Rotationally resolved spectroscopy of asteroid pairs: No spectral variation detected

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Introduction: The split of an asteroid due to a fast rotation [1] can expose sub-surface material that was never altered before by the *Space Weathering* mechanism [2]. We were searching for the "location of fission" on *asteroid pairs* — asteroids that were disrupted in the last 2 million years [3]. We studied the possibility that the sub-surface material has different spectral characteristics than the original weathered surface, by performing rotationally resolved spectroscopic observations and looking for local variations as the asteroid rotates.

Method: We spectrally observed 11 asteroids in pairs in near-IR with the IRTF/SpeX and visible range with Magellan/LDSS3. Photometric observations were also conducted at the Wise Observatory (Israel) to derive the asteroid lightcurves and to determine the rotational phases where the spectral observations took place and to verify that the asteroid is not observed pole-on.

Results: We could not find a single case of a repeating, significant and convincing, spectral variation within the noise of our measurements. For each observed segment of an asteroid we estimate the maximal size of an undetected "spot" with a spectral signature different than the average. In some cases (asteroids *2110*, *6070*, *10484*, *25884* and *63440*), the maximal diameter of such a "spot" is significantly smaller than the diameter of the secondary member of the asteroid. Therefore, we can conclude that at least for these asteroids the "location of fission" does not have different spectral signature.

Discussion: The specific case of asteroid *6070* can reveal the way pairs are formed: The time for its fission (17 kyr [3]) is shorter than any suggested timescale of space weathering [e.g., 4,5,6]; indeed, its secondary member *54827* presents fresh, Q-type, reflectance spectrum [7]. However, *6070* presents more mature reflectance spectrum (Sq-type). Since its "location of fission" does not present spectral variation compared to the rest of the surface as demonstrated by our study, we can conclude that the rotational-fission process is followed by the spread of dust, as seen in the disintegration event of the asteroid *P/2013 R3* [8], that re-accumulates on the primary asteroid and covers it homogeneously, preventing the appearance of a "fresh spot" on its surface.

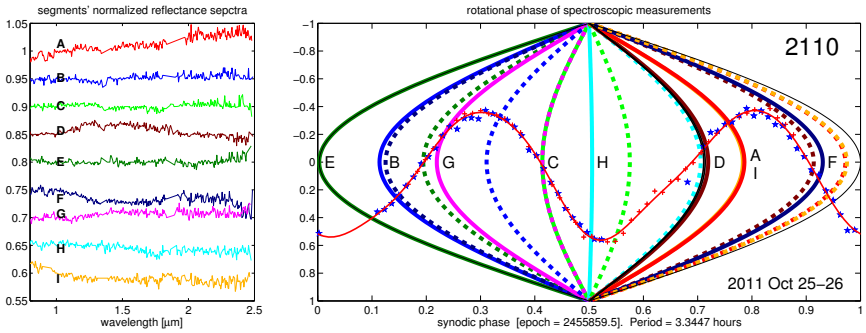

Figure: An example for the normalized reflectance spectra of each segment of asteroid *2110* (left) and the times each segment was taken marked on an ellipsoid (right). A segment's start (solid lines) and end (dashed lines) are marked. The folded lightcurve, observed two nights after the spectra were collected, is displayed on the right, and its phasing and epoch time match those of the spectra (the lightcurve's amplitude is scaled to fit the mid-section of the ellipsoid). A longitude that was not observed at sub-Earth location is marked with black. No significant, repeating, and convincing spectral variation was found for any of the observed asteroids.

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References: [1] Pravec et al. 2010, Nature 466, 1085–1088. [2] Clark et al. 2002, Asteroids III 585–599. [3] Vokrouhlický and Nesvorný 2008, AJ 136, 280–290. [4] Sasaki et al. 2001, Nature 410, 555–557. [5] Nesvorný et al. 2010, Icarus 209, 510–519. [6] Vernazza et al. 2009, Nature 458, 993–995. [7] Polishook et al. 2014, Icarus 233, 9–26. [8] Jewitt et al. 2014, ApJ 784, L8.