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NEOSHIELD: THE PHYSICAL PROPERTIES OF THE MOST FREQUENT IMPACTORS

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ABSTRACT

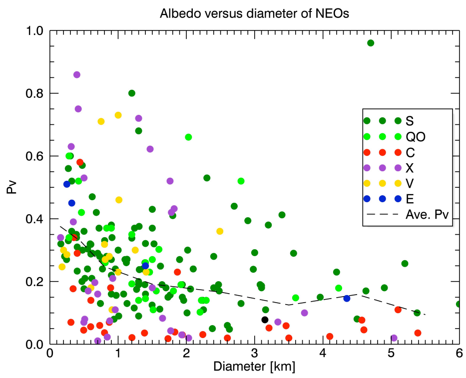
NEOShield is a consortium of 13 research institutes, universities and industrial partners from 6 countries. The aim of the project is to explore mitigation options in the event that a NEO is found to be on a potential collision course with Earth, and to pave the way for demonstration missions to test proposed mitigation techniques. Finding an accessible and appropriate target NEO for a demonstration mission is an important aspect of mission design. We are carrying out a statistical investigation of the properties of the known NEO population, using the latest published data, with the aim of estimating the most likely mitigation-relevant physical properties of the first NEO to trigger a space-borne mitigation action.

Our investigation focuses on the physical properties of the most frequent serious impactors. We define a serious impactor to be one with the potential to lead to major loss of life and damage to infrastructure. At the low end of the size range our definition includes atmospheric events such as the 1908 Tunguska explosion, caused by a body with a diameter, D, of around 50 m. We consider the upper limit of our size-range of interest to be around D = 200 m, because for objects above this size the impact frequency drops below 1 per 10 000 years. However as there are large uncertainties related to the calculation of diameter, we include NEOs with H > 20 mag (D < 300 m). Another reason for considering objects larger than 200 m is the fact that present guidance, navigation, and control (GNC) technology may dictate a minimum size larger than 200 m for the target of a feasible demonstration mission to insure a high chance of success (although research to improve GNC performance is part of the NEOShield project).

Very little is known about NEOs with D <300 m, as only 2% of the more than 5400 discovered NEOs in this size-range have had any physical properties measured beside H magnitudes. Our investigation includes recently published data from the NEOWISE and Warm Spitzer ExploreNEOs surveys, without which this fraction would be much smaller.

NEO discovery surveys in the visual region suffer from an observational bias against dark asteroids, which is especially important for small objects and leads to underrepresentation of NEOs with low albedos, such as C-types, in the known population. In Figure 1 it can be seen that the average albedo rises from around 0.14 for D > 3 km to 0.38 for D < 300 m. This is possibly due solely to discovery bias but size-dependent physical effects related to space weathering and the recent exposure of unweathered sub-surface material might also play a role.

1



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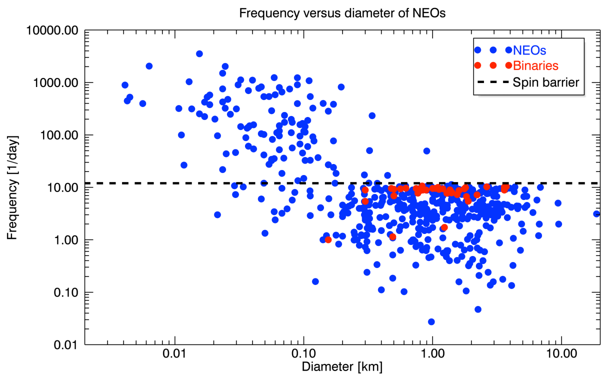

Figure 1: Albedo versus diameter with taxonomic types of NEOs.
Figure 2: The rotation frequency versus the diameter of NEOs
(Data from EARN)

An important aspect of our study is to determine to what extent common assumptions about NEO physical properties are justified for mitigation planning concerned primarily with small objects (D < 300 m), and to identify the most critical areas of ignorance.

When considering the rotation rates of NEOs (Figure 2), it is clear that NEOs with D < 300 m are different from the larger ones. Almost all of the NEOs with D > 300 m spin slower than the spin barrier at (period ~2.1 hour), which suggests a predominance of rubble-pile structures in the case of objects with diameters larger than 300 m. For D < 300 m, on the other hand, spin rates are generally much higher, implying that the smaller NEOs have some cohesion holding them together.

Depending on the technique chosen, both the degree of cohesion and the possible very high rotation rate of the target NEO can be crucial considerations for mitigation mission planning.

We present and discuss the results obtained to date from our statistical investigation of mitigation-relevant physical properties of NEOs in the 50 m – 300 m size range, and the requirements for selection of realistic demonstration mission targets.

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