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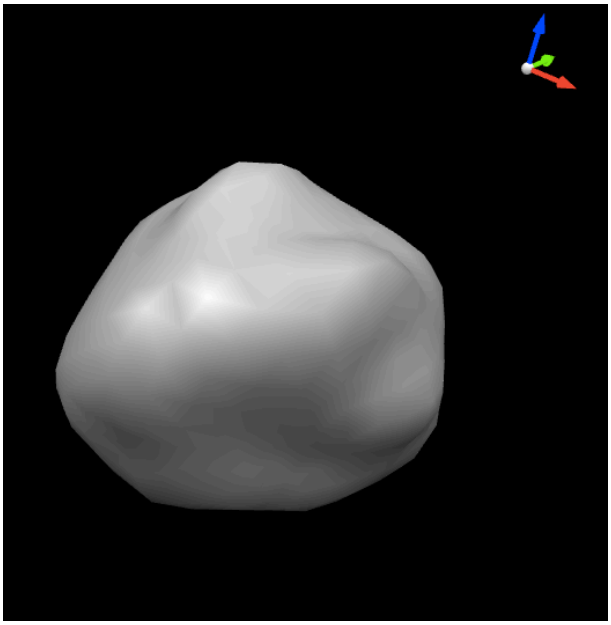
The enigmatic “Barbarians” and their physical properties: obtaining a clearer view

Stage M1



The reconstructed shape of the asteroid (234) Barbara (Tanga et al. 2012).

Science context

The degree of linear polarization of sunlight scattered by asteroid surfaces exhibits a variation as a function of the illumination conditions, described by means of the phase angle, namely the angle between the directions to the Sun and to the Observer, as seen from the asteroid. In particular, the general morphology of the resulting phase-polarization curve has some general properties which, apart from some differences related mainly to the geometric albedo of the surface, tend to be shared by all known asteroids. A few years ago, however, Cellino et al. (Icarus 180, 565, 2006) discovered a class of asteroids exhibiting peculiar phase-polarization curves, characterized by a very unusual extent of the interval of phase angles for which the plane of linear polarization is parallel to the scattering plane. In more technical terms, these are objects exhibiting a “negative polarization branch” much wider than usual, with an “inversion angle” around 30°, a much larger value with respect to the ~ 20° displayed by other objects. Since the prototype of this class is the asteroid (234) Barbara, these objects have been since then commonly known as the “Barbarians”. Only half a dozen Barbarians are known today (Gil-Hutton et al., A&A 482, 309, 2008; Masiero and Cellino, Icarus 199, 333, 2009). In terms of taxonomy, based on spectro-photometric data, they are classified as members of a few unusual classes, including L, Ld, and K. (234) Barbara itself is an Ld

asteroid.
The polarimetric properties of the Barbarians are fairly unexpected. In particular, a so large width of the negative polarization branch is not predicted by theoretical models of light scattering. Barbarians are certainly uncommon, but they do exist, and it is not easy to interpret their polarization curves. Possibilities range from peculiar surface composition and/or texture, to the possible presence of anomalous properties at macroscopic scales, for instance the presence of large concavities associated with big impact craters.

Aims
In recent times, we have discovered that the prototype object of the family, (234) Barbara, is a body with large concavities (impact basins?) on its surface. This discovery was allowed by photometric observations, and by stellar occultations. Only by combining these two techniques it is possible to derive useful information on possible concavities on asteroid surfaces.
Both concavities and the slow rotation period of Barbara suggest that this body has suffered large impacts in the past, which could have reshaped it and exposed the internal mineralogy, possibly linked to the peculiar polarization.
Further investigations, in particular deriving the shape and the rotation periods of the other Barbarians (known or candidate) should bring additional information. In fact, it appears that most of them can be classified as "slow rotators". A search for the available data (shapes, photometry, occultation results, infrared observations…) is first required. Then, appropriate observations can be planned for data that are missing (in fact, most probably, a large fraction) – photometry in particular, but also polarimetry and stellar occultations.

Method
We propose, in this stage the investigation of the on-line archive for extracting the data relevant to Barbarians; the preparation of complementary photometric.
Several methods for studying the physical properties of Solar System bodies will thus be approached.

Results of the stage
We expect to have: a clear view of the available physical properties of the Barbarians. A plan for future observations. New photometric data.

Location
The stage will take place at OCA (Mont Gros) with sessions of observation at Calern.