threat to the safety of the planet due to collisions. With sufficient warning time, a kinetic-impact deflection could be extremely effective in mitigating this threat. The possibility of kinetic-impact deflection of a threatening near-earth asteroid will be tested for the first time in NASAs DART (Double Asteroid Redirection Test) mission. The impact of the DART spacecraft onto the secondary of the binary asteroid 65803 Didymos, at a speed of 5 to 7 km/s is expected to alter the mutual orbit by an observable amount. The velocity transferred to the secondary depends largely on the momentum enhancement factor, typically referred to as beta. We use two hydrocodes developed at Los Alamos National Laboratory, Rage and PAGOSA, to calculate an approximate value for beta, both in laboratory-scale benchmark experiments and in large-scale asteroid deflection simulations.

While both hydrocodes are used extensively at Los Alamos, Rage has been used for hypervelocity impact simulations for decades while this is a new application for PAGOSA. The hydrocodes employ different numerical schemes but the most important difference when calculating beta is the automatic mesh refinement (AMR) used in Rage while PAGOSA does not have AMR capabilities. This causes a large discrepancy in the beta calculation of the same experiment between the two codes. We are also investigating the effect of strength and porosity of the asteroid material on the computed beta value.

Another factor that has a significant effect on the value of beta is the mesh resolution employed. Convergence studies performed with PAGOSA and Rage demonstrate the importance of mesh size in estimating the magnitude of beta, and indicate that the beta value calculated may in fact be larger than previously expected.

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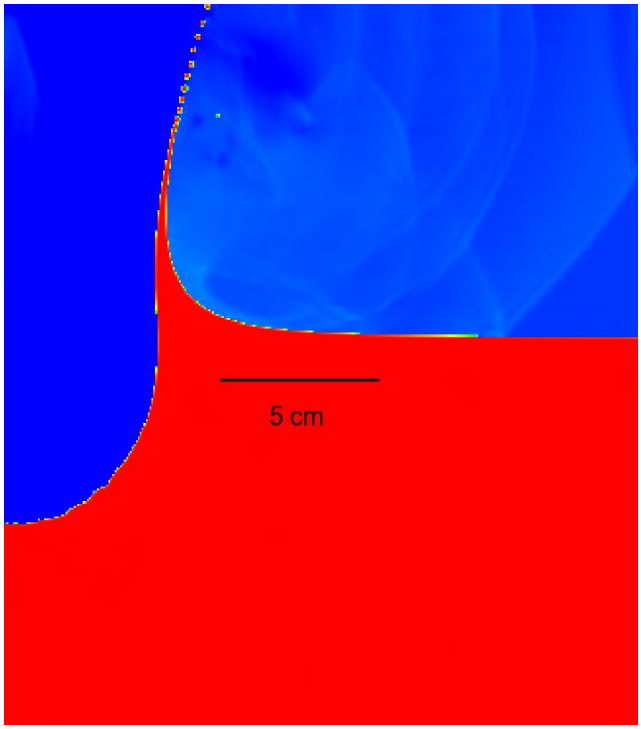

Figure 1: Crater in PAGOSA simulation at 300 microseconds.

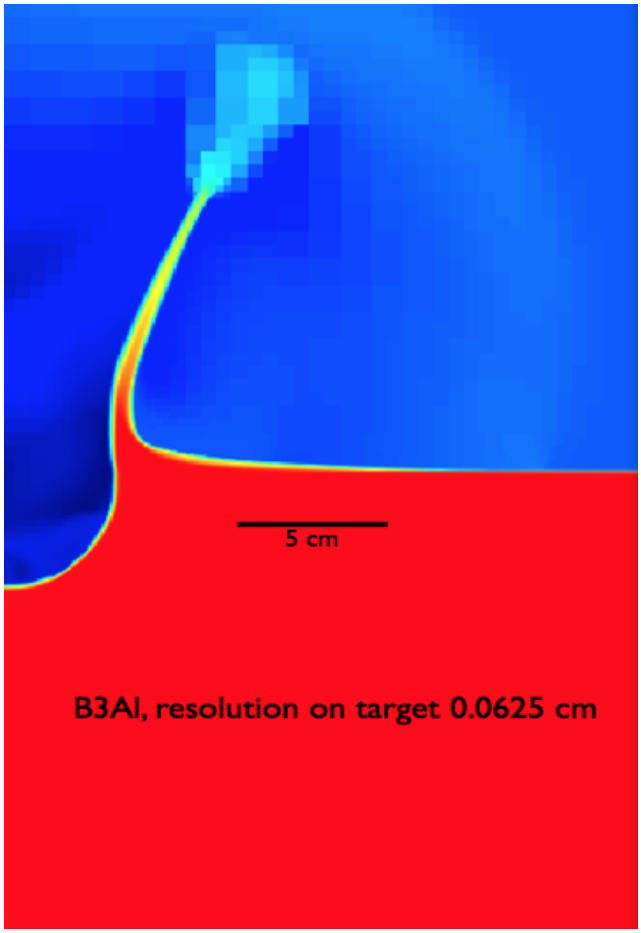

Figure 2: Crater in RAGE simulation at 300 microseconds utilizing the AMR capabilities.