Size and 3-D Shape of Asteroid Pallas Revisited

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Introduction Asteroid 2 Pallas is the third largest asteroid and until very recently [1,2,3], its physical properties were only loosely constrained.

We developed a tool allowing us to combine asteroid shapes measured from adaptive optics (AO) images with light-curves (LC) inversion techniques [2,4]. LC inversion brings long-term constrains on asteroid spin axis and 3-D shape, without providing absolute measure of its size, nor any surface information. On the other hand, high angular-resolution images provide a direct measurement of an asteroid shape and absolute size, as well as albedo information, but require good rotational phase sampling to derive pole and shape solutions.

Observations We thus compiled near-infrared, high angular-resolution images, with equivalent spatial resolution of about 60 km, obtained within six observation programs conducted at the Keck II Observatory (2) and the ESO Very Large Telescope (4) between 2003 and 2007 (Fig. 1). The observations span a range of sub-Earth latitudes and longitudes on the asteroid, providing constraints on Pallas' shape from different observing geometries.

Spin, Size and 3-D Shape From LC/AO combined analysis, we removed the ambiguity of the pole solution resulting from the LC only observations. We determined that the coordinates of Pallas' spin vector are within 5 deg of (λ=35°, β=-12°) in ECJ2000.0. We also derived a 3-D model (2038 facets - 276 x 266 x 243 km $\pm$ 10 km) rendering Pallas' shape (Fig. 1). Such a model allows refined volume measurement. Considering Pallas' mass measurement distribution [see 5], its density (2.8 to 5.4 g.cm^{-3}) is now limited by the mass uncertainty. Pallas' tri-axial values found here are smaller (but consistent) with HST measurements [3], implying a higher density.

We also detected a large, flat surface feature, which may have been created by the impact that formed the Pallas family [7].

Surface Mapping We produced near-infrared broad-band albedo maps of Pallas' surface [following the method of 6]. These maps, covering 40%, 40% and 70% of Pallas' surface in J, H and K-band respectively, reveal albedo variations of nearly 10% across its surface.

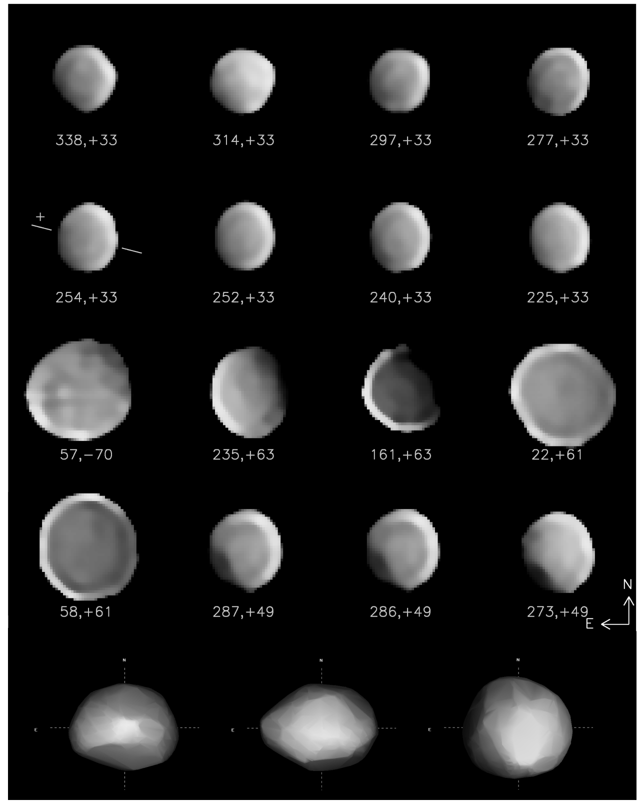

Figure 1: Various views of Pallas in K-band and of its shape model (last row). The sub-Earth longitude, latitude are indicated below each images. The rotational axis is shown for the first two rows (from Keck in 2006). The image stretch was chosen to enhance the surface features visible on Pallas at the cost of a well-defined terminator. The brighter rings visible near the limb of Pallas in some of the images are artifacts from the deconvolution. Pallas' irregular shape is evident from these images.

Reference

[1] J. Torppa et al 2003, *Icarus* 164, 346-383 [2] B. Carry et al 2007, *DPS* 39, 30.08 [3] B. Schmidt et al 2008, *LPSc* 39, 25.02 [4] M. Kaasalainen et al 2007, *DPS* 39, 30.12 [5] J. L. Hilton, in *Asteroids III*, 103-112 [6] B. Carry et al 2008, *A&A* 478, 235-244 [7] R. Gil-Hutton 2006, *Icarus* 183, 93-100