Constraints on the Spin Axis and Thermal Properties of Asteroids in the WISE Catalog

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It has widely been accepted that dynamical state of asteroids can strongly be influenced by radiation forces (e.g., Yarkovsky and YORP). Determination of an object's thermal properties and spin state are a critical step towards understanding the effects of these forces. In this respect, observations of thermal flux emitted from the surfaces of asteroids are a powerful tool. The emission of flux is determined by the temperature distribution which is controlled by the thermal inertia, rotation rate, and spin axis orientation. By gathering data at multiple viewing geometries, the temperature distribution can be modeled accurately enough to separate the effects attributed to (some of) these parameters. Over the length of its mission, the Wide-Field Infrared Survey Explorer (WISE) observed many asteroids in two epochs (i.e., on either side of opposition) such that data for both morning and afternoon times were gathered. We have begun a project that employs a Thermophysical Model (TPM) in order to analyze these multi-epoch thermal observations with the goal of deriving the thermal properties and spin axis of a large number of asteroids.

Here, we first investigate the validity and limits of our method on objects with a previously determined spin axis. Asteroid (413) Edburga has a published spin axis of $\lambda = 202^o$, $\beta = - 45^o$ (ecliptic longitude and latitude, respectively) using the lightcurve inversion method. With our technique, we estimate a solution consistent with the previous estimate. Applying our TPM to WISE multi-epoch thermal observations of (155) Scylla (no known spin axis estimate), we also place estimates for the ecliptic longitude and latitude of its spin axis. Analysis of multi-epoch thermal data enables determination of spin axis orientation without knowing the rotation period, in contrast to the lightcurve inversion method. This is due to the coupling of thermal inertia and rotation rate in determining the longitudinal distribution of temperature. Their combined effects on surface temperature can adequately be described by a dimensionless thermal parameter, which is a ratio of the time scale for radiating heat to the diurnal time scale.