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Analytic NEO Deflection Formula Update and Expansion

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The planetary defense community practices mission-planning to deflect or disrupt any near earth asteroids (NEAs) that are found to be on an Earth-impacting trajectory. Many scenarios must be considered to determine the optimal mission type to recommend. While a kinetic impactor is the first choice for a deflection mission, either a large asteroid or a short warning time may require using a stand-off nuclear explosive device (NED) to deflect the NEA. Therefore a simple analytic model to estimate the Δv imparted to a NEA by a stand-off NED is a valuable tool for mission planners. Roughly a decade ago an initial analytic model was provided to NASA for this purpose. In 2021 the model was somewhat revised and published[1]. In 2023 a further revision[2, 3] was presented to better handle cases that had high x-ray fluences.

The revised model is still in need of improvement. The model was fit to calculations for SiO_2 at full density, 2.65 g/cm^3. Since NEAs are rarely at full density[4, 5, 6, 7] the effect of porosity is currently handled by using the density scaling inherent in the model. Since the density-scaled analytic model diverges from simulations that include porosity the current results are likely inadequate and should explicitly include simulated porosity data to fit the model. The model would also benefit from having coefficients for materials other than SiO_2.

We have performed asteroid deflection simulations with four materials (SiO_2, forsterite, ice, and iron), four porosities (10%, 30%, 50%, and 70%), two diameters (100 and 500 m), several heights of burst (HOB), and several fluences. These hydrocode simulations are initiated using Burkey's energy deposition model[8]. The goal is to provide model coefficients for each material. Whether the coefficients need to include a dependency on porosity will be investigated as well. The uncertainty of the coefficients and the Δv provided by the model will be examined and presented as results warrant.

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Comments:
(If possible, an oral presentation would be preferred)

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