EPSC Abstracts
Vol. 5, EPSC2010-434, 2010
European Planetary Science Congress 2010

Ground-based polarimetric observations in the study of asteroids 2867 Steins and 21 Lutetia and lessons learned from the Rosetta data

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Abstract

Surface properties of asteroids 2867 Steins and 21 Lutetia inferred from the results of ground-based polarimetric observations will be compared with the *in situ* evidence obtained during Rosetta's fly-bys to these asteroids. The accuracy of polarimetric methods in remote studies of asteroid surfaces is shortly discussed.

1. Introduction

Since a long time, polarimetric observations have been successfully used in remote studies of asteroid physical properties. The main applications are related to (1) determinations of asteroid albedo based on empirical relationships between polarimetric parameters and albedo; (2) constraints on asteroid surface texture, e.g. the presence of a regolith layer and an average particle size; and (3) studies of asteroid surface heterogeneity. In support of Rosetta fly-bys to asteroids 2867 Steins and 21 Lutetia, ground-based polarimetric observations in a wide range of phase angles were performed for both targets [1-3,5]. A comparison of the results of ground-based polarimetry with the data that were obtained for Steins and will be obtained for Lutetia during Rosetta's fly-bys is thus essential to assess the effectiveness of polarimetric methods for the remote studies of Solar system bodies.

2. Results

Polarization-phase dependences measured for asteroids 2867 Steins and 21 Lutetia are shown in Fig.1. The data for Steins were taken from [2], while for Lutetia we include numerous polarimetric observations, both published in [1,3,5] and still unpublished.

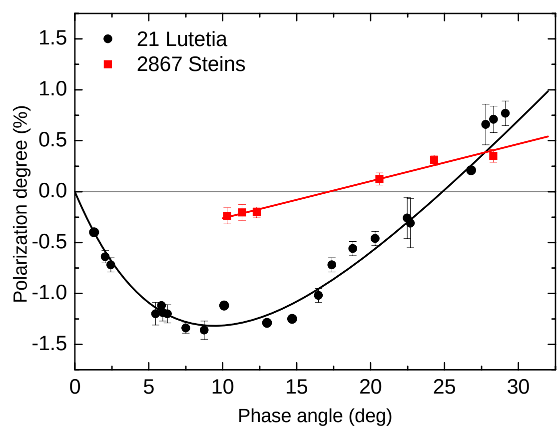

Figure 1: Polarization phase dependences of asteroids 2867 Steins and 21 Lutetia.

A very different behaviour of the linear polarization degree versus phase angle reflects differences in surface properties of these two asteroids. The polarization phase curve of Steins is characterized by a shallow negative polarization, a small polarimetric slope *h* and an inversion angle α_{inv}=17.3º. All these features are typical for high-albedo E-type asteroids [2]. On the contrary, the polarization phase curve of Lutetia displays a wide and deep negative branch with P_{min}=-1.3% and α_{inv}=25º which is not usual for a moderate albedo surface. The scatter of the data from the fitted phase curve exceeds the estimated errors of each measurement and gives an evidence of a variation in polarization degree across the Lutetia's surface. The measurements of Steins do not show noticeable deviations from a linear fit (see Fig.1).

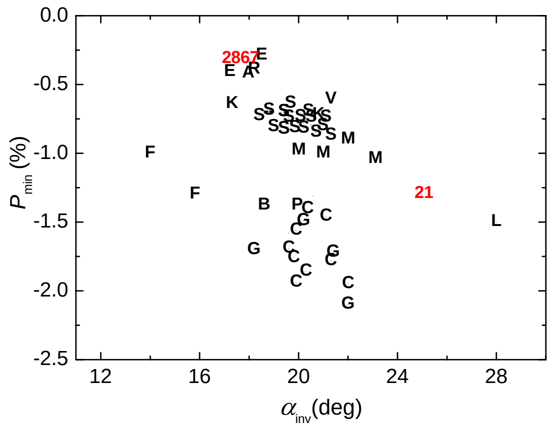

Figure 2: Minimum polarization value versus inversion angle for asteroids. Letters designate taxonomic class of asteroids [4] and numbers show positions of Steins and Lutetia.

A relationship between P_{min} and α_{inv} for asteroids of different composition classes is shown in Fig.2 (see [1] for more details and references). It shows that the polarimetric properties of Steins are within the domain typical for high-albedo objects while Lutetia show particular polarization characteristics as compared to a variety of asteroids observed so far. The possible explanations of these peculiar properties were proposed in [1].

We will discuss all the above at the light of the information obtained during the Rosetta fly-by to Lutetia. The empirical relationship between the polarimetric slope and albedo will be checked and re-calibrated using Rosetta data.

Acknowledgement

The research of INB has been supported by a Marie Curie Fellowship of the European Community.

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