

Dwarf Planet Binaries: The Discovery of a Satellite of Makemake

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The discovery of faint satellites of the Pluto/Charon binary (Weaver et al. 2006, Showalter et al. 2012) demonstrated that deep searches with HST are capable of finding faint satellites otherwise lost in the scattered light of the primary. We applied this technique to the two largest and most Pluto-like transneptunians, Eris and Makemake. Observations searched for faint satellites around both objects and can break the orbit-plane degeneracy of the orbit of Eris' known companion, Dysnomia. A new satellite orbiting the dwarf planet (136472) Makemake was found in HST images obtained on April 27, 2015 (Parker et al 2016). A co-moving companion, 7.80 ± 0.04 magnitudes fainter than Makemake, was clearly detected 0.57 arcsec from the primary. The satellite was not detected in a second observation on April 29, 2015, nor in less-deep observations obtained in 2006, most likely because it was lost within the glare of Makemake. Makemake requires two different albedo components to fit the observed thermal emission spectrum (Stansberry et al. 2008, Lim et al. 2010). This observation, combined with the low-amplitude lightcurve, led to suggestions of a pole-on orientation. The discovery of the satellite suggests instead, that the dark material in the system is associated with the smaller companion with Makemake being primarily covered by higher albedo ice. The non-detections rule out a high-inclination configuration for the mutual orbit plane and favor nearly equator-on orientations. This orientation is consistent with the occultation-derived shape of Makemake (Ortiz et al. 2012). Makemake's non-spherical shape yields tidal circularization timescales at the observed separation that are short enough that the orbit could be circularized. If so, we can constrain the orbit to have $P > 12.4$ days and $a > 21,000$ km. With this discovery, all of the IAU-defined dwarf planets have known satellites, an observation that constrains the collisional evolution of the protoplanetary disk.