Novel method of thermal-inertia determination

E. MacLennan[1] and J. Emery[1]

[1]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, USA

Spacecraft missions have shown how asteroids can be covered by a regolith ranging from fine-grained to large cobbles and boulders. Regolith properties for many objects can give information on processes altering the surfaces of these bodies, yet only a few have been imaged in sufficient detail to directly investigate their regoliths. For objects not visited by spacecraft, thermal inertia can be used to infer the physical properties of the regolith [1]. In general, surfaces of bare rock have a higher thermal inertia, whereas the presence of small regolith grains yields a lower thermal inertia. Thermal inertia is a quantity indicative of how resistive a material is to changes in temperature. An insulating layer of fine-grained material will cause large diurnal changes in temperature, whereas a ”bare rock” surface causes temperatures to be longitudinally isothermal. Thermal inertia is thus also important for understanding the radiative forces acting to alter the dynamical properties of airless bodies (e.g. Yarkovsky and YORP; [2]). Traditional methods of thermal inertia determination require knowledge of the spin axis as input for thermophysical models (TPMs). TPMs invoke the heat diffusion equation in order to calculate surface temperatures for a rotating asteroid [3]. Asteroid spin axes provide the boundary condition needed to calculate the incident solar energy across the surface. Since spin axes for only small fraction of the total asteroid population are known [4], application of the traditional method is limited. Here, we assess the effectiveness of a method that does not require previous knowledge of an object’s spin axis. This method uses multi-epoch observations of asteroid thermal emission at different viewing geometries. Many such observations of objects were made in 2010 by the WISE mission during its all sky survey [5]. As a result, object flux data for a warmer "afternoon" and cooler ”morning” side are gathered at two wavelengths (12 & 22 µm). This makes it possible to accurately constrain the surface temperature distribution of an asteroid, and thus thermal inertia, without knowing an object’s spin axis. To test the validity of this method we select objects that have previous spin axis and shape information from the DAMIT website [4] and estimate thermal inertia using both the traditional and multi-epoch method. We present thermal inertia, size and albedo results for over a dozen such objects observed by WISE and compare to previous thermal inertia estimates of other objects. The future application of this method to asteroids with undetermined spin axes is sure to dramatically increase the number of asteroid thermal-inertia estimates.

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