Estimating Asteroid Thermal Inertia from Multi-epoch Observations

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Granular material, or regolith, is observed to be ubiquitous on asteroid surfaces. To date, two feasible mechanisms of regolith generation have been proposed: recurrent impacts and thermal fracturing. By combining thermal infrared observations and a thermophysical model (TPM), the thermal inertia of an asteroid surface can be used to infer its physical properties, including the average regolith grain size. With the regolith properties of a large population of diverse asteroids (i.e. different spectral class, size, rotation period etc.), information regarding the details of regolith generation can be inferred.

Traditional thermal inertia determination methods use a TPM with a previously derived asteroid shape model and spin axis for constraining the observed surface temperature distribution. TPMs invoke the heat diffusion equation to calculate surface temperatures for a rotating asteroid. An asteroid spin axis provide the boundary condition needed to calculate the surface energy balance in a TPM. However the limited amount of objects with a shape model and thermal infrared observations inhibit the number of thermal inertias that can potentially be calculated. Here, a technique using WISE (12 & 22 micron) observations taken before or after opposition is employed to derive thermal inertias of asteroids without using a shape model. By gathering thermal infrared data at multiple viewing geometries the temperature distribution, thus thermal inertia, is constrained.

We first demonstrate the validity of this method on objects with a previously determined shape model and spin axis from the DAMIT website. Our analyses show that not knowing an asteroid's shape does not significantly affect the resulting thermal inertia estimates. Additionally, we apply our TPM to WISE multi-epoch thermal observations to place estimates for the thermal inertia for more than 100 objects. The set of objects used samples many sizes, spectral classes and rotation periods, which may be important factors in the generation of regolith. We search for and quantify dependencies on these physical properties with our preliminary thermal inertia estimates.