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Polarimetry as a tool for characterization of potentially hazardous aseteroids

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The degree of linear polarization of sunlight scattered by an asteroid contains valuable information for rapid characterization of the surface properties of Near-Earth objects. In the case of atmosphere-less bodies the state of linear polarization varies as a function of the phase angle (α) and is described using the so-called $P_{\rm r}$ parameter (see left panel of Fig. 1).

The properties of the phase-polarization curve (see right panel of Fig. 1) of an asteroid are mostly defined by its albedo ($p_{\rