REVEALING REGOLITH PROPERTIES OF NEAR-EARTH ASTEROIDS. A. Gustafsson[1] and N. Moskovitz[2], [1]Department of Astronomy and Planetary Science, Northern Arizona University, P.O. Box 6010, Flagstaff, AZ 86005, [2]Lowell Observatory, 1400 W Mars Hill Rd., Flagstaff, AZ, 86011

Introduction: The most common method for estimating surface grain size of asteroids is by determining thermal inertia of the body using thermophysical models. Calculating accurate values of thermal inertia for asteroids is a difficult process requiring a shape model, thermal-infrared observations of the object obtained over broad viewing geometry, and detailed thermophysical modeling. However, thermal inertia is a sensitive probe of surface regolith properties [1], and therefore is of great importance in the design of instrumentation and observing strategies for asteroid missions where knowledge of surface properties is critical.

However, thermal inertia alone cannot uniquely describe the fully complexity of asteroid surface properties. This was true for OSIRIS-REx target (101955) Bennu whose thermally derived grain size estimates did not accurately represent the rough, bouldered surface observed by the spacecraft [2].

Radiative transfer models are some of the most widely used tools for compositional analyses of planetary bodies. In application to silicate-rich asteroids, radiative transfer models have almost exclusively been used to derive olivine to pyroxene abundance ratios. However, new formulas for deriving mineralogies from visible and near-infrared spectra of asteroids with prominent olivine and pyroxene (1 and 2 micron) absorption bands have been developed (e.g. [3, 4]), and the effects of non-compositional parameters (temperature, phase angle, grain size) have been well characterized, allowing for a more detailed analysis of second order effects like grain size and observing geometry with radiative transfer models.

Methods: We investigate these second order effects using Hapke radiative transfer modeling. We generate visible to near-infrared spectra across a range of model compositions encompassing the silicate-rich ordinary chondrites meteorites and S/Q type near-Earth asteroids, grain sizes from 1 micron to 1 cm, and degrees of space weathering from 1-5. We are then able to validate these model spectra against ordinary chondrite meteorites and unresolved S/Q type asteroids with previously measured physical properties to assess the limitations of our model.

Expected Results: We have implemented a new technique utilizing Hapke radiative transfer modeling to constrain grain size for unresolved asteroid surfaces. This technique can be applied to a large number of targets including NEAs and Main Belt asteroids. This model is optimized for investigating S/Q type asteroids whose spectra are dominated by olivine and pyroxene absorption bands. Results from this study will be used to compliment thermal grain size estimates when they exist and provide standalone estimates of the surface properties for a much larger number of near-Earth and Main Belt asteroids. The visible and near-infrared spectral analysis in conjunction with thermal grain size estimates will improve mission target and/or sample site selection and hazard assessment for potential impactors.

Applications to Apophis: The 370-m [5] near-Earth asteroid Apophis has been measured as an Sq-type, matching well with LL6 ordinary chondrite meteorites [6] and consistent with the mineralogy range implemented in our model. Our technique will allow for reanalysis of existing data [6], of new observations during future apparitions (e.g. early 2021), and ultimately of ground based and space based observations during the 2029 flyby. Specifically, we will be able to characterize changes in regolith properties as a result of the flyby. Our tools will provide an excellent means to assess the consequences of the flyby on the surface properties from both in situ and remote observations and will help answer key science questions regarding surface alterations like grain sorting, landslides, surface weathering, and more.

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