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Haumea cluster versus the Haumea family

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Abstract

It is well known that the asteroid belt contains asteroid families: large groups of asteroids that have very similar orbital elements. They come from catastrophic collisions. Recently, it has been discovered that the asteroid belt not only contains asteroid families, but also smaller groups of asteroids with similar orbits, whose mechanism of formation is rotational fission induced by some process [1,2]. These groups are called "mini-families" or "asteroid clusters". Here we present data from the literature on several asteroid clusters and compare them with similar data for Haumea and the group of transneptunian objects orbitally related to it, which is usually referred to as the "Haumea family". The coincidence of the data on asteroid clusters and the rotational breakup model that describes them is excellent when applied to Haumea plus the group of bodies orbitally related to it. This leads us to think that the Haumea family should be referred to as the Haumea cluster and that the preferred mechanism of formation for this group of transneptunian objects is rotational fission, as already proposed in [3] based on other arguments. This mechanism might also be able to explain the recent discovery of a ring around Haumea [4].

1. Introduction

Haumea is an exotic dwarf planet residing in the transneptunian region. Apart from showing a very elongated shape and a very fast rotation rate, the fastest known for a transneptunian object, it shows other remarkable features. For instance, it has very similar orbital elements to those of a group of ~10 TNOs that also share very similar spectra. Besides, it has a dense ring around it. Perhaps all these features are highly related and all of them might make sense if Haumea suffered a rotational fission long ago, perhaps triggered by a small collision with a small TNO, instead of a large collision. Here we investigate this possibility in the context of the recent discovery of the so-called "asteroid clusters", which are closely related to "asteroid pairs". Asteroid pairs and asteroid clusters are now known to result from rotational fissions [3]. By comparing the rotation rates of the largest member of the asteroid clusters with the mass ratio of the smaller fragments with respect to the largest some clear conclusions can be made. Here we do the same analysis for Haumea and the group of bodies with similar orbits to it, using the latest information on Haumea and the group of TNOs.

2. Observations from the literature

The rotation periods of the largest members of asteroid clusters versus the mass ratio between the largest member and the rest of the members is shown in figure 1 as blue plus signs. Asteroid pairs are also shown.

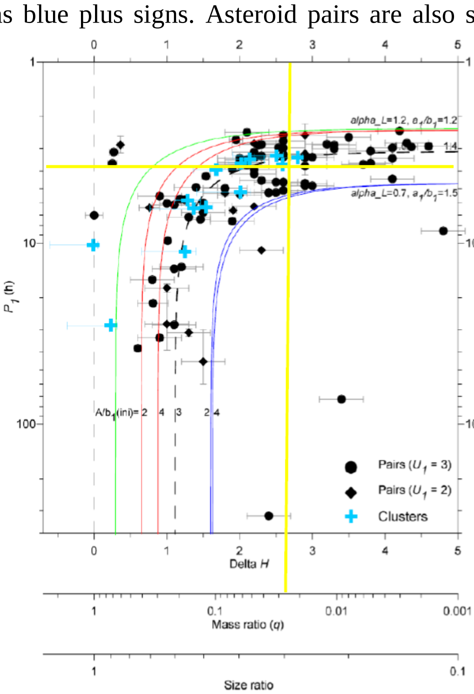

Figure 1. Primary period versus mass ratio of the fragments to the primary. Adapted from [2]. The yellow lines correspond to the rotation rate of Haumea (3.92h) and the mass ratio of the "Haumea family" of 0.024 according to [5]. The dashed line is the nominal rotational fission model.

3. Results

As can be seen in figure 1, the intersection of the yellow lines, which correspond to Haumea and the alleged family, is very close to the behavior of two asteroid clusters, and also very close to the nominal rotational fission model depicted in dashed line. Given that Haumea is not really a single body as it has a large satellite (and at least a smaller one), we can assume that Haumea is a single body with the same specific angular momentum as the system of the satellite and Haumea. In this case, Haumea should be spinning even faster. The modified rotation rate would be ~3.65h and using this new period for the primary, the agreement with the model is even better. Also, it is possible that the mass ratio of the Haumea cluster is somewhat higher than the value from [5] if smaller fragments are still unidentified. According to [5] the smaller fragments could have been ejected at faster speeds, which together with their faintness would make them more difficult to identify. In this case the mass ratio would be even higher and the agreement with the model would be even better. However, given the slope of the size distribution determined in [4], the contribution of smaller fragments to the total mass cannot be very large and cannot exceed 0.04. Hence, it appears that Haumea and the group of TNOs dynamically related to it match the characteristics of asteroid clusters and are well-described with a rotational fission model. Combining the data presented here and the different arguments for the rotational fission given in [3], it appears that “the Haumea family” should be called “the Haumea cluster” instead.

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