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☒ **Deflection and Disruption Models & Testing**

AN OVERVIEW OF THE LOS ALAMOS PROJECT SUPPORTING PLANETARY DEFENSE STUDIES

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ABSTRACT

We give an overview of the tasks that Los Alamos National Lab is supporting for Planetary Defense/Asteroid Mitigation. Our effort is part a of a larger joint project coupling the National Labs to NASA/Godddard and NASA/Ames through an InterAngency Agreement (IAA). We have active efforts on kinetic impactor simulations, nuclear stand-off burst simulations as well as assessments of the consequences of not mitigating Earth bound Potentially Hazardous Objects (PHOs).

The technical work described here involves studies of nuclear stand-off burst mitigation and disruption techniques. We will show a few radiation transport simulations of stand-off nuclear bursts above a 250 meter radius asteroid (Case study 1). Case study 1 (CS1) is a follow-on to a Los Alamos National Lab to Livermore National Lab code comparison that has been published. CS1 is defined to be deflection simulations for a Bennu sized asteroid with both idealized asteroid parameters and nuclear source description at a height-of-burst (HOB) of 100 m above the asteroid surface. For simplicity, the asteroid is defined to be a spherical SiO_2 object of density 1 g/cc, with the orbit of Bennu. The simplified source output is defined to have 1 Mt of energy, with an initial black-body temperature of 2 keV, in a mass that is approximately that of the nuclear source plus the Hammer spacecraft. Simulations with real nuclear sources are also performed by both Los Alamos and Livermore. In this study we compare the Los Alamos results for the deflection velocity of the asteroid by the idealized description to that from real sources. The real nuclear source simulations use calculated outputs for x-rays neutrons and gammas.

The physics of interest here is the energy coupling of the output from the source to the asteroid. This coupled energy heats up a thin surface layer to very high temperatures which results in asteroid material being vaporized and ablated from the surface. The magnitude of this coupling is very non-linear, depending on the source energy, the source output spectra (x-rays, neutrons and gammas) and the HOB. The hot surface leads to re-radiation by the asteroid back into space, representing a loss term total for the energy remaining in the asteroid. This ablation leads to an

integrated ejected momentum that gives a counter force on the asteroid and results in the deflection velocity. All of the radiation absorption, heating and re-emission energy are treated in an integrated, time-dependent, non-linear fashion by our codes. In part, this leads to the requirement for the use of radiation transport algorithms.

Results will be shown for the idealized 2 keV black-body source model, where we compare 3 HOBs: the prescribed 100 m, then 50 m and 25 m. A transport accurate simulation of an idealized 1 Mt 100 m HOB source is shown in the Figure.

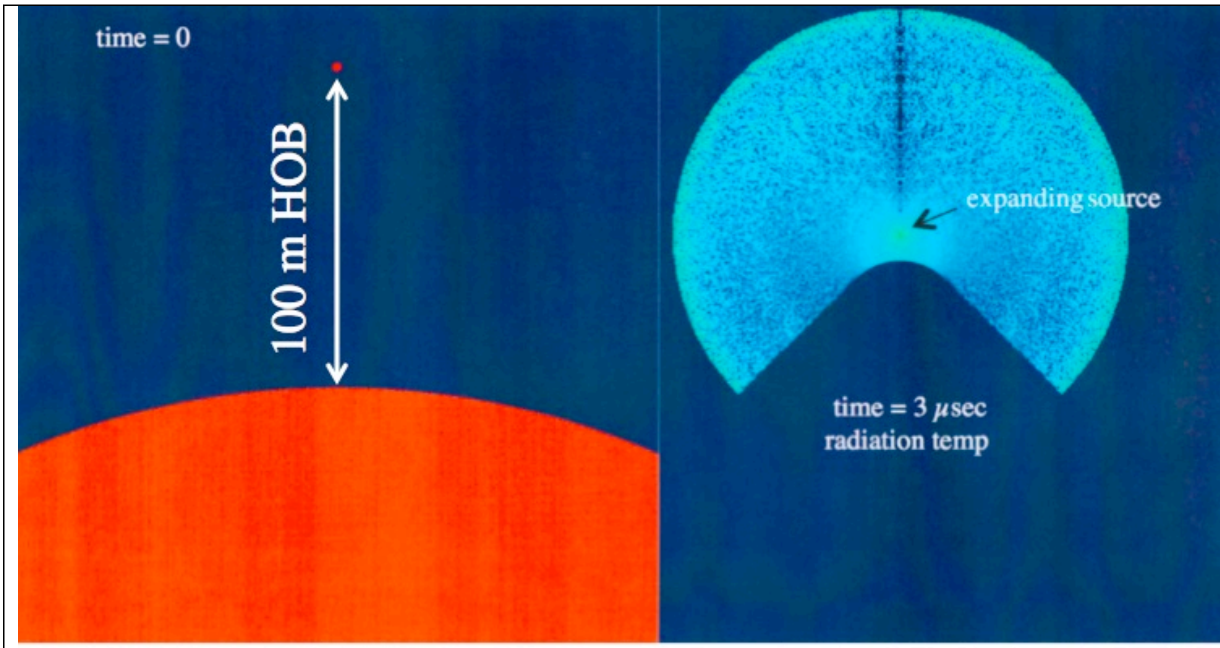

Figure. A sample of the transport based results for a 1 Mt idealized source with a black-body temperature of 2 keV. This simulation results in a 1.6 cm/s deflection velocity.