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- [ ] **Key International and Political Developments**
- [ ] **Advancements in NEO Discovery**
- [ ] **New NEO Characterization Results**
- [x] **Deflection & Disruption Modeling and Testing**
- [ ] **Mission & Campaign Design**
- [ ] **Impact Consequences**
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- [ ] **The Decision to Act**
- [ ] **Public Education and Communication**

NEO Deflection Formulae

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If a NEO is discovered on an impact trajectory with Earth a deflection mission would need to be planned. The planetary defense community practices planning such missions so they can be prepared to do the best job possible. While a kinetic impactor is the first choice for a deflection mission, either a large size or a short warning time may require using a stand-off nuclear device to deflect the NEO. A stand-off nuclear device emits x-rays that heat the surface layer of the NEO and cause it to blowoff and impart momentum to the NEO. Several years ago a simple formula to estimate the Δv imparted to a NEO by a stand-off nuclear explosion was developed and informally distributed for use in planning NEO deflection missions. This work will give the derivation of that formula. In addition the formula will be extended to properly handle the low fluence limit that was not included in that initial formula. This covers the case where the whole irradiated surface of the NEO is not melted. The original formula also did not account for how the angle of incidence lowers the deposition scale length. This keeps the energy closer to the surface and reduces the depth to which material is melted. In addition another formula based on the impulse developed by the energy deposition profile is compared to the previous formula.

These formulae cannot predict the blowoff momentum from first principles. This is due to the fact that the blowoff momentum depends on the shape, composition, and structure of the NEO which are poorly known. In addition, because the x-rays deposit their energy on a length scale measured in microns, the surface will be heated enough to reradiate some of the deposited energy. Therefore the coefficients in these formulae are fit to the results of radiation-hydrodynamic calculations done for a grid of stand-off

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distances and yields. These calculations are required to account for the reradiation of energy by the surface and for thermal waves that propagate into the material before the hydrodynamic blowoff gets fully underway. Several materials will be studied including SiO_2, Forsterite, iron-nickel, and ice. Figure 1 shows results for a NEO with a radius of 150 meters and made of SiO_2 as the yield varies from 1 kt to 1 Mt and the stand-off distance varies from 10 m to 3 km. The optimal stand-off distance is obvious from the contours but is not a constant fraction of the NEO radius.

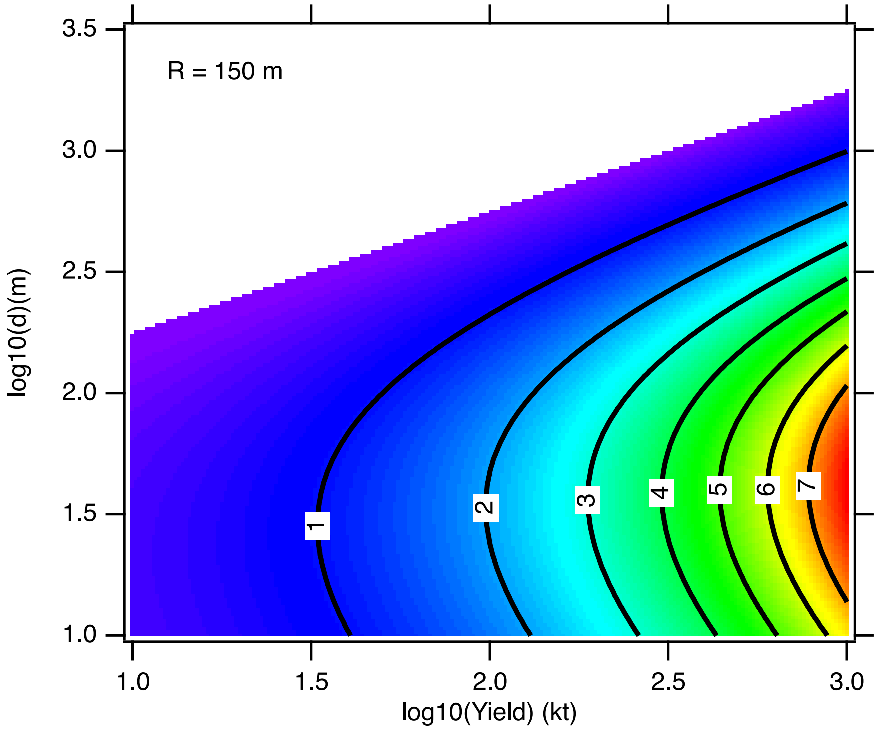

Figure 1: Δv **for a 150 m radius meter asteroid. Contours are labeled by cm/s**

Comments:

Oral presentation preferred, poster is acceptable

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