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Colors of Jupiter Trojan dynamical families as measured by the Zwicky Transient Facility

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ABSTRACT

We use data from the first two years of the public survey of the Zwicky Transient Facility to analyze colors of proposed Jupiter Trojan asteroid families. The well studied Eurybates cluster remains the only family with a significant number of color measurements, and we find that the average colors of this family are less red than typical Jupiter Trojans, in agreement with smaller studies. The limited number of objects detected in this and other surveys for the other families makes their colors continue to be uncertain.

Within the Jupiter Trojan population, the asteroid (3548) Eurybates is unique in having a large dynamical family associated with it (Brož & Rozehnal 2011; Nesvorný et al. 2015; Vinogradova 2015; Rozehnal et al. 2016). From limited photometry and spectrophotometry, it has been known that Eurybates and – at least the brightest – family members are generally slightly more blue than typical Jupiter Trojans (Fornasier et al. 2007; De Luise et al. 2010).

While the existence of other potential Jupiter Trojan families has been proposed (Nesvorný et al. 2015; Rozehnal et al. 2016), membership and colors of these additional potential Jupiter Trojan families are less well known. Here we use a recent analysis of the colors of the brightest ∼1000 Jupiter Trojan asteroids to investigate the colors of reported Jupiter Trojan families.

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Schemel & Brown (2021) developed a method to take the sparse photometry provided by the Zwicky Transient Facility public survey (Bellm et al. 2019) and fit for absolute magnitude, $g-r$ color, rotation amplitude, and phase function, even in the face of an unknown rotation period. We use the colors provided by this analysis and compare them to the lists of potential Jupiter Trojan families provided in Nesvorný et al. (2015). For each family we calculate an average color weighted by the inverse of the square of the uncertainty. Final uncertainties are likewise calculated.

We show the results of this comparison in Table 1, which also includes the median colors of the less-red and red populations of the Juptier Trojans, as determined by Wong et al. (2014). The ZTF data nearly doubles the number of color measurements for members of the Eurybates family, and the unusually blue colors of these family members reported by Fornasier et al. (2007) remain robust at this larger sample

Table 1. Colors of Trojan families

primary object	$g-r$ color	number of measured colors	weighted mean color
(624) Hektor	$0.61^{+.02}_{-.01}$	2	0.59 ± 0.06
(3548) Eurybates	0.51 ± 0.02	30	0.521 ± 0.005
(4709) Ennomos	$0.45^{+.04}_{-.03}$	4	0.560 ± 0.007
(9799) 1996 RJ	0.58 ± 0.01	0	-
(20961) Arkesilaos	0.61 ± 0.07	2	0.58 ± 0.06
(37519) Amphios	$0.62^{+.03}_{-.04}$	1	0.58 ± 0.10
median red Trojan:	0.61		
median less-red Trojan:	0.53		

size. We see no indication of a change in color with absolute magnitude hinted at by Fornasier et al. for some families.

Unfortunately, the colors of the other proposed families remain poorly constrained. It has been suggested that the family of Hektor, for example, could differ strongly from that of Eurybates and consist of mostly red objects (Rozehnal et al. 2016), but with only two family members in our sample (and each with high uncertainty), we cannot determine the color of this family. Rozenhal et al. likewise had only two relatively noisy color measurements, so we deem the color of this family inconclusive. Ennomos is even more blue than Eurybates, but the 4 potential family members appear to have an average color approximately midway between the red and less-red color centers. The other families have too few members to draw conclusions, though in all cases the primaries are more consistent in color with the red, rather than the less-red Trojans.

Collisions and their aftermaths hold important clues to the nature and origin of the Jupiter Trojan asteroids. We anticipate that the Vera Rubin Observatory will greatly increase the number of potential family members with high quality color measurements, allowing us to eventually exploit this important resource.

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