Polarimetry of asteroids

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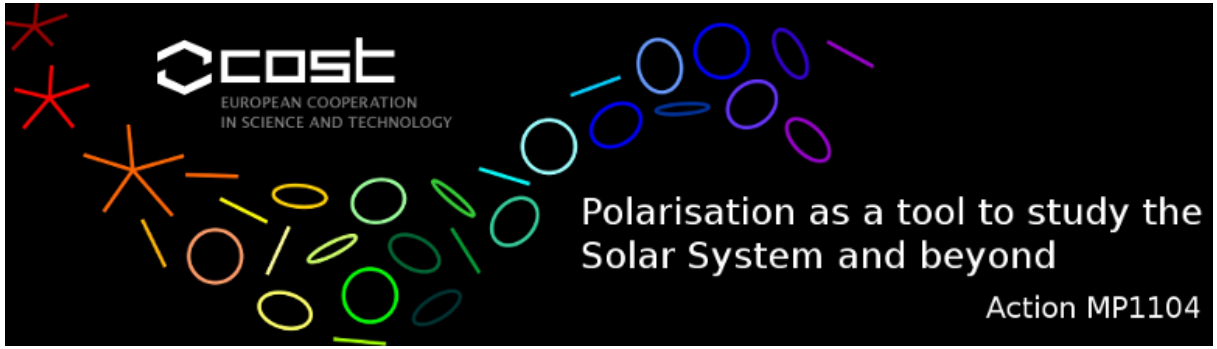
POLARIMETRY vs. OTHER TECHNIQUES

Photometry: magnitudes/colors ~150000 estimates of sizes, taxonomy
Photometry: lightcurves ~6000 rotational periods, shapes
Radiometry ~150000 sizes, albedos
Spectrometry ~1000 surface composition, taxonomy
Radar ~500 shapes, sizes, rotation rates
Occultations ~400 sizes, shapes
Polarimetry ~350 regolith properties, albedos

Objects	r	D	N_D	N	$N_{polarim}$
Near-Earth	≤1.3 AU	≥1 km 10 – 32 km	~1000 3	13019	~15
Main belt	2.2- 3.2 AU	≥15 km 100 – 950 km	~3000 ~200	646650	~330
Jupiter Trojans	~5.2 AU	≥50 km 100 – 150 km	~100 ~20	6385	1
TNOs	>30 AU	≥700 km 1300 – 2300 km	~15 4	2014	9

NEW FINDINGS FROM OBSERVATIONS



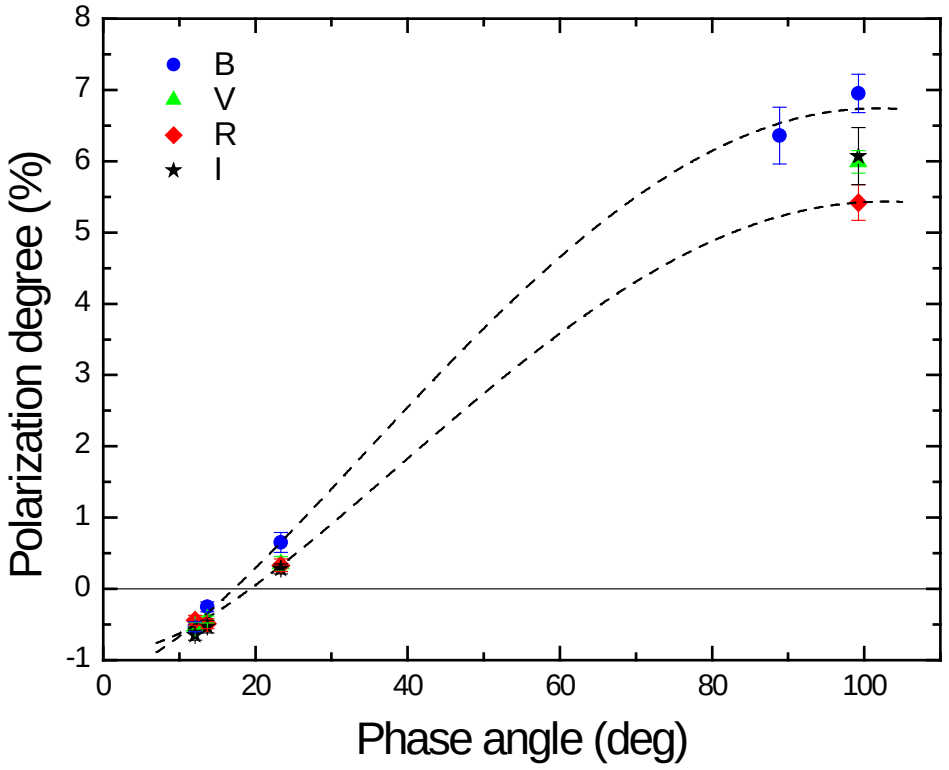
• measurements of a near-Earth asteroid at polarisation maximum;

