Spectro-dynamical asteroid families in the main belt

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Spectral observations of collisionally-derived asteroid families continue to provide strong evidence that the surfaces of members from each family are spectrally homogeneous. This apparent homogeneity provides motivation to use new approaches in combining physical observations, such as spectral colors or albedo, with orbital parameters for the identification of family members and interlopers (e.g. [1,2]). The work described here uses the combined Sloan Digital Sky Survey colors (fourth release of the SDSS Moving Object Catalog [3]) and proper orbital elements from the Asteroids-Dynamics Site (AstDyS [4]) for 39,147 asteroids with semimajor axes between 2.1 and 3.2 au to search for "spectro-dynamical" families. The analysis is designed to identify groupings of asteroids that form statistically significant peaks in number density compared to the background population for a fixed spectral color distribution. A number of techniques from multivariate analysis are folded together and have been calibrated to accommodate asteroid families of different size, shape, and number density. In the final phase of the analysis, the number density for asteroids within a given spectral range is represented by 2-dimensional contour slices through proper-element space, and a visual inspection is made to confirm the reality of each grouping. Some families show evidence of complex structure that may be indicative of multiple collisional events over the history of the family. An example of this is the Karin family, which is located within the older, much larger Koronis family [5]. While both families are composed of asteroids classified as S-types, there is a significant color difference between the Koronis and Karin asteroids that is used to distinguish between members of the two families. In the same way, the Vesta family appears to be comprised of two distributions of asteroids that are offset in proper-element space and exhibit a statistically significant difference in the shape of their V-type spectra that is related to the strength of the 1-micron absorption band. This spectral offset between the two groupings is consistent with the color differences observed in the Rheasilvia and Venenia impact basins on Vesta [6]. The same level of analysis used to determine the structure of the Vesta family is now being applied to all families in the main belt. An update on results, including a final count of asteroid families identified in this search, will be presented.

References: [1] Parker, A. et al. (2008), Icarus 198, 138. [2] Masiero, J. et al. (2013), Ap. J. 770, 7. [3] Ivezic, Z. et al. (2002), SPIE 4836, 98. [4] http://hamilton.dm.unipi.it/astdys/. [5] Nesvorny, D. et al. (2002), Nature 417, 720. [6] De Sanctis, M. et al. (2012), Science 336, 697.