EPSC Abstracts
Vol. 9, EPSC2014-171, 2014
European Planetary Science Congress 2014

Asteroid Polarimetry: recent advances.

A. Cellino (1) and S. Bagnulo (2)
(1) INAF - Osservatorio Astrofisico di Torino, Italy, cellino@oato.inaf.it / Fax: +39-011-8101930), (2) Armagh Observatory, UK

Abstract

We are living in these years a phase of overall renaissance of asteroid polarimetry. This is due to the activity of a number of research teams in different countries, to the availability of better telescopes and detectors, and to the results of several investigations, which have been sufficiently important to trigger and stimulate further advances. Among the most recent achievements, we can mention the discovery of a dynamical family of rare, so-called Barbarian objects, and some new hints to interpret the properties of these objects, which may be among the most primitive bodies to have survived since the very early epoch of planetary growth in our solar system. Another field of investigation which has been recently open and promises to be very important in the future is that of asteroid spectro-polarimetry, made possible by the presence of suitable detectors at ESO VLT and WHT telescopes.

1. Introduction

Asteroid polarimetry has taken profit in recent years of a renewed interest triggered by the results obtained in a series of investigations including both new observing campaigns and theoretical studies. The state of partial linear polarization of the sunlight scattered by asteroid surfaces in different illumination conditions is diagnostic of a number of important physical properties of the objects. Historically, the most important applications of polarimetry to asteroid studies have been focused on the derivation of the geometric albedo and of the typical sizes of the particles forming the regolith layer covering the surface. This kind of information can be derived by measuring the variation of linear polarization as a function of phase angle, namely the angle between the directions to the Sun and to the observer, as seen from the target asteroid. This means that, making use of sufficiently large telescopes, polarimetry can be of crucial importance to achieve a reasonable physical characterization of interesting objects, including members of dynamical families as well as near-Earth objects, particularly those which are potentially hazardous for the terrestrial biosphere.

A wealth of new data has been obtained in the last decade from investigations aimed at studying the polarimetric behavior exhibited by asteroids belonging to different taxonomic classes, and at investigating the presence of possible systematic differences between albedo values found by polarimetric studies and the corresponding values obtained from radiometric surveys. Very interesting applications of polarimetry to the study of potentially hazardous near-Earth objects have been also obtained, including observations of (25143) Itokawa before the rendez-vous with the Hayabusa space probe [1], and of (99942) Apophis, a well known potentially hazardous object [2].

In addition, in more recent years it has been realized also that polarimetric properties can be useful to identify objects which may be extremely primitive. In this respect, the discovery of the classes of the so-called Barbarian objects (so named after the prototype of the class, asteroid (234) Barbara) exhibiting peculiar polarization properties has been very important [3].

After a few pioneering investigations based on broad-band, UBVRI data, the field of asteroid spectro-polarimetry is currently blossoming, with preliminary results which suggest that this observation technique could become in the future a major tool for obtaining a quick physical characterization of the objects.

There are therefore good reasons to expect that asteroid polarimetry will be very important in the years to come. In addition to existing observing facilities, new ones are going to begin operations in the near future. Some much needed developments of future investigations include a better calibration of the relation between polarimetric properties and albedo, a better understanding of the physics of light scattering phenomena, and some applications to hot topics in asteroid science, including asteroid families, the effects of space weathering, asteroid-comet relations, and techniques of alarm and mitigation of the danger posed by potential Earth impactors.

2 An example: Barbarians in the Watsonia family

Recently, we have discovered [4] that the dynamical family of Watsonia is an important repository of rare Barbarian asteroids. Fig. 1 shows phase-polarization data for 7 members of this family (full symbols) which have been found to share the same "Barbarian" behaviour as that displayed by (234) Barbara itself (the overall phase polarization curve of Barbara is also displayed in the Figure). Other two objects (open symbols in Fig. 1) do not display the Barbarian properties, namely an unusually large value of the inversion angle (the angle at which the so-called negative polarization branch ends), but show a normal behaviour, like the ne of the L-class object (12) Victoria (also shown in the Figure). These two, non-Barbarian asteroids may well be random family interlopers, since the presence of interlopers within nominal family member lists is unavoidable. The seven Barbarians (out of nine observed targets) in the Watsonia family more than double the inventory of Barbarians which were known before this investigation.

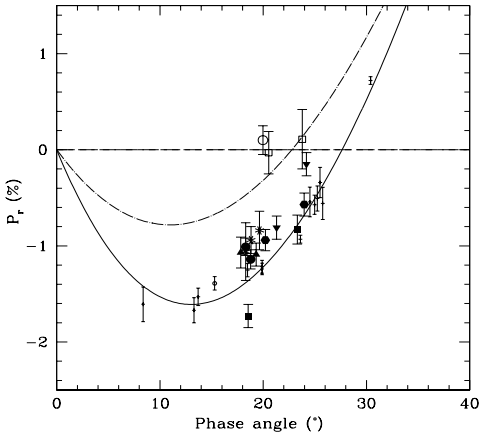

Figure 1: Phase - polarisation data for seven members of the Watsonia family (full symbols and large asterisks refer to single observations of these targets) compared with the phase - polarisation curve of the prototype of Barbarians, (234) Barbara, and with the phase - polarization curve of (12) Victoria, a large L-class asteroid which does not exhibit the Barbarian behaviour. The open symbols refer to single nights measurements of two targets found to display a "normal" polarimetric behavior, similar to that of (12) Victoria (dotted-dashed curve). The small symbols and the solid curve indicate available polarimetric data for (234) Barbara, and the corresponding best-fit curve for this object

Acknowledgements

We thank I. N. Belskaya and P. Tanga for useful discussions.

References

[1] Cellino, A., Yoshida, F., Anderluccci, E., Bendjoya, Ph., Di Martino, M., Ishiguro, M., Nakamura, A.M., Saito, J.: A polarimetric study of Asteroid 25143 Itokawa, Icarus, Vol. 179, pp.297-303, 2005

[2] Delbò, M., Cellino, A., Tedesco, E.F.: Albedo and size determination of potentially hazardous asteroids: (99942) Apophis, Icarus, Vol. 188, pp.266-269, 2007

[3] Cellino, A., Belskaya, I.N., Bendjoya, Ph., Di Martino, M., Gil-Hutton, R., Muinonen, K., Tedesco, E.F.: The strange polarimetric behavior of Asteroid (234) Barbara, Icarus, Vol. 180, pp. 565-567, 2006

[4] Cellino, A., Bagnulo, S., Novaković, B., and Delbò, M.: A successful hunt for hidden Barbarians in the Watsonia asteroid family, MNRAS Letters, Vol. 439, pp. L75-L79, 2014.