• a pilot study of the polarisation properties of Jupiter Trojans;

• a probe of polarimetric properties of large transneptunian objects.

POLARIMETRY OF POTENTIALLY HAZARDOUS ASTEROID (214869) 2007 PA8

- approached the Earth at the minimal distance of 0.043 AU in November 2012;
- Polarimetry was carried out at the NOT in the BVRI bands covering low (12–23°) and large phase angles (88–99°).



$P_{min} < -0.6\ \%$

$\alpha_{inv} = 19°$

$h = 0.078\ \%/deg$

$P_{max} = 6\ \%$

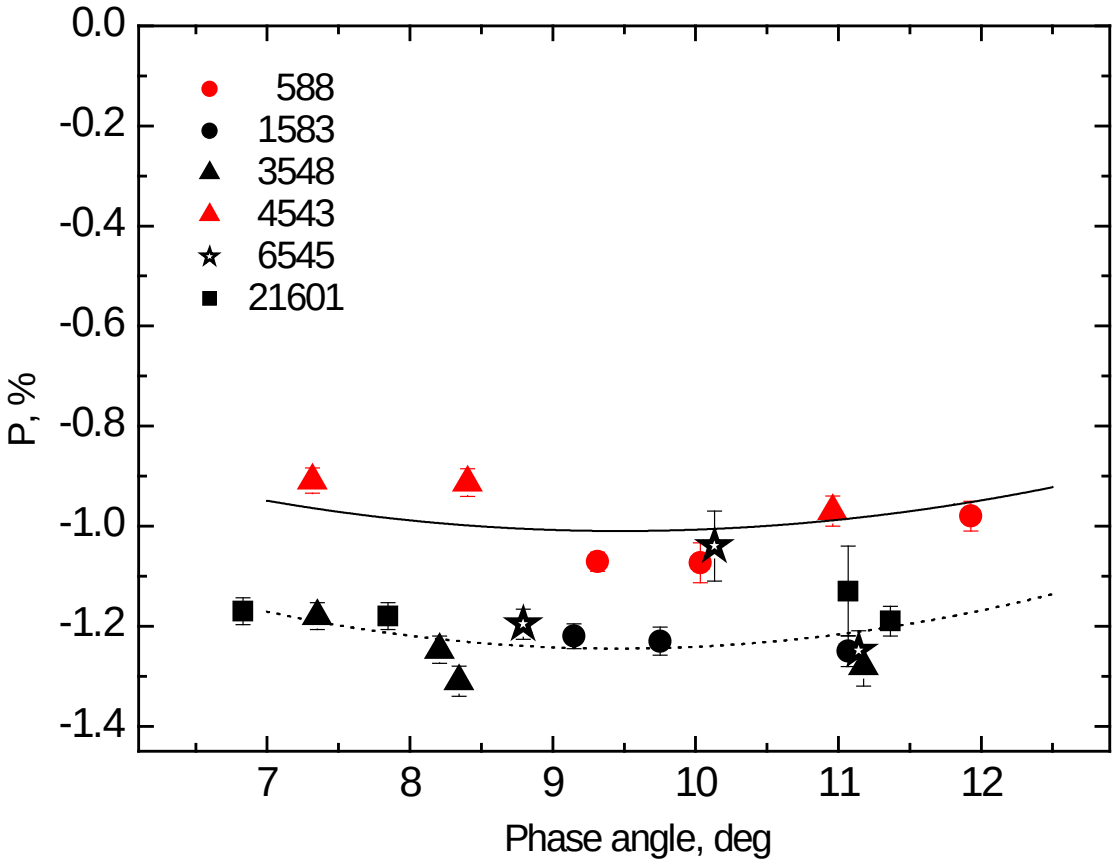
$\alpha_{max} \sim 100°$

$p_V = 0.29 \pm 0.08$

$D = 1.4 \pm 0.2$ km

POLARIMETRY OF JUPITER TROJANS

- observations with FORS2/VLT in April-June 2013;
- measurements of the linear polarization in the Bessell *R* filter;
- 6 Jupiter Trojans (L4 population) were observed at 3-4 different phase angles in the range 7°-12°.



