Polarimetry of asteroids

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### POLARIMETRY vs. OTHER TECHNIQUES

<table>
<thead>
<tr>
<th>Technique</th>
<th>Objects</th>
<th>$r$</th>
<th>$D$</th>
<th>$N_D$</th>
<th>$N$</th>
<th>$N_{polarim}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photometry: magnitudes/colors</td>
<td>Near-Earth</td>
<td>$\leq 1.3$ AU</td>
<td>$\geq 1$ km</td>
<td>$\sim 1000$</td>
<td>13019</td>
<td>$\sim 15$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$10 - 32$ km</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main belt</td>
<td>2.2- 3.2 AU</td>
<td>$\geq 15$ km</td>
<td>$\sim 3000$</td>
<td>646650</td>
<td>$\sim 330$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$100 - 950$ km</td>
<td>$\sim 200$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jupiter Trojans</td>
<td>$\sim 5.2$ AU</td>
<td>$\geq 50$ km</td>
<td>$\sim 100$</td>
<td>6385</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$100 - 150$ km</td>
<td>$\sim 20$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TNOs</td>
<td>$&gt;30$ AU</td>
<td>$\geq 700$ km</td>
<td>$\sim 15$</td>
<td>2014</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$1300 - 2300$ km</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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°).

\[
P_{\text{min}} < -0.6 \% \\
\alpha_{\text{inv}} = 19° \\
h = 0.078 \%/\text{deg} \\
P_{\text{max}} = 6 \% \\
\alpha_{\text{max}} \sim 100°
\]

\[
p_V = 0.29 \pm 0.08 \\
D = 1.4 \pm 0.2 \text{ km}
\]
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 $7^\circ-12^\circ$.

Polarization properties are similar but not identical!

$P_{\text{min}} \sim -1.1 - 1.3\%$

$\alpha_{\text{min}} \sim 9 - 10^\circ$
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): $|P_{\text{min}}|$ increases as the albedo decreases down to $\sim 0.05$, but with further decrease of albedo $|P_{\text{min}}|$ decreases.

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

$$\log(p) = C_1 \log(P_{\text{min}}) + C_2$$
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

![Graph showing the polarization-phase angle dependence of the largest TNOs. The x-axis represents the phase angle in degrees, and the y-axis represents the polarization percentage (P%). Different symbols represent different TNOs: Eris (green up triangles), Pluto (blue stars), Haumea (magenta diamonds), and Quaoar (red circles).]
POLARIZATION-PHASE ANGLE DEPENDENCE OF THE LARGEST TNOs

![Graph showing polarization phase angle dependence for various TNOs.](graph.png)
POLARIZATION-PHASE ANGLE DEPENDENCE
OF THE LARGEST TNOs

![Graph showing the polarization-phase angle dependence of the largest TNOs. The graph plots phase angle (0.0 to 2.0 degrees) on the x-axis and polarization (P, %) on the y-axis. Different markers represent different TNOs: Eris (green triangles), Pluto (blue asterisks), Haumea (magenta diamonds), Quaoar (red circles), and Orcus (black stars).]
POLARIZATION-PHASE ANGLE DEPENDENCE OF THE SMALLER SIZE TNOs

Phase angle, deg

$P_\%$

Legend:
- Huya
- Ixion
- Varuna
- 1999 DE9
- Orcus

Orcus
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

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Host: Sonia Fornasier, Observatoire de Paris, France, 24/03/2014 - 02/04/2014

List of the papers with COST Acknowledgement:


