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A Tale of Two TNOs

D. Rabinowitz(1), M. E. Schwamb (1), E. Hadjiyska (1), P. Rojo (2), and S. Tourtellotte (3)
(1) Center for Astronomy and Astrophysics, Yale University, New Haven CT, USA, (2) Department of Astronomy, Universidad de Chile, Santiago, Chile, (3) Dept of Astronomy, Yale University, New Haven CT, USA
(david.rabinowitz@yale.edu)

Abstract

We present observations of two TNOs, 2010 FD49 and 2010 FE49, recently discovered by La Silla QUEST and sharing intriguingly similar color and orbital elements. We formulate a metric and compare their orbit/color separation to the closest pairs of the larger TNO population. We find the pair to be as significant as pairs drawn from the Haumea family. We also integrate clones to determine the stability of the association. It is possible that the two objects once formed a binary that separated several hundred Myr ago, or they are the first discovered members of a new collisional family.

1. Introduction

Since 2010, we have been conducting a search of the entire hemisphere south of the ecliptic to mag R=21.5 with the 160 Megapixel QUEST camera [1] on the 1.0-m Schmidt telescope of the European Southern Observatory (ESO) at La Silla, Chile [2]. Here we report the discovery and photometric characterization of a pair of trans-Neptunian objects (TNOs), 2010 FD49 and 2010 FE49, sharing nearly the same orbit and visible colors. To determine the significance of the pairing, we analyze the clustering of all the known TNOs with well determined colors and orbits and measure the separation distribution of all closest pairs. We also present orbital integrations to probe the long-term stability of the separation between 2010 FD49 and 2010 FE49.

2. Observations

Table 1 shows the orbital elements for 2010 FD49 and 2010 FE49, both discovered with La Silla QUEST (LSQ). Using pre-discovery observations from LSQ, we have extended the time span of our astrometric observation to three years, yielding well determined orbits. We subsequently measured the visible colors of both objects with the ESO NTT at La Silla and were intrigued to discover the two objects have similar color. These colors are not unusual for TNOs, and do not distinguish these two objects in any remarkable way relative to the general TNO population. However, taking into account the similarity of the two orbits, we found the coincidence in the colors unusual.

To study the significance of the coincidence, we formulated a simple metric to measure the similarity in orbit and color of any pair of TNOs with well determined orbital elements (a, e, i,) and magnitude ratios (BV and VR):

$$d^2 = (a_1-a_2)^2/(a_1+a_2)^2 + (e_1-e_2)^2/(e_1+e_2)^2$$
$$+ (\sin i_1-\sin i_2)^2/(\sin i_1+\sin i_2)^2$$
$$+(BV_1-BV_2)^2/(BV_1+BV_2)^2$$
$$+ (VR_1-VR_2)^2/(VR_1+VR_2)^2$$

We then formed a database of orbits and colors for all known TNOs using orbits from the Minor Planet Center and colors from MBOSS [3]. For all TNOs with observational arcs exceeding 1 year and BV and VR errors less than 10%, Fig. 1 shows the distribution of d values for each TNO and its closest pair. The dotted histogram shows the distribution for the Haumea family alone. The vertical dashed line show the d value between 2010 FD49 and 2010 FE49.

Table 1: Orbital Elements for the TNO Pair

Element1	2010 FD49	2010 FE49
a(AU)	55.4	55.7
e	0.42	0.37
i(deg)	10.7	11.7
ω	66.3	58.0
Ω	142.4	131.5
B-V	0.85 ± 0.04	0.86 ± 0.08
V-R	0.44 ± 0.04	0.43 ± 0.05

From Figure 1, it is apparent that the orbit/color separation between 2010 FD49 and 2010 FE49 is

similar to the closest pairs of the Haumea family. To study the long-term stability of the similarity of the orbits, we integrated test bodies with orbits spanning the orbital uncertainties for 2010 FD49 and 2010FE49. We found that 9/10 clones of 2010 FD49 remained within the 5:2 resonance with Neptune for 100 Myr, with insignificant changes in the orbital elements a, e, and i. Our integrations for the 2010 FE49 showed all clones outside the 5:2 resonance, but generally stable for 100 Myr. A few clones migrated to significantly larger orbits with lower inclinations.

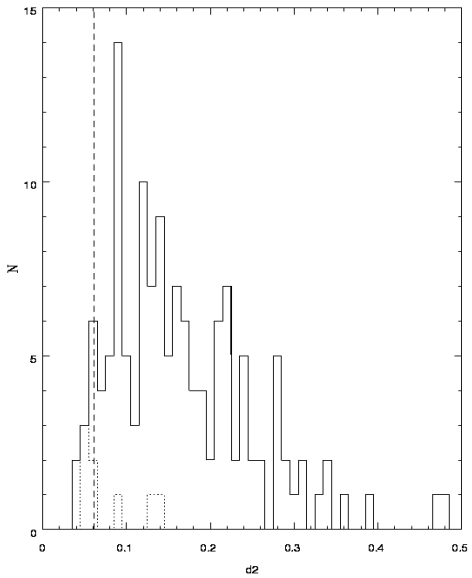

Figure 1. The orbit/color pair-separation distribution for all known TNOs (solid line) and for the Haumea family alone (dotted line). The vertical dashed line shows the separation between for 2010 FD49 and 2010 FE49.

3. Summary and Conclusions

We find the similarity between the orbits and colors of 2010 FD49 and FE49 unusual, but do not understand the significance. If the two objects once formed a binary, it is possible the binary followed a stable orbit within the 5:2 resonance for most of the age of the solar system before separating several 100 Myr ago, with one member escaping the 5:2 resonance. We have not yet determined the likelihood of such an encounter. It is also possible that these two objects are the first discovered members of a new collisional family. If so, then our preliminary analysis indicates that 1998 WA31 could be a third member of such a family, with a similar orbit and color.

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