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Spectroscopic Analysis of Unbound Asteroid Pairs

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Abstract

The Yarkovsky-O'Keefe-Radzievskii-Paddack or YORP Effect has been shown to increase the rotation rate of asteroids [2,3,4]. An asteroid experiencing YORP-induced spin-up can undergo shape changes and rotational fission resulting in a binary asteroid system [6]. It has recently been suggested that if the mass ratio of such a system remains below 0.2, the asteroids can decouple from their mutual orbit and become two independent bodies orbiting the Sun [5]. Models suggest that this decoupling occurs at low relative velocities. Through backward integration of the orbits of asteroids with similar orbital elements, 35 pairs of asteroids were shown to have had recent (<1 Myr), close, low-velocity orbital encounters consistent with models of the decoupling process, prompting speculation that these objects are the result of YORP-induced fission followed by decoupling.

We have begun a survey of the asteroids in these pairs to determine whether they share a similar composition, expected if they have originated from the same parent body. We have conducted optical, low-resolution spectroscopy of the asteroids in several unbound pairs. Observations were obtained in January and March 2011 using the 3.6m NTT+EFOSC2 covering the wavelength range 0.4-0.95 microns, and in May 2011 using the 4.2m WHT+ACAM, covering the wavelength range 0.5-0.95 microns. The observations of the components in each pair were kept as consistent as possible to reduce spurious effects introduced to the spectra. For example, the same solar analog was observed to remove the solar spectrum from the spectra of each component. Chi-squared fitting of the extracted spectra to the Bus-DeMeo taxonomy [1] allowed taxonomic classifications to be assigned to each asteroid. A chi-squared test was then used to determine the similarity of the spectra of the asteroids in each pair.

Initial results suggest that the asteroids in the unbound pair (7343) Ockeghem - (154634) 2003 XX38 exhibit an S-type spectrum. The spectra of these asteroids are excellent matches, with the same spectral slope and apparent silicate-absorption band depth. This information will allow us to use further optical and thermal observations obtained using the Palomar Observatory 200" Hale Telescope and 8m VLT to conduct a thorough dynamical analysis to further constrain the likely formation time of these objects. We will also present the optical spectra of several other unbound pairs obtained during recent observations using the 4.2m WHT and the 8m VLT.

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Observations were also obtained at the Palomar Observatory 200" Hale Telescope, operated by the California Institute of Technology.

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