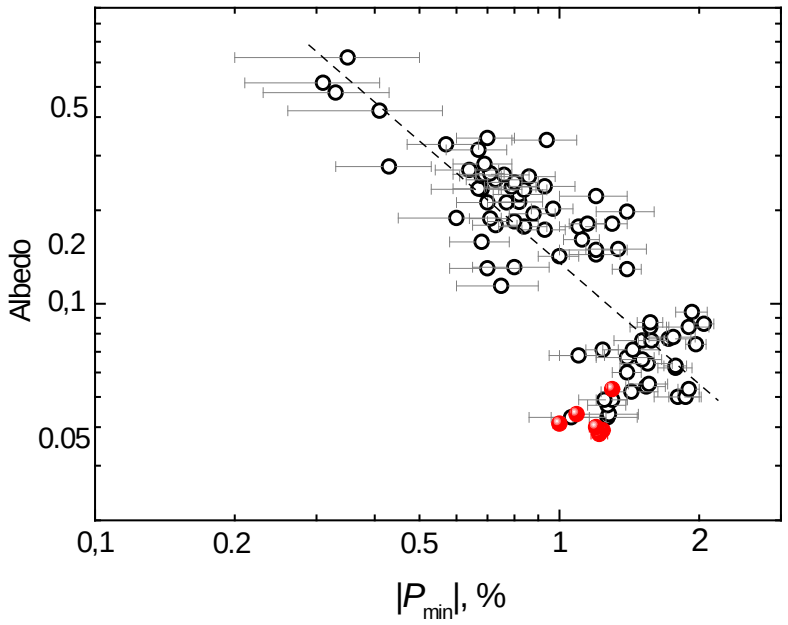
Polarization properties are similar but not identical!

