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Charon/Pluto Light Ratio

K. B. Clancy, J. L. Elliot, M. J. Person

Department of Earth, Atmospheric, and Planetary Sciences, MIT, Cambridge, MA 02139, USA

Prediction of the occultations of the stars P126 and P131.1 by Pluto on 2002 July 20 (UT) and August 21 (UT), respectively (Clancy et al. 2002, BAAS 34, 1212) involved astrometric data sets spanning more than three months that were acquired on several telescopes. Pluto's position in each frame was determined relative to a UCAC astrometric reference network (Zacharias et al. 2000, AJ 120, 2131) with a dual-source point-spread function (PSF) model that was fit to the blended Pluto-Charon image. The relative position of Charon from Pluto was fixed in the PSF using values from the JPL Horizons ephemeris, and the light ratio fixed at values from resolved photometric observations of Pluto and Charon presented in Buie, Tholen, and Wasserman (1993, Icarus 125, 233). Although the final predictions proved to be quite accurate (see http://occult.mit.edu/research/occultations/Candidates/Predictions/P126.html and http://occult.mit.edu/research/occultations/Candidates/Predictions/P131.1.html), empirical corrections were made to the offset of Pluto from its ephemeris. These corrections were based on the residuals of Pluto's measured position from its ephemeris, which were sinusoidal. The consistency of the fitted residual phase and amplitude between all prediction data sets implies either an incorrect Charon to Pluto mass ratio was used for calculating Charon's ephemeris, or that we used incorrect Charon/Pluto light ratios in this reduction. Resolved images of Pluto-Charon were taken over a period of six days (2003 April) in nine filters at the Magellan 6.5-m Clay telescope in order to uncover the cause of these residuals. Combined with other Magellan Pluto frames taken in 2001 and 2002, the images were fit with a dual-source PSF model. The Charon/Pluto light ratio determined from the PSF modeling was then plotted against orbital phase and fit with a sinusoidal model for each filter. A strong trend with wavelength was found for the mean light ratio of Charon to Pluto. This trend partially explains the residuals found, as the astrograph and CTIO data were taken in a filter of mean wavelength ~720nm, whereas the Buie et al. resolved light curve was obtained in the F555W filter of mean wavelength ~537 nm. This trend can account for 0.026" of the 0.053" residual amplitude. However, if the only other effect were an erroneous Charon/Pluto mass ratio, the remaining residual would imply a mass ratio of 0.086 rather than 0.120 (as used in the JPL Horizons ephemeris). A value of 0.086 does not agree with recent mass ratio measurements (0.157 ± 0.003 by Young et al. 1994, Icarus 108, 186; 0.124 ± 0.008 by Null and Owen 1996, AJ, 111, 1368; and 0.122 ± 0.008 by Olkin et al. 2003, Icarus 164, 254), thus more work must be done in these analyses to understand the cause of these residuals. This work was funded at MIT in part by NASA Grant NAG5-10444 and NSF Grant AST-0073447.