Discovery of Companions to Asteroids 762 Pulcova and 90 Antiope by Direct Imaging

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We present images of two asteroid companions from adaptive optics (AO) observations. These detections bring to four the number of binary systems ever imaged, the previous discoveries being 243 Ida/Dactyl by Galileo in 1993 (Belton *et al.* 1995, *Nature* **374**, 785) and 45 Eugenia/Petit-Prince in 1998 (Merline *et al.* 1999, *Nature* **401**, 565).

A satellite of 762 Pulcova was discovered on 2000 Feb 22 UT at the Canada-France-Hawaii Telescope (CFHT) and was later confirmed by additional observations at CFHT and Keck II. The satellite is about 4 mag fainter than the primary and our fit to the orbit indicates that it was inclined approximately 60 deg to the line-of-sight, with a semi-major axis of 800 km (0.6″) and a period of 4.0 days. We derive a density for this FC-type primary of $1.8\,\mathrm{g\,cm^{-3}}$, higher than our nominal value of $1.2\,\mathrm{g\,cm^{-3}}$ for F-type Eugenia.

On 2000 Aug 10 UT, Keck AO observations revealed that the C-type 90 Antiope is a double asteroid, with similar-sized components, separated by only 170 km (0.12″), with a brightness difference of less than 0.1 mag. The co-orbiting pair was observed on 6 consecutive nights and was found to have an orbital period of about 16.5 hours, consistent with the established photometric "rotation" period. While we cannot rule out a very thin bridge of material connecting the two, we show that it is not similar to the dumbbell-shaped 216 Kleopatra reported by Ostro *et al.* 2000 (*Science* **288**, 836). The two components are clearly separated in the raw images, with a contrast consistent with the PSF. We acquired similar images of Kleopatra before, during, and after the radar observations of Ostro *et al.* Our Kleopatra images show a bridge connecting the two components, but such a bridge is absent in our Antiope images.

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