Combining Thermal and Radar Observations of Near-Earth Asteroids. E. S. Howell[1] , R. J. Vervack, Jr. [2], M. C. Nolan[1], C. Magri[3], Y. R. Fernandez[4], P. A. Taylor[1], and A. S. Rivkin[2], [1]Arecibo Observatory HC 3 Box 53995 Arecibo PR 00612 ehowell@naic.edu, [2]JHU/Applied Physics Lab, [3]U. Maine at Farmington, [4]U. Central Florida.

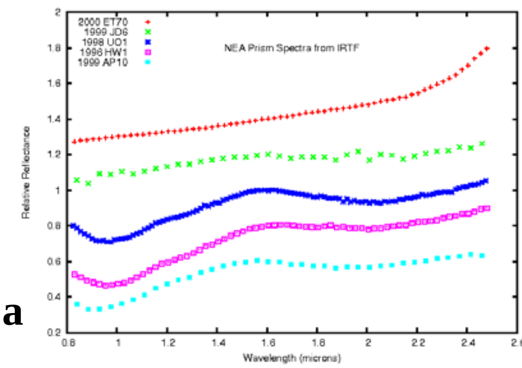
Introduction: As we sample ever-smaller sizes of near-Earth asteroids (NEAs), we see an increasing variation in the range of physical properties. Radar experiments show a diverse range of shapes, surface features, and rotation states among NEAs. Infrared observations of these objects are equally varied, illustrating a range of spectral types and thermal characteristics. While spacecraft missions will reveal details of a few NEAs, only ground-based observations will provide an overall understanding of the population of these small bodies.

The goal of our investigation is to use both radar images and near-IR spectra to better understand the regolith of different types and shapes of NEAs. The regolith on an asteroid surface controls its thermal properties and often its radar reflectance as well. At smaller sizes the irregular shape plays an increasingly important role.

We choose NEAs that will be observed well enough with radar to have high-quality shape models. We then observe these objects with SpeX at the NASA IRTF (0.8-4 microns) [1] at several different viewing geometries and rotation phases to see how the inferred thermal properties depend on the detailed shape. This knowledge is then used to quantify the systematic biases in existing thermal models that are based on simple assumptions such as spherical shape or zero thermal inertia.

Asteroids Sampled: We have observed 37 NEAs to date, including 22 S-complex, 11 X-complex, and 4 C-complex objects. The X-complex group includes two high-albedo (Tholen E-type) and two low-albedo (Tholen P-type) asteroids. Figure 1 shows several example spectra. These asteroids have effective diameters ranging from a few hundred meters to several kilometers. We observed three binary and one triple system, eight contact binaries, and three other spheroidal objects that do not appear to be binary systems. The rest of the sample have irregular shapes, or have not yet been determined. We include both very fast and very slow rotators, as indicated by the radar observations.

Thermal Modeling: We have applied simple thermal models, assuming spherical shapes with and without obliquity, and have also applied a shape-based thermophysical model. Even the spheroidal objects show different model diameters and albedos at different viewing geometries, and cannot all be fit with a single set of thermal parameters. For 1996 HW1, the shape-based thermophysical model is required in order to fit 1996 HW1 on all four dates of observation [2,3]. We will present a summary of our observations to date and preliminary results of the thermal modeling.



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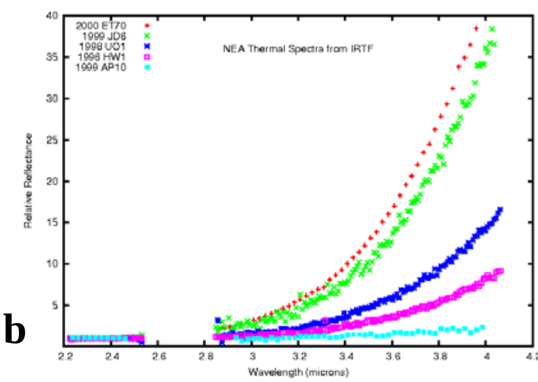

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Figure 1 a. Example spectra using prism mode of SpeX (0.8-2.5 microns) for several NEAs are shown in the upper plot. The top two spectra are flat, X- and C-complex asteroids, while the lower three spectra are S-complex objects. The spectra are normalized at 1.6 microns, and offset for clarity. **b.** The thermal emission spectra for the same objects are shown in the lower plot. The upper two spectra are low-albedo objects, while the lower three S-complex asteroid spectra are higher albedo, though there is a wide range. The gap at 2.6-2.8 microns is where the atmosphere is opaque.

References: [1] Rayner, J. T. et al. (2003) *PASP*, 115, 362-382. [2] Magri, C. et al., (2011) *Icarus, 214*, 210-227. [3] Magri, C. et al. (2011) *EPSC-DPS*, 666.