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A perspective of the Ceres' missing family

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Abstract

Ceres was recently linked to the dynamical family 93 (Milani et al. 2014). However, asteroids belonging to this family are likely to be S-type, while Ceres is a C-type. Different scenarios, dealing with a catastrophic disruption, compositional heterogeneity on the Ceres surface, or the overlapping of families with different origin, could explain this diversity.
We propose to spectroscopically characterize family 93 to add physical information that help constraining the dynamical models, through data acquired from ground-based and from space telescopes in the infrared.

1. Introduction

The classification of numbered asteroids in dynamical families, proposed by Milani et al. (2014), identifies 19 dynamical families with more than 1000 members, and several medium to small families. However, one major issue of this study is the missing family of Ceres, despite the large size of the body. According to dynamical hypothesis, family 93 could be the source of bodies where we should look for the ancient Ceres' family. The family 93 counts about 1800 members, part of which could be the result of an impact event on Ceres' surface (Milani et al. 2014).

Ceres and 93 Minerva are spectroscopically classified as C-type asteroids with an albedo lower than 0.1 (Li et al. 2006). However, family 93 includes asteroids quite different one another and also different from 93 Minerva, their parent body, and Ceres. Most of them show an albedo higher than 0.1 (Wright et al. 2010). For this reason, the identification of the family is quite difficult, and it was revised several times during the last decades. This asteroid group was formerly classified as the Ceres family (Zappalà et al. 1995) and as the Gefion family (Bus 1999). Subsequently, asteroid 93 Minerva was identified as the parent body of this family (Mothé-Diniz et al. 2005); in their classification the family counts 865 members, 34 of which have an associated spectroscopic classification. The majority of these asteroids belong to the S-complex (precisely 26 S class, 2 Sl class, 2 Sr class, 1 Sq class, and 1 L class), while 2 asteroids belong to the C complex (1 Cb class and 1 Ch class), and finally there is one X class asteroid. This seems to contradict the hypothesis proposed in Milani et al. (2014) but at the same time arises a big question on the possible link between Ceres, family 93 and its parent body.

2. Data analysis

To search for Ceres' family, we study the spectral properties of low albedo primitive asteroids, in comparison to Ceres and Minerva. Data were selected from the available ground-based dataset. In addition, a comparison with vis-NIR spectra acquired with the VIR instrument (De Sanctis et al. 2011) on board the NASA DAWN mission (Russell and Raymond, 2011) may shed light on the relationship between Ceres and the primitive asteroids belonging to family 93. It is worth noting that the Ceres and Minerva vis-NIR spectra show some differences (see Figure 1). VIR data, acquired while approaching Ceres and during the early phases of the spacecraft orbit about the body, could be used to associate the rest of the primitive asteroids in 93 family with Ceres or Minerva as parent bodies.

Spectral slope in the infrared is quite peculiar in the Ceres and Minerva, as shown in Figure 1. Hence, this parameter, together with the low albedo, can be used as a diagnostic to infer if an asteroid can belong to the Ceres' family. The same parameter will enable us to discriminate among C-type asteroids.

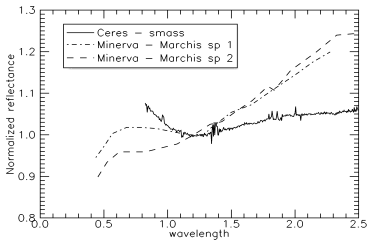

Figure 1: Comparison between the spectra of Ceres and Minerva.

A proposal for new observations of selected asteroids from the family 93 was submitted to IRTF for the next observing period. This will complement the literature investigation with new and dedicated observations.

6. Summary and Conclusions

The present investigation is done using archive data of primitive asteroids associated with the family of 93 Minerva, in comparison to the VIR data acquired in the recent observing campaign of Ceres. In combination with a campaign of ground-based observations that is on-going, it attempts to answer to the intriguing question about the missing family of Ceres. Our immediate objectives can be summarized as follows:

1) Search for the Ceres family, by investigating the spectral propertied of low albedo asteroids in comparison to the Ceres' spectra provided by VIR at DAWN.

2) Characterize, at the same time, asteroids belonging to the Minerva family, through the investigation of differences in the spectral properties.

3) Study the distribution of C and S type asteroids in the region from 2.5 AU to 2.8 AU, where Ceres and the family 93 are located.

Acknowledgements

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