PALLAS: PLANET, PROTOPLANET, OR ASTEROID? B. E. Schmidt,[1] P. C. Thomas[2], J. M. Bauer[3], J.-Y. Li[4], L. A. McFadden[4], M. J. Mutchler[5], J. Wm. Parker[6], A. S. Rivkin[7], C. T. Russell[1], and, S. A. Stern[8]. [1]UCLA-IGPP (britneys@ucla.edu), [2]Cornell Univ., [3]JPL, [4]Univ. of Maryland, [5]STScI, [6]SwRI, [7]APL, [8]LPI.

Introduction: Pallas is the third most massive body in the asteroid belt, and as such joins Ceres and Vesta as a probable protoplanets. Pallas's size, shape and mass are indicative of an object that has remained largely intact over the life of the solar system. Orbiting at the same semi-major axis as Ceres but with a size similar to Vesta, Pallas presents a chance to better understand the formation of early solar system bodies.

Observations: Images of Pallas were taken using HST's WFPC2. WFPC2 has an angular resolution of 0.045" or ~70 km/pix resolution in the images. Observations occurred Sept. 8, 2007 in five broad filters at 336nm (NUV,), 439nm (B), 555nm (V), 675nm (R), and 815nm (I). Deep satellite search exposures were taken in V. We present the results of the satellite search, capable of detecting objects down to ~900m radius for an assumed albedo of 0.1.

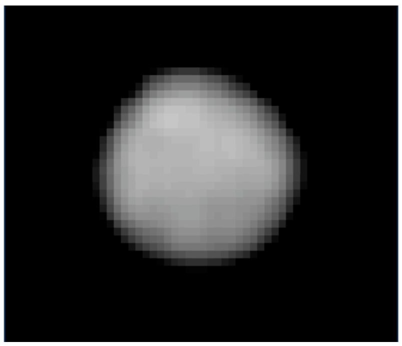


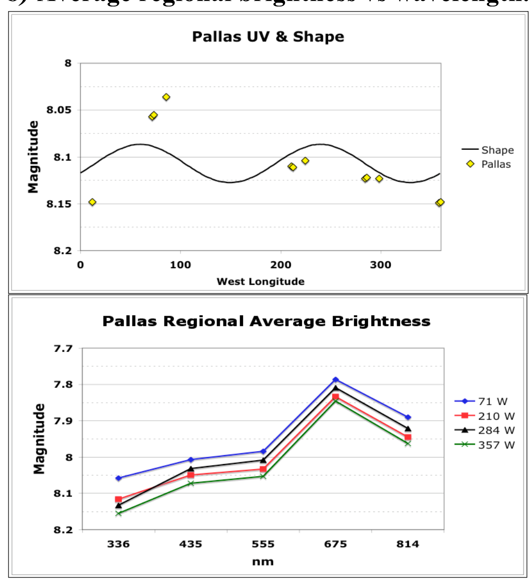
Figure 1: HST image of Pallas at 336nm (NUV).

Shape Modeling: The asteroid's pole position and shape were obtained primarily from limb coordinates and some stereo control of faint surface markings. This method was used to model Ceres [8] and Vesta [6] and is described in [7]. The resulting semi-axes and pole position, with one-sigma errors, are: 291 x 278 x 250 km(±9), RA= 42°, Dec=-12°, (±10°). Assuming a mass of 1.17×10^{-10} kg [4], our shape implies a density for Pallas of 2747 ± 570 kg/m^3.

Historical size estimates of Pallas' semi-axes have varied, from 287 x 262 x 250.5 ±10 km [3] to 275±3 x 252.5±2 x 234±9 km [2]. The densities that derive from these estimates span 2954-3444 kg/m^3. Our results are consistent with [3] within the uncertainties. Our density is lower than that of previous estimates, and is significantly lower than Vesta at 3750 ± 500 kg/m^3 [5,6] and higher than Ceres at 2077 ± 330 kg/m^3 [8] Since Pallas' size likely eliminates much porosity, Pallas' interior is likely intermediate between Vesta and Ceres making it a provocative planetary body.

Surface variation: Photometry of the calibrated images was used to create rotational light curves in each of the five filters. The shapes of the light curves are generally similar, except the NUV that shows possible albedo features near 75 and 285 degrees W longitude. With a UV light curve amplitude of ~0.1 and an a/b axes ratio of 1.04, only 0.04 magnitude amplitude can be derived from shape. The amplitude due to albedo variation is therefore expected to be ~0.06 magnitudes, or ~6% total variation., We modeled the brightness variation due to shape alone using the method of [1], and validated the possibility of albedo features in the NUV using the average brightness of each surface region in each filter, shown in Figure 2. We also present our first surface mapping efforts, including both albedo and color maps.

Figure 2: *a)* UV and shape-derived light curves. *b)* Average regional brightness vs wavelength.



Conclusions: Using HST's WFPC2 camera, we have measured Pallas' size, shape, and physical properties. There is evidence for albedo variation at the few-percent level. The shape measured implies a bulk density directly between those of Ceres and Vesta. This work presents new views of Pallas that place it in context with its large protoplanetary neighbors as one of the earliest solar system bodies.

References: [1] Bauer, J. M., et al. (2004). Ap. J. 601, L57-L60. [2] Drummond, J. D., pers. comm. [3] Dunham et al. (1990) Astr. J 99, 1636-1652. [4] Goffin, B. (2001) A&A, 365, 627-630. [5] Michalak, G. (2000) A&A, 360, 363–374. [6] Thomas, P.C. et al. (1997) Science 277, 1492–1495 [7] Thomas, P. C. et. Al. al. (1998) Icarus, 135, 175-180. [8] Thomas, P. C. et al. (2005) Nature 437, 224-226.