Thermal-Infrared Observations of Near-Earth Asteroids

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We rely on thermal measurements (5-20 microns) for most of the albedo and diameter estimates we have for asteroids. However, many size and albedo results for NEAs are based on thermal-IR observations made at solar phase angles greatly exceeding 30 degrees. This is because of the very close approaches these objects make to the Earth and the very brief periods over which they are typically observed. These large phase angles are well beyond the range over which the standard thermal models are assumed to be valid.

Therefore the authors have initiated an observing program to test thermal models with observations of NEAs made at high solar phase angles. With good thermal models for NEAs it will be possible to have much higher confidence in the albedo and size distributions being obtained by various researchers based on thermal-IR measurements.

As an example of our results, thermal model fits to weighted-mean flux measurements of the C-type NEA 1580 Betulia are shown in the accompanying figure. These data were obtained in June 2002 with the IRTF and JPL's mid-infrared camera called MIRLIN. Before averaging, the original flux measurements were corrected for Betulia's rotational variability by means of an R-band (visible) lightcurve obtained simultaneously on the University of Hawaii's 88-inch telescope.

The plotted curves represent best-fit solutions to three different thermal models: the standard thermal model (STM; which assumes the asteroid has a low thermal inertia and/or is a slow rotator), the fast rotating model (FRM; which assumes the asteroid has a high thermal inertia and/or is rapidly rotating), and the near-Earth asteroid thermal model (NEATM; a model developed by Harris and our best guess at a useful model for NEAs).

The albedo based on these new IRTF data is about 0.1. This value is consistent with Betulia being a relatively dark C-type asteroid, but is somewhat higher than previous estimates. We obtain an effective diameter (i.e. that of a sphere of equivalent projected area) of about 4.4 km. The IRTF results given here are preliminary, and analysis is still in progress.

As can be seen in Figure 1, the NEATM results provide an excellent fit to the thermal emission spectrum of the asteroid, while the other models do not. This demonstrates the potential of NEATM to provide reliable size and albedo estimates of NEAs. **Combined with future observations with the IRTF, a large database of albedos and diameters will be produced for NEAs that will be vital for understanding their true size distribution.**

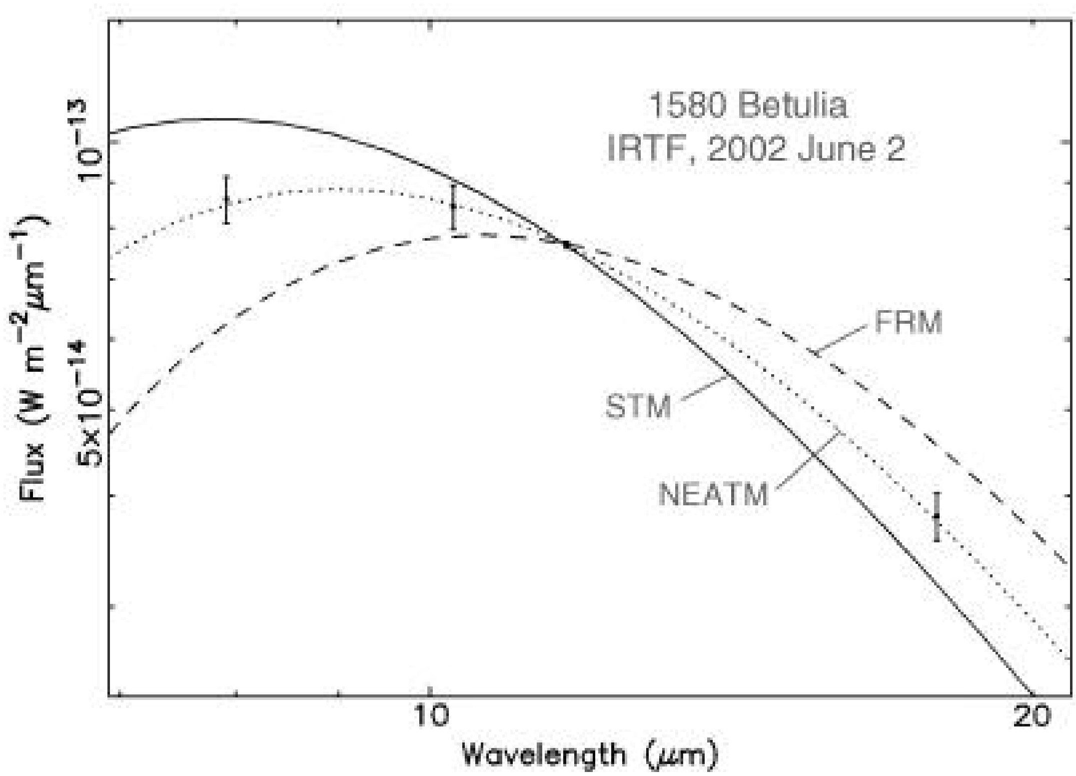

Figure 1. Comparison of thermal models to observations of 1580 Betulia made at 7.9, 10.3, 11.7 and 17.9 microns. The near-Earth asteroid thermal model (NEATM) developed by Harris provides a much better fit than the standard thermal model (STM) and the fast rotating model (FRM). This better fit is primarily due to the inclusion of a variable "beaming parameter" that allows for variations in how the thermal flux is emitted from rough surfaces on irregular-shaped objects. More NEAs will be observed to provide proper calibration of the NEATM model.