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Polarimetric properties of transneptunian objects and Centaurs from the VLT Large Programme

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Abstract

Polarimetric observations of 3 Centaurs and 5 transneptunian objects (TNOs) carried out within the VLT Large Programme (VLT-LP) show that, first, all objects display negative polarization at small phase angles whose minimum values varied from -0.3% to -2.2%; second, even a single polarization measurement at a phase angle larger than 1º can discriminate between a high-albedo and a low-albedo surface; third, polarimetric properties of Centaurs are more diverse than those of TNOs; and, fourth, polarimetric properties of distant objects are different from those of main-belt asteroids, providing evidence for different surface texture of these bodies.

1. Introduction

Polarimetry is a powerful tool for investigating the physical properties of Solar system bodies, providing a way to assess the microscopic properties of the surface using remote observations. The study of the polarimetric properties of TNOs and Centaurs is in its early stages. The first polarimetric observations for a TNO (except Pluto) were carried out by Boehnhardt et al. [5]. Succeeding polarimetric observations were performed for three more distant objects [1,6]. New polarimetric observations were made within the context of the ESO VLT-LP 178.C-0036 in 2006-2008 with the aim to probe the surface properties of objects from different dynamical groups.

2. Observations and results

About 50 hours of VLT observing time has been dedicated to the polarimetric observations within the two years of VLT-LP. This has allowed us to measure 8 objects selected on the basis of two main criteria: (1) R-filter brightness $m_R<21^m$ to enable polarimetry with observational error ~0.05% in less than 2 hours of telescope time; and (2) diversity of physical and dynamical properties of the sample objects. Measurements of linear polarization were carried out with the FORS1 instrument in the R filter. A detailed description of the methods of observations and reduction can be found in [1]. The objects observed are given in Table 1 together with the orbital type, taxonomy, and the range of phase angles covered by the observations.

Table 1: Objects observed within VLT-LP

Object / Type	Class	Phase angles
(2060) Chiron / C	BB	0.5–4.2[1]
(5145) Pholus / C	RR	0.9- 2.6
(10199) Chariklo / C	BR	2.7–4.4
(20000) Varuna / Cl	IR	0.1–1.3
(26375) 1999 DE9 /S	IR	0.1–1.4
(38628) Huya / R	IR	0.6–2.0
(136108) Haumea / Cl	BB	0.99
(136199) Eris / D	BB	0.1–0.6

[1]Including the previous observations [1]

The observations of individual objects were discussed in [1-4]. Here we finalize the results of our polarimetric program and highlight its main results.

3. Discussion and conclusions

All objects observed show a negative branch of polarization at small phase angles with a minimum measured polarization varying from -0.3% for Eris, the brightest object in our sample, to -2.2% for Pholus, one of the darkest objects.

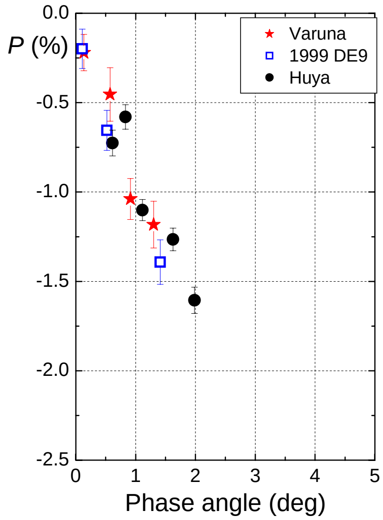

Figure 1: Polarization phase dependence of TNOs

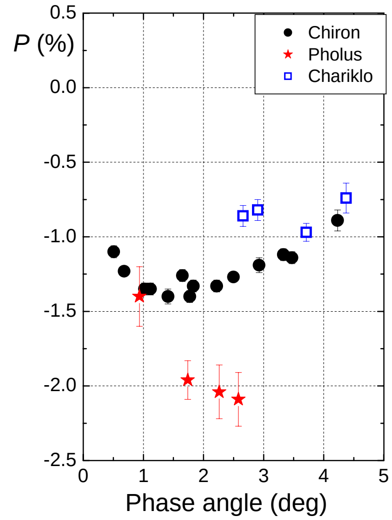

Figure 2: Polarization phase dependence of Centaurs

A correlation is seen for the polarization degree and surface albedo although it is weaker than that of asteroids. This weaker correlation can be caused by the uncertainties both in the measured geometric albedos of TNOs and in the minimum polarization $P_{\min}$ due to the limited phase-angle range. It can be also due to a greater diversity in the surface texture of TNOs as compared to asteroids. Nevertheless, our observations have demonstrated that a single measurement of polarization at a phase angle ≥1° can discriminate between a high-albedo and low-albedo surface. We found two distinct polarization phase dependences for TNOs. The largest and brightest TNOs show a shallow negative branch, whereas the smaller and darker TNOs show a deep branch [2]. Figure 1 shows the dependence of polarization measured for three TNOs with sizes less than 800 km. All objects display similar dependences with a rapid increase in polarization reaching ~1% at the phase angle of 1°. Figure 2 illustrates polarization versus phase angle for three Centaurs, each of which have their unique phase dependences. This implies noticeable differences in the physical properties of the topmost surface layers of these objects. The detailed observations of Chiron allow us to determine the angle of minimum polarization α_{min}=1.5°, the smallest value among Solar-system objects observed so far. When comparing polarization of the distant objects and main-belt asteroids, negative-polarization minimum shifting toward small phase angles seems to be a characteristic feature of the distant objects. This constitutes unequivocal evidence that the surface textures differ for these two classes of objects.

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References

[1] Bagnulo, S., Boehnhardt, H., Muinonen, K., et al.: Exploring the surface properties of Transneptunian Objects and Centaurs with polarimetric FORS1/VLT observations. A&A, Vol. 450, pp. 1239-1248, 2006.

[2] Bagnulo, S., Belskaya, I., Muinonen, K. et al.: Discovery of two distinct polarimetric behaviours of trans-Neptunian objects, A&A, Vol. 491, pp. L33-L36, 2008.

[3] Belskaya, I., Bagnulo, S., Muinonen, K., et al.: Polarimetry of the dwarf planet (136199) Eris, A&A, Vol. 479, pp. 265-269, 2008.

[4] Belskaya, I., Bagnulo, S., Barucci, M.A., et al.: Polarimetry of Centaurs (2060) Chiron, (5145) Pholus and (10199) Chariklo, Icarus, 2010, submitted.

[5] Boehnhardt H., Bagnulo S., Muinonen K.,et al. Surface characterization of 28978 Ixion (2001 KX76), A&A, Vol. 415, pp. L21-L25, 2004.

[6] Rousselot P., Levasseur-Regourd A. C., Muinonen K., Petit J.-M. Polarimetric and photometric phase effects observed on transneptunian object (29981) 1999 TD10. Earth, Moon, Planets, Vol. 97, pp.353-364, 2005.