$P_{min} \sim -1 - -1.3\ \%$

$\alpha_{min} \sim 9 - 10°$

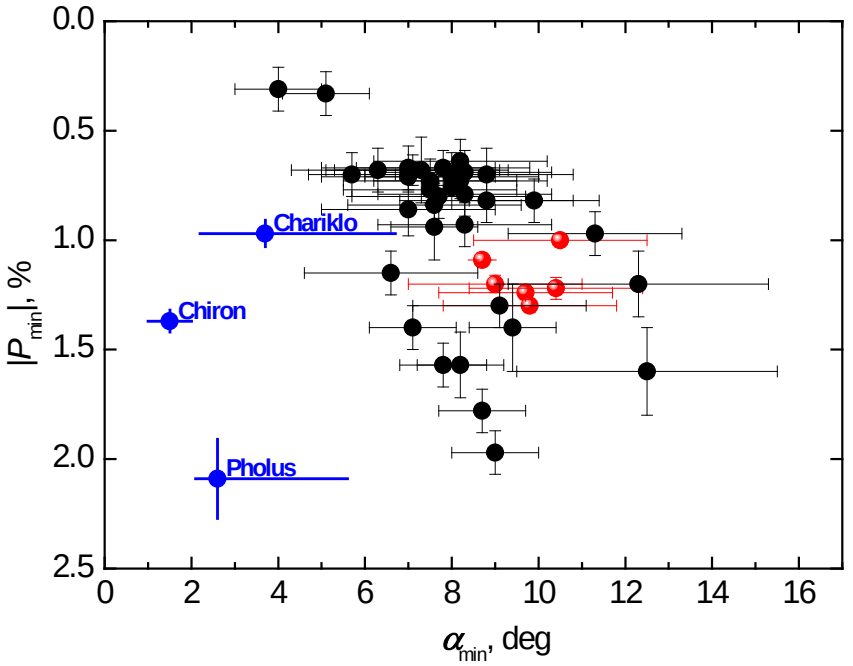
POLARIMETRY OF JUPITER TROJANS

$$\log (p) = C1 \log (P_{min}) + C2$$



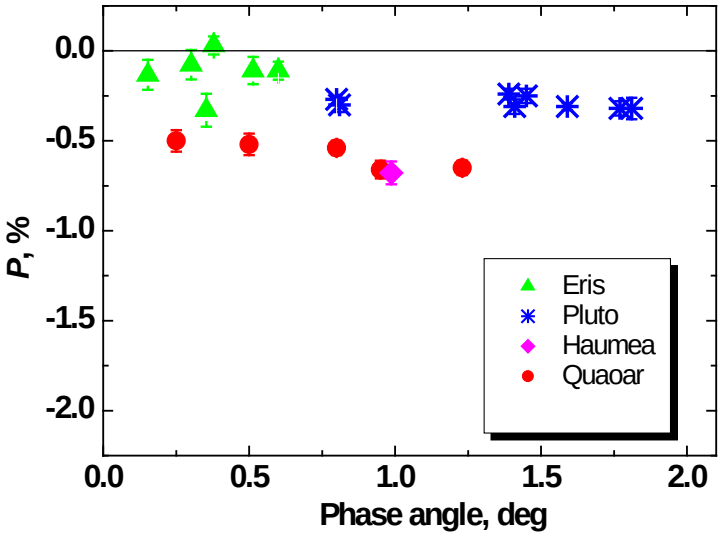
- The polarization properties of the observed **Trojans** is similar to **asteroids** and different from **Centaurs.**

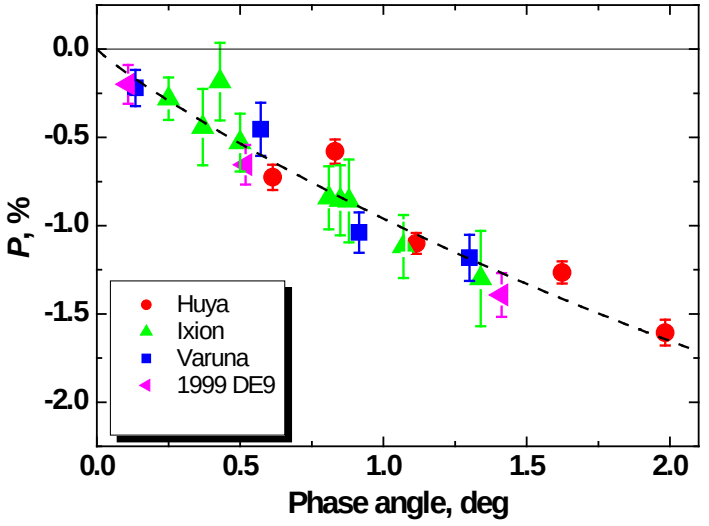
• Observational evidences of "saturation" effect found in laboratory (Zellner et al. 1977): $|P_{min}|$ increases as the albedo decreases down to ~0.05, but with further decrease of albedo $|P_{min}|$ decreases.



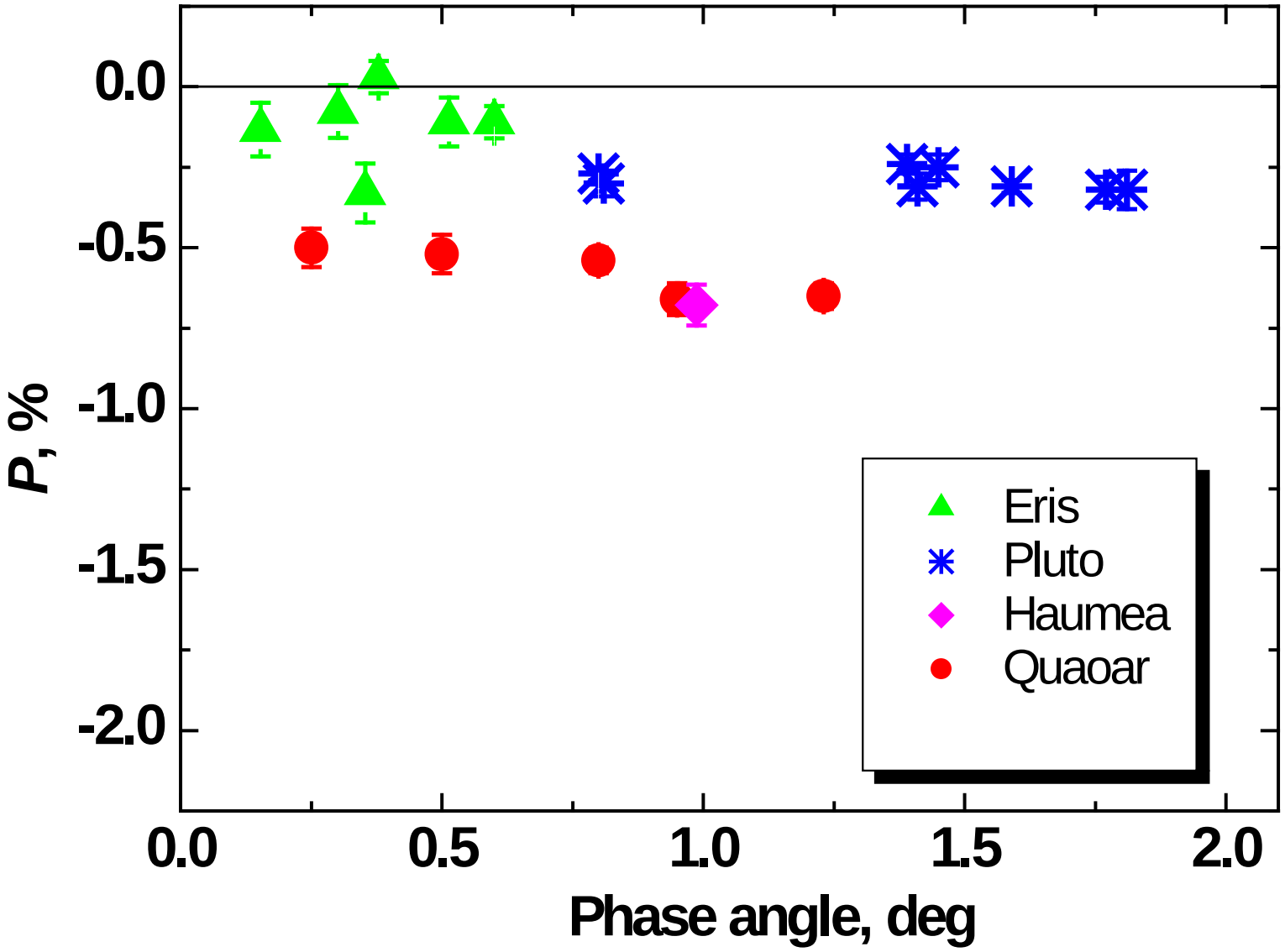
POLARIMETRY OF TRANSNEPTUNIAN OBJECTS (136472) MAKEMAKE AND (90482) ORCUS

- observations with FORS2 at the 8.2 m ESO VLT;
- measurements of the linear polarization in the Bessell *R* filter;
- observations aimed to characterize surface properties of these distant bodies and to verify the different types of polarisation phase behaviour for the largest and smaller-sized TNOs *(Bagnulo et al. 2008)*,





POLARIZATION-PHASE ANGLE DEPENDENCE OF THE LARGEST TNOs



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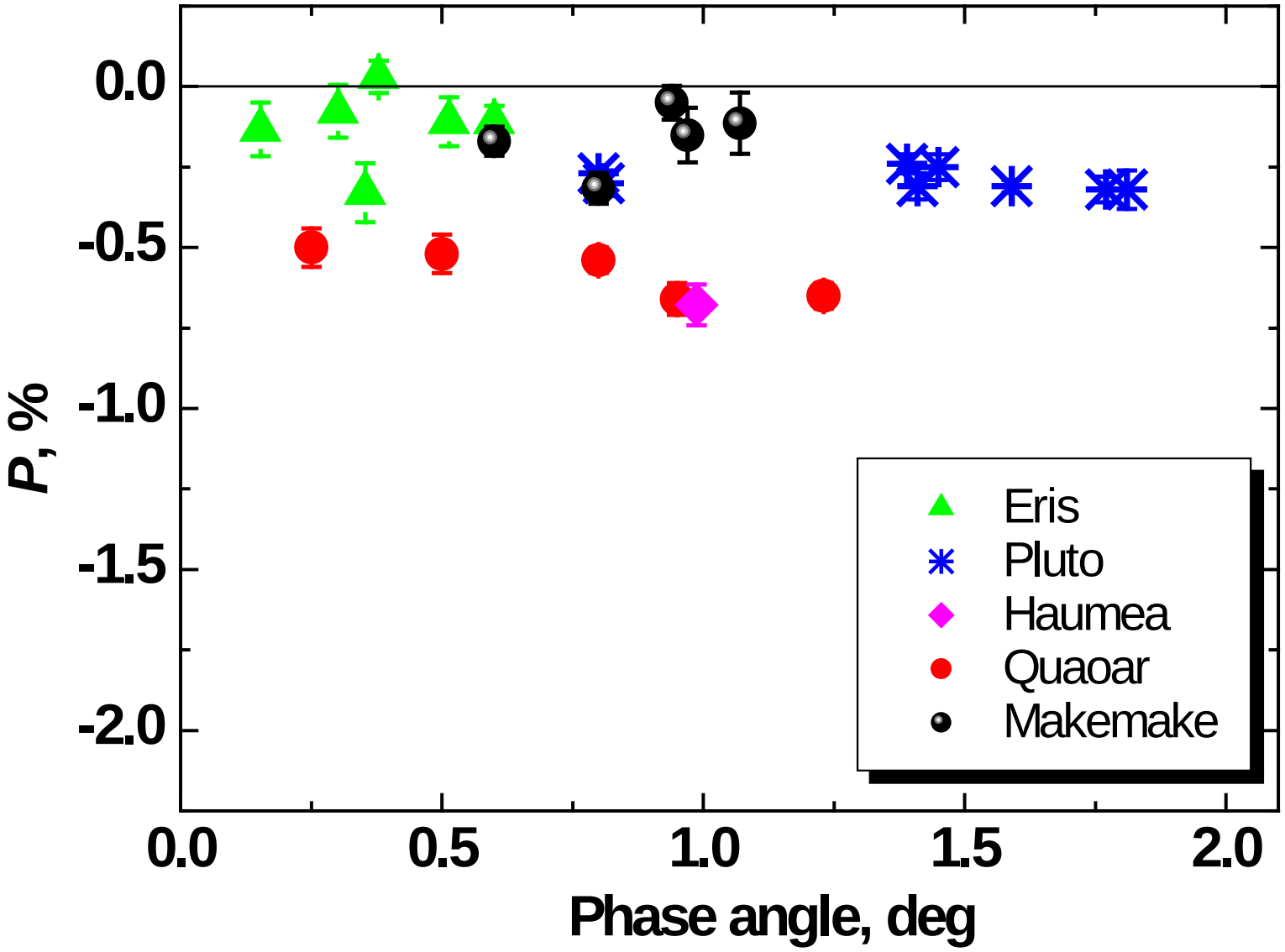

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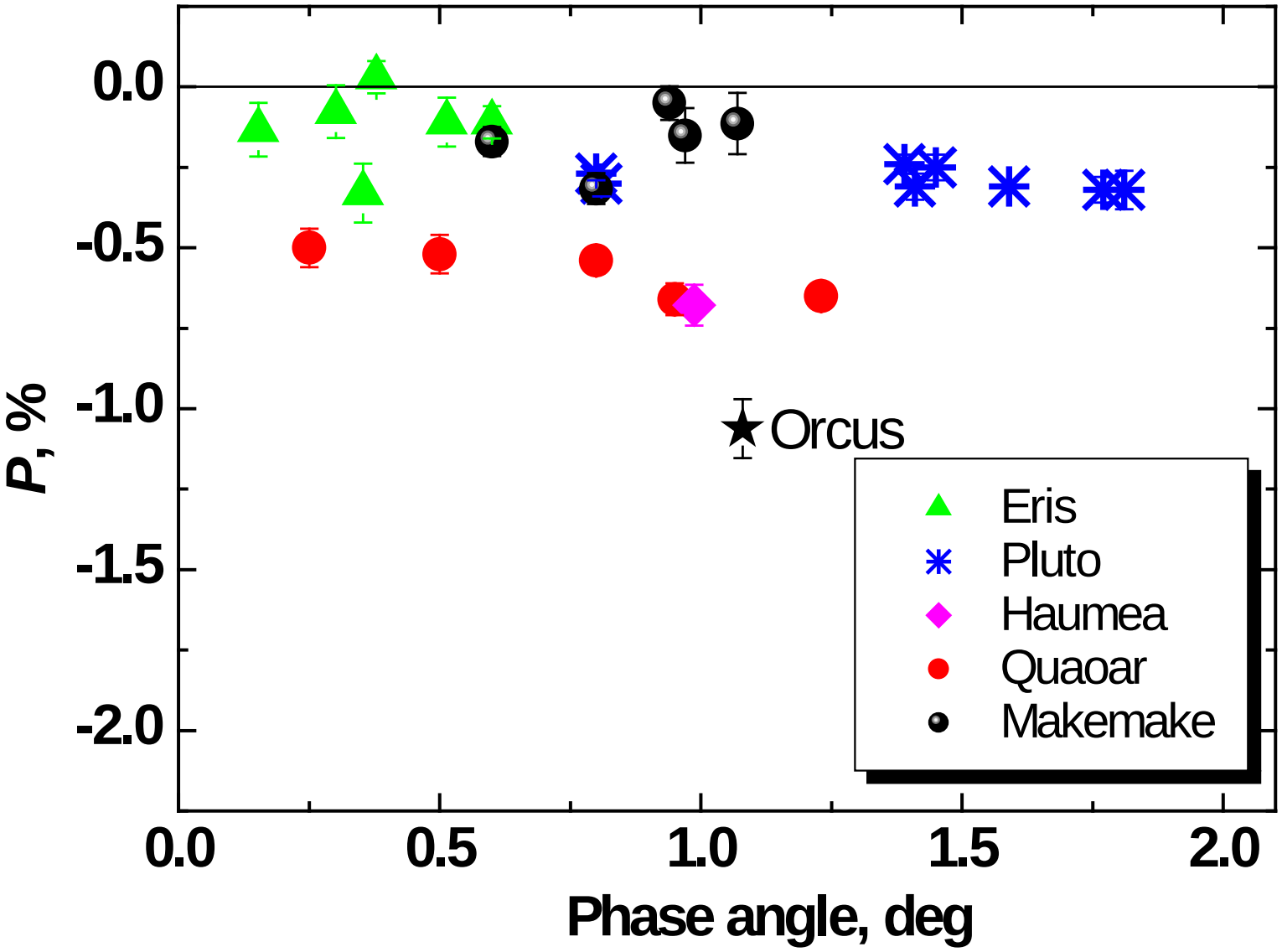
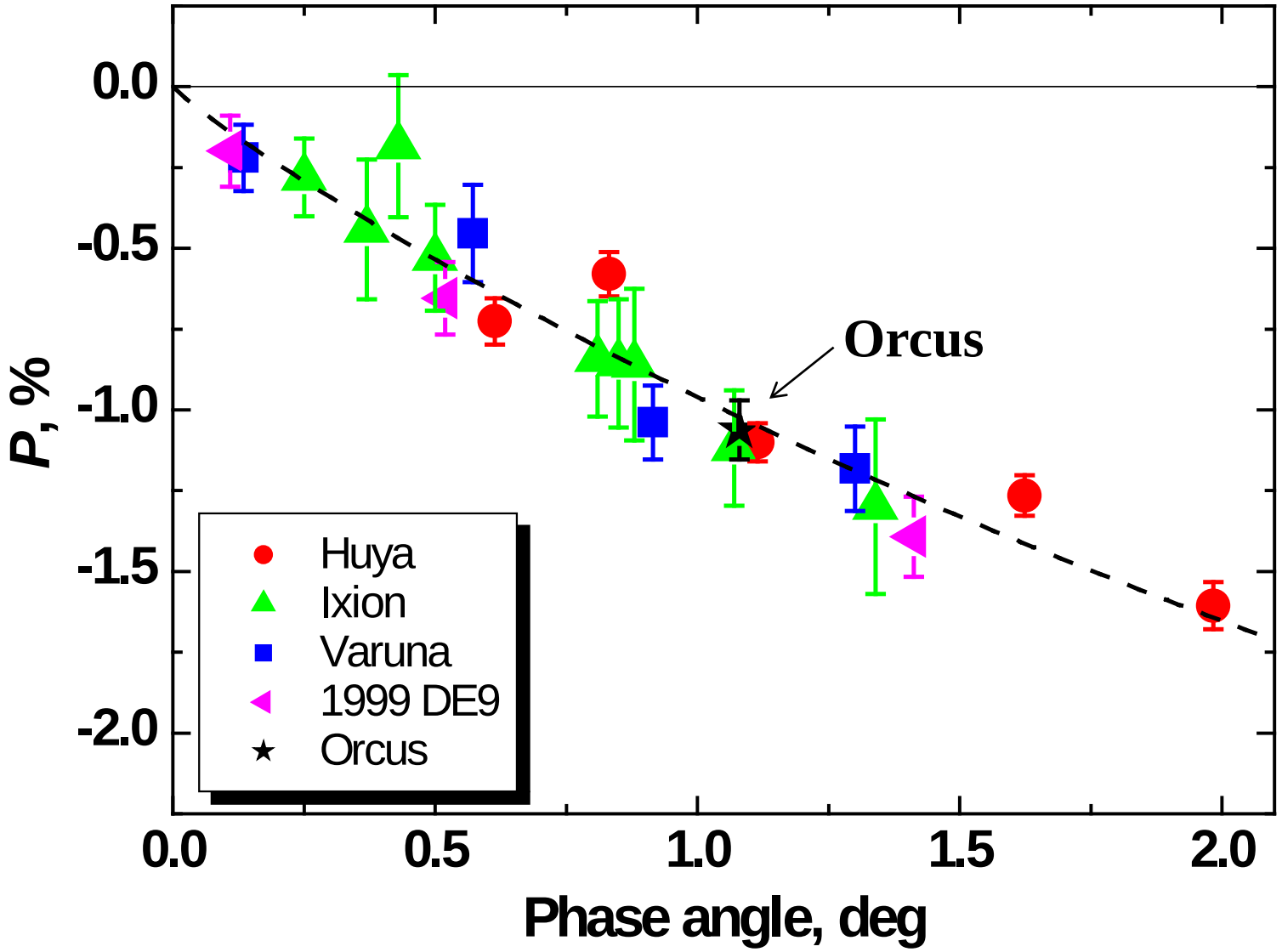


POLARIZATION-PHASE ANGLE DEPENDENCE OF THE SMALLER SIZE TNOs



POLARIMETRY OF TRANSNEPTUNIAN OBJECTS: MAIN RESULTS

- We confirm the different types of polarization phase behaviour for the largest and smaller-sized TNOs; there are significant differences in the polarization of the large objects and the smaller ones and between large TNOs with water-ice and methane-ice dominated surfaces.

- To explain subtle surface polarization of the largest TNOs, we assume that their surfaces are covered by a thin layer of hoarfrost masking the surface structure.

COST ACNION MP1104: SHORT TERM SCIENTIFIC MISSIONS

Host: **Stefano Bagnulo**, Armagh Observatory, UK, 19/11/2012 - 03/12/2012
Host: **Sonia Fornasier**, Observatoire de Paris, France, 24/03/2014 - 02/04/2014

List of the papers with COST Acknowledgement:

1. **Belskaya I. N., Bagnulo S.**, Stinson A., Tozzi G. P., Muinonen K., Shkuratov Yu. G., Barucci M. A., **Fornasier S.** (2012). Polarimetry of trans-Neptunian objects (136472) Makemake and (90482) Orcus. Astronomy & Astrophysics 547, id.A101, 5 pp.
2. **Fornasier S., Belskaya I.N**., Perna D. (2015). The potentially hazardous Asteroid (214869) 2007 PA8: An unweathered L chondrite analog surface. Icarus 250, p. 280-286.
3. **Belskaya I.N., Bagnulo S**. (2015) Transneptunian objects and Centaurs. In: Polarimetry of stars and planetary systems (L. Kolokolova, A.-C. Levasseur-Regourd, J. Hough, eds.), Cambridge University Press, Cambridge, U.K, ISBN 978-1-1070-4390-9, p.405-418.
4. **Bagnulo S., Belskaya I.,** Stinson A., Christou A., Borisov G.B. (2015) Broadband linear polarization of Jupiter Trojans. Astron, Astroph., accepted.
5. **Belskaya I.N.,** Cellino A., Gil-Hutton R., Muinonen K., Shkuratov Yu.G. (2015). Asteroid polarimetry. In: Asteroids IV (P. Michel et al., eds.). Univ. Arizona Press, Tuscon, accepted.