ESF Research Networking Programmes

Short Visit Grant Report

Spectroscopic Characterization of asteroids in the Polana Family-ies

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1 Purpose of the Visit

The aim of this visit was to work with a spectroscopic data base from ground-based telescopes in support of Gaia Mission. Our data-base is focused in the population of asteroids in the inner main asteroid belt (2.15 to 2.5 AU), which is the dominant source of near-Earth asteroids (NEAS). This region is populated by objects in three main groups, the Nysa family, and the old and new Polana family (Walsh et al. 2013). The three families are difficult to disentangle on the basis of their orbital elements distribution, but if the reflectance colors or spectra are also considered they are easily separated. This has already been probed for the Nysa-Polana complex (Campins et al. 2010) but needs confirmation for the old and new Polana families (Walsh et al. 2013).

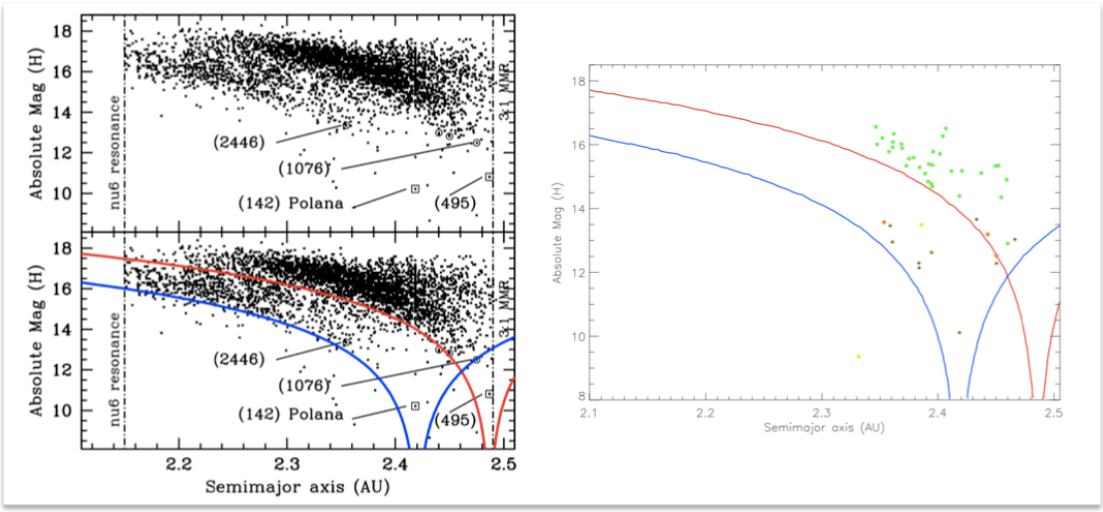

Figure 1: Left panel: The absolute magnitude, H, for Polana-Eulalia asteroids, plotted as a function of their semi- major axes (AU). The points with circles around their dots indicate the objects with published visible and near-IR spectra shown in Fig.2. In the bottom panel lines are drawn to outline the Yarkovsky V-shape in the data (Figure from Walsh et al. 2013). Right panel: Sample of data analyzed in this work. The yellow dots (data obtained by N. Pinilla-Alonso have NIR spectra, the green squares have visible spectrum (obtained by de Leon).

According to Walsh et al. (2013) what was before known as the Polana family,

a group of asteroids with low inclination and albedo, with semi-major axis between 2.16 and 2.5 AU is not just a family whose parent body is (142) Polana. Instead of that, that group of asteroids belongs to two different families overlapping in the space of parameters semi major axis, eccentricity and inclination. The formerly known as Polana family is now the (495) Eulalia family and the proper semimajor axis of this asteroid at a = 2.488 AU is adopted as the center of the family. The age of this family is estimated to be between between 900 - 1500 Myr. Together with this we can find the new Polana family. This family is more extended as it is older (estimated age > 2000 Myr) and its nominal center would be a = 2.418 AU. It comprises most of the objects that were previously considered as 'background'.

Figure 1 shows the regions where these two families extend. The two V-shape lines show the limits of each of the families. Above the red line we can find asteroids belonging to the two families, while between the red and blue line, all the objects are supposed to belong to the "New Polana" family (all of this according to Walsh et al. 2013). The overlapping makes it difficult to separate asteroids in these two groups according to their orbital parameters.

Walsh et al. (2013) suggest that they can be distinguish according to their near-infrared spectral characteristics however, this is based on the analysis of a small number of spectra (see Fig. 2) and further confirmation from more observational data is needed. This is the aim of this project, analyze a sample of NIR spectra of objects in this region of the main belt.

The Gaia mission will result in a dramatic increase in the number (more than 100,000 asteroids) and quality of asteroid spectra in the 0.35 - 0.9 μm wavelength range. This homogeneous set of spectra, with high sensitivity in the near-ultraviolet, will be of great benefit to the study of asteroids. Our work will shed light in the physical nature of the asteroids in this interesting region. This will help in constraining the dynamical models, all of this in advance of the promising results that the mission will accomplish by collecting data for a broader sample for asteroids up to H<20.

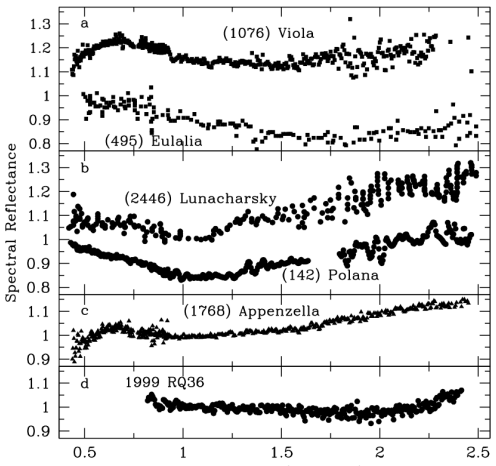

Figure 2: Visible and near-Infrared spectra available in the literature. Differences between (142) Polana and (495) Eulalia are visible. on the contrary some similarities appear between (1076) Viola and (2446) Lunacharsky respect to (495) Eulalia and (142) Polana, respectively. This is in agreement with the characteristics of their orbital parameter that situates them in the Eulalia and New-Polana families respectively.

2 Work Carried out during the visit and Main Results

During these two weeks we have complete the following objectives:

Preliminary results were presented at the workshop

ASSG2013 : Asteroid Spectroscopy in Support of Gaia in an oral exposition under the title: Near-Infrared Spectroscopy of asteroids in the Polana's family `http://assg2013.sciencesconf.org/resource/page/id/1`

Complete Data Reduction

Before this meeting we had only done a preliminary reduction. Now we have complete the reduction and the study of the solar analogues.

RESULTS: We have spectra of 14 objects. As the targets were obtained in different nights and in different conditions, we carried out a detailed study of the spectra of the Solar analogues observed during the campaign, to characterize the differences that could propagate during the reduction process into

the spectra of the asteroids. We concluded that the systematic errors are no larger than 0.65 % of the slope measured between 0.85 and 2.00 μm. The average slope of the spectra of the targets in the same wavelength range is 17%. So the systematic errors are not larger than 3.5%.

Analysis of the data

It is not completed but we have set the guidelines for the analysis and started with it.

RESULTS: In our sample three objects were recognized as interlopers, most probably belonging to the Nyza family. The other nine have a spectrum very similar to the spectrum of (142) Polana, that is one of the objects in our sample. None of these objects have a spectrum similar to the spectrum of Eulalia

Prepare more observations

We have been granted with three nights next semester.

RESULTS: We have planned the observations, our main goal this run is to observe objects that, according rot Fig. 1 can only be Polanas or Eulalias to test their spectral classification. It is extremely interesting to find objects with an spectrum similar to that of Eulalia to confirm this is really the parent body of the family. We also have discovery that there is a clear missmatch between the visible and NIR sample, this is due to the fact that faint objects are easier to observe in the visible than in the NIR. We can try to avoid this difference in the analysis by completing our database with visible observations from other sources or by applying for more observing time to observe in the visible those objects in the NIR sample that do not have optical information.

3 Future Collaboration

Some steps to achieve for the future work have already been established.

I. Collect visible colors. We will use the SDSS survey for this purpose.

II. Finish the taxonomy for all the objects and compare with meteorites. We will use the RELAB data base for this purpose.

III. Compare with visible spectroscopy. When available we will complete our spectra to shorter wavelengths (optical range) using the databases available online e.g. the PDS Small Bodies Node (`http://sbn.pds.nasa.gov`)

IV. Observe the same objects in the visible. When possible, we will submit future observational proposals to complete the characteristics of our objets in the optical wavelengths, however this is not high priority as the most diagnostic wavelength range (according to Walsh et al. 2013) is the NIR.

4 Projected Publications

Results from the 2012 campaign all together with the next 2013 campaign will be presented and analyzed in one publication to be submitted to a scientific per review publications such as Astronomy & Astrophysics or Icarus. All the tools already developed for the analysis of the data from the 2012 campaign can be used with the data from the upcoming campaign so that the work will be straight forward. Depending on the dates allocated for our observations, we plan to submit the manuscript sometime in the last semester of 2014. Also, we will present the final results at least in an international meeting such as the DPS 2014 or Europlanet 2014. Both publications will include the proper acknowledgement to this funding program.

References

[1] Walsh, Kevin J.; Delb, Marco; Bottke, William F.; Vokrouhlický, David; Lauretta, Dante S. (2013) Icarus, 225, p. 283-297

[2] Campins, Humberto; Morbidelli, Alessandro; Tsiganis, Kleomenis; de Len, Julia; Licandro, Javier; Lauretta, Dante. (2010) The Astrophysical Journal Letters, Volume 721, Issue 1, pp. L53-L57