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Investigating Taxonomic Diversity of the Main Belt through KMTNET-SAAO and ATLAS Multi-band Photometry

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Abstract

We present multi-band photometry from the South Africa node of the Korea Microlensing Telescope Network (KMTNet-SAAO) and the Asteroid Terrestrial-impact Last Alert System (ATLAS) which we use to classify several thousand main-belt asteroids with the Bus-DeMeo taxonomic scheme. For asteroid family members within our KMTNet data set we see excellent agreement between our determined taxonomies and what has been reported in literature for the relevant families. For the majority of families in our data set we observe a high degree of taxonomic homogeneity but also observe families with a significant level of mixture in taxonomies. We investigate and discuss these mixed families in more detail and also show how we are able to reproduce this observed mixing of taxonomies from the ATLAS data set.

1. Taxonomic Diversity

We have measured the *V-R* and *V-I* colors of more than 2000 main-belt asteroids over a 2-year period using KMTNet-SAAO in Sutherland, South Africa [1]. By using a machine-learning generated decision surface in color-color space we classify >85% of our targets as one of the four main Bus-DeMeo complexes: S-, C-, X-, or D-type. As expected, we observe that many asteroid families within our sample set (e.g. the Themis and Koronis families) display a high degree of taxonomic homogeneity (see Figure 1). However, we also observe that the Vesta, Flora and Nysa-Polana families all show a significant level of mixture in taxonomies (see Figure 2). This is not unexpected for the Vesta and Nysa-Polana families due to the Vesta family's differentiated parent body origin [2] and the Nysa-Polana family actually consisting of two nested families [3]. The mix in taxonomies in the Flora family is however intriguing as no nested family has been confirmed and a differentiated parent body as origin for the Flora family has only been speculated [4]. Since we see no dependence on proper orbital parameters of the different taxonomies present we conclude that the mixture of taxonomies in the Flora family is most likely due to a collisionally-disrupted differentiated parent-body.

To corroborate our findings from the KMTNet data we extract the rotation periods and the *C-O* colors for identified Flora, Vesta, Nysa-Polana, Themis, and Koronis family members within the historic dataset of ATLAS. The Themis and Koronis families are well-known to be pure C- and S-type Bus-DeMeo taxonomic families, respectively, and the extracted color data from the ATLAS broadband *C*- and *O*-filters of these two families is used to demonstrate that the ATLAS *C-O* color is a sufficient parameter to distinguish between the C- and S-type taxonomies. Finally, the ATLAS color data for the Vesta, Flora and Nysa-Polana families also show the mixing of C- and S/V-type taxonomies as was seen in the KMTNet data.

2. Summary and Conclusions

We present multi-band photometry from KMTNet-SAAO and ATLAS and both data sets reveal the presence of asteroid families that are taxonomically pure and families that display a diversity in taxonomies. Using the Vesta family as a benchmark for a mixed-taxonomic family due a differentiated parent body, and the Nysa-Polana family as a benchmark for a mixed-taxonomic family due to two nested families, we conclude that the Flora family most likely also originated from a differentiated parent body.

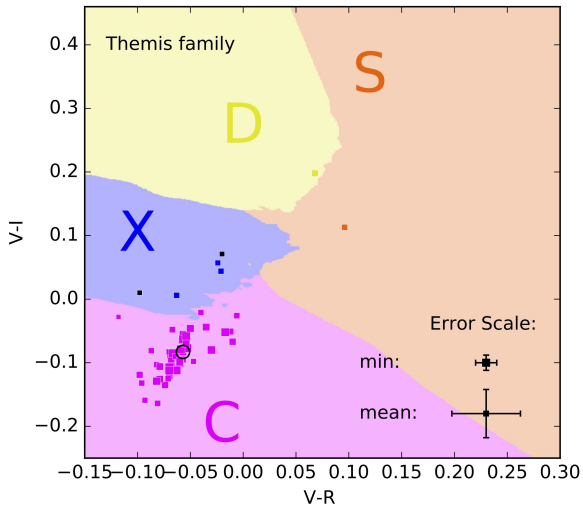

Figure 1: The Themis family color data from KMTNet-SAAO as an example of a taxonomically pure family (see [1] for more detail).

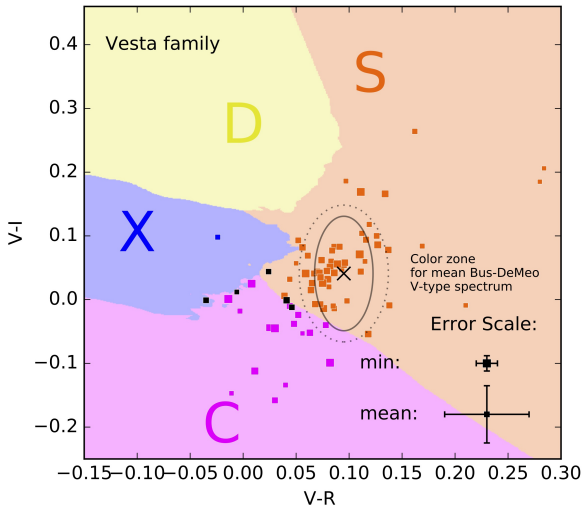

Figure 2: The Vesta family color data from KMTNet-SAAO as an example of a taxonomically diverse family due to the Vesta family's differentiated parent body origin (see [1] for more detail).

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