

POLARIMETRY OF TRANSNEPTUNIAN OBJECTS: UPDATED RESULTS. I. N. Belskaya¹, S. Bagnulo², A. Stinson², G.P. Tozzi³, K. Muinonen^{4,5}, A. Barucci⁶, S. Fornasier⁶, ¹Institute of Astronomy of Kharkiv National University (Sumska Str. 35, Kharkiv 61022, Ukraine, irina@astron.kharkov.ua), ²Armagh Observatory (College Hill, Armagh BT61 9DG, Northern Ireland, U.K.) ³INAF - Oss. Astrofisico di Arcetri (Largo E. Fermi 5, I-50125 Firenze, Italy), ⁴Department of Physics, University of Helsinki (PO Box 64, FI-00014 U. Helsinki, Finland), ⁵Finnish Geodetic Institute (P.O. Box 15, FI-02431 Masala, Finland), ⁶LESIA, Observatoire de Paris (5, pl. Jules Janssen, FR-92195 Meudon cedex, France).

Introduction: The first study of the polarimetric properties of transneptunian objects (TNOs) brought along a number of interesting results [1-4]. In particular, two distinct polarization phase curve behaviors were found for TNOs [4]. The objects with diameters smaller than 1000 km exhibit negative linear polarization that rapidly increases (in the absolute sense) with the phase angle, reaching about -1% at the phase angle as small as 1°. The largest TNOs exhibit shallow negative linear polarization which does not noticeably change across the phase-angle range of the observations. The different types of polarimetric behavior have been suggested to be related to the surface geometric albedo and the capability of the objects to retain volatiles [4]. We present new results of polarimetric observations of two TNOs and compare them to the previously available polarimetric data of TNOs. We search for a correlation between the polarimetric behaviour and the surface albedo by using highly improved data on the diameters and albedos obtained with the surveys aboard the Herschel Space Observatory and with stellar occultations by TNOs.

Results: We report results of the first polarimetric observations of (90482) Orcus and (136472) Makemake. With a diameter of ~850 km [5], Orcus is the largest known plutino after Pluto. Orcus has a water-ice-rich surface with a geometric albedo about 0.3 [5]. Makemake is a dwarf planet with a diameter of ~1400 km and albedo of ~0.8 [5], having a methane-ice-rich surface. The observations of Makemake and Orcus have been carried out in April - May 2011 at the ESO VLT. The linear polarization of their surfaces has been measured in the Bessell *R* filter with the FORS2 instrument operated in service mode. We find noticeable differences in the values of polarization degree for these two objects.

(90482) *Orcus*. The linear polarization degree has been measured at the single phase angle of 1.1°. The measured value is about -1% which is in very good agreement with the data available for other TNOs smaller than 1000 km in diameter.

(136472) *Makemake*. We have measured a small negative polarization, about -0.3%, in the phase-angle range of 0.6°-1.1°. Within the accuracy of our measurements (0.05-0.1%), the observed polarization is

practically constant across the phase-angle range covered. The phase-curve behavior of Makemake is similar to that of Eris and Pluto. The linear polarization measured for Makemake is closer to that for Eris than that for Pluto when we consider the values obtained at the same phase angles.

Our new observations have increased the number of TNOs and Centaurs for which polarimetric measurements were carried out to 14. The sample includes all dwarf planets, 3 Centaurs, 3 resonant, and 2 classical objects. Physical properties of these bodies have been recently studied with other techniques, in particular, within the Herschel Space Observatory survey. We analyze the polarimetric data together with other available data on each object in order (1) to better characterize the surface properties of individual objects, and (2) to search for relationships between polarization parameters and other physical and orbital characteristics of TNOs.

Conclusions: We present results of the first polarimetric observations for (90482) Orcus and (136472) Makemake at the ESO VLT. They confirm the earlier detection of different polarimetric behavior for the largest TNOs and those smaller than 1000 km in diameter. The analysis of the available polarimetric data on 14 TNOs and Centaurs together with data obtained by other techniques allows for a better characterization of their surface properties. We discuss possible relationships between polarization parameters and other physical and orbital characteristics of TNOs.

References: [1] Boehnhardt H., Bagnulo S., Muinonen K., Barucci M.A., Kolokolova L., Dotto E., Tozzi G.P. (2004) *Astron. Astroph.*, 415, L21-L25. [2] Bagnulo S., Boehnhardt H., Muinonen K., Kolokolova L., Belskaya I.N., Barucci M.A. (2006) *Astron. Astroph.*, 450, 1239-1248. [3] Belskaya I.N., Bagnulo S., Muinonen K., Barucci M.A., Tozzi G.P., Fornasier S., Kolokolova, L. (2008) *Astron. Astroph.*, 479, 265-269. [4] Bagnulo S., Belskaya I.N., Muinonen K., Tozzi G.P., Barucci M. A., Kolokolova L., Fornasier S. (2008) *Astron. Astroph.*, 491, L33. [5] Lim, T. L., Stansberry, J., Muller, T.G., et al. (2010) *Astron. Astroph.*, 518, L148.