9 Future work

9.1 Thermal inertia measurements

More NEA measurements are required. While we consider our result for the typical thermal inertia of NEAs to be well established, its apparent size dependence may require more data points to be confirmed.

M-type asteroids Judging from near-infrared spectroscopy (Rivkin et al., 2000) and radar measurements (e.g. Magri et al., 1999), some M-type asteroids appear to be metallic, while others appear to be non-metallic. Metal is an excellent thermal conductor, potentially leading to an enhanced thermal inertia. We have performed thermal-infrared observations of M-type MBAs at the IRTF. A preliminary analysis indicates that metallic M types have indeed a larger thermal inertia than their non-metallic counterparts, but further study is required.

Does thermal inertia correlate with taxonomic type? In general, the efficiency of regolith formation and the thermal properties of regolith may be a function of mineralogy, which may translate into a dependence of thermal inertia on taxonomic type. This is supported by our preliminary M-type results (see above) and the difference in thermal inertia between the two NEAs 1998 WT24 (E type) and Itokawa (S type), which are roughly equal in size. Any such taxonomy dependence would not only enable more accurate model calculations of the Yarkovsky effect but also inform future modeling of regolith formation through impact processes.

Small MBAs The diameter distribution of asteroids with measured thermal inertia displays a dichotomy between relatively small NEAs and much larger MBAs. Measurements of the thermal inertia of smaller MBAs, with diameters of 10–100 km, would be required to fill the gap. In particular it would be instructive to compare the thermal inertia of MBAs of Eros' size with that of Eros.

Karin family We have performed Spitzer observations of 17 members of the intriguing Karin family of MBAs, which was formed in a catastrophic collisional event only 5.8 ± 0.2 Myr ago. The data analysis is ongoing (due to calibration problems which we hope are now resolved). We expect to determine the typical thermal inertia of our targets, which range between < 2 and ~ 14 km in diameter.

Kuiper belt objects (KBOs) Very little is currently known about the thermal inertia of KBOs. Due to their large heliocentric distance, their thermal emission peaks at wavelengths which are inaccessible from the ground, requiring the use of airborne (SOFIA) or space-based telescopes (Spitzer, Herschel). Knowledge about the thermal inertia of KBOs would aid the accurate determination of KBO sizes and albedos and would provide information on the surface particle grain size which is difficult to obtain otherwise.

9.2 Binary asteroids

Mass densities from TPM-derived diameters The elusive mass density of asteroids can be determined in the case of binary systems from accurate determinations of the mutual orbit (providing the mass) and diameter measurements. TPM-derived diameters promise to reduce the usually large uncertainties, which are very sensitive to diameter uncertainty ($\rho \propto D^{-3}$). An ongoing collaboration has been established with a group of researchers (based in Paris and Berkeley) who determine mutual orbits through high-angular-resolution optical observations. We have been awarded observing time with Spitzer in cycle IV (starting summer 2007) to characterize 26 binary asteroid systems.

More eclipses We aim at further thermal-infrared observations of eclipsing binaries. The number of suitable targets (with well determined mutual orbit to allow precise prediction of eclipse events and later thermophysical modeling) is limited but increasing; potential targets have been identified in collaboration with our partners.

9.3 Improvements to the thermophysical model (TPM)

TPM for concave shapes Our TPM for non-convex shapes does not yet include the effect of mutual heating beyond craters and is not well tested, yet.

Furthermore, its practical applicability is limited by its current numerical inefficiency. Numerically more efficient algorithms have been developed but not yet implemented.

Generalized models of asteroid surface roughness An important application of the general non-convex-shape TPM to be developed would be thermal modeling of boulders on NEA surfaces. In the current TPM, surface roughness is modeled in terms of craters (negative relief) but, judging from Hayabusa imaging of (25143) Itokawa, boulders (positive relief) appear to be more abundant on small asteroids. This may have a significant influence on the temperature distribution, particularly so at large solar phase angles, when shadowing effects are important. We propose a "brute-force" model of boulders, whereby cuboids are added to each facet of asteroid shape models.