DIAMETER, ROTATION, AND THERMAL PROPERTIES OF ASTEROID 4 VESTA L. A. Lebofsky*, W. B. Hubbard, E. Asphaug, D. M. Hunten (LPL, U. of Arizona), R. L. Millis, O. G. Franz, L. H. Wasserman (Lowell Obs.), M. A'Hearn, R. Schnurr (U. Maryland), A. R. Klemola (Lick Obs.), W. Osborn (Central Michigan U.), F. Vilas, A. E. Potter (JSC), P. D. Maley (IOTA and Houston Museum of Nat. Sci.), P. L. Manly (IOTA and Saguaro Astron. Club)

Thermal infrared observations and thermal models of asteroids have been used for over two decades for the determination of asteroid diameters and albedos. A *standard* thermal model is generally used which assumes a non-rotating spherical asteroid. For most asteroid observations, this model is sufficiantly accurate. The standard thermal model has been calibrated at 10 μm to the occultation diameters of asteroids Ceres and Pallas (1) and has been used for the reduction of groundbased and IRAS thermal IR observations of asteroids.

The phase dependence of the standard thermal model diameter of an asteroid can be used to determine the sense of direction of its rotation (2): For a prograde rotator, the warmer evening terminator is seen before opposition and the cooler morning terminator is seen after opposition, thus the model diameter will be largest before opposition. For Ceres, the model diameter was several percent larger before opposition relative to after opposition implying prograde rotation for Ceres. The Pallas results were inconclusive (1). When good quality observations of an asteroid are made over a range of solar phase angles, a more sophisticated thermophysical model can be used (2).

Combining thermal IR observations made at the IRTF with the occultation results on asteroid 4 Vesta reported by Millis *et al.* (3), we have begun a study of the rotational and thermophysical properties of Vesta. A comparison of the phase-dependent standard thermal model diameter of Vesta with its observed occultation diameter (independent of phase angle, see Fig. 1) shows that Vesta rotates in a prograde direction, similar to what has been observed for Ceres. However, the mean thermal model diameter is about 10–15% smaller than the observed occultation diameter! Thus the standard thermal model fails to predict the diameter of Vesta. Also, the model diameter before opposition is up to 10% greater than after opposition. This is the first clear evidence for the limitations of the standard thermal model for even the large asteroids.

Observations over a wide range of phase angles have allowed us to use a thermophysical model to study the thermal properties of Vesta (Fig. 2). Our preliminary analysis indicates that the surface regolith is substantially rockier than either Ceres or Pallas (4). However Vesta's thermal inertia indicates a surface regolith similar to that of the Moon. This would be consistant with the observations that the surface materials of Ceres and Pallas are primitive and thus their surfaces have been altered very little (other than meteoritic impacts) since their formation. The surface of Vesta, on the other hand, has seen more recent episodes of magmatic activity and so is likely to have a less mature (rockier) regolith.

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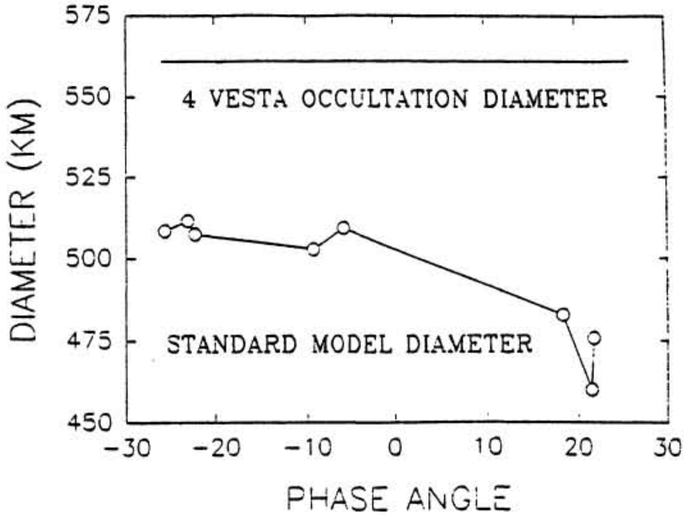

Fig. 1: A comparison of the 1989 occultation diameter of 4 Vesta (571 km) with the phase-dependent diameter determined from groundbased thermal IR observations and the standard thermal model Note that the mean thermal model diameter is about 10–15% less than the occultation diameter.

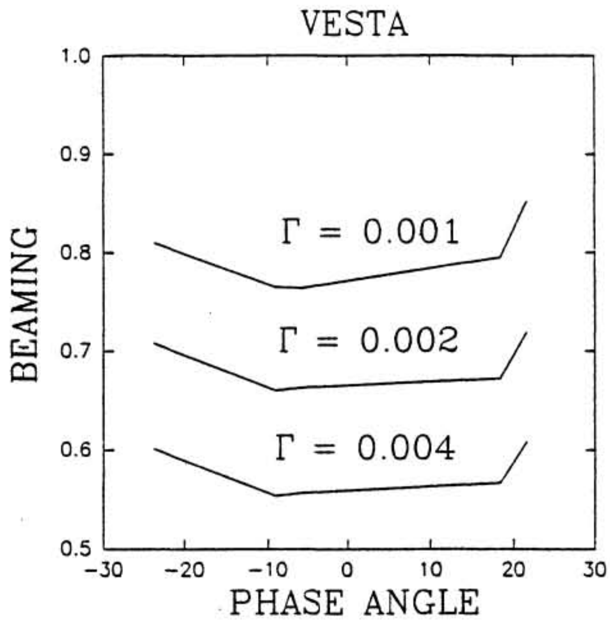

Fig 2: A comparison of thermophysical models for 4 Vesta using three different thermal inertias. The best fit is obtained from the bottom model (symmetric about zero phase). This is a thermal inertia 4 times (rockier) that of Ceres.

Acknowledgements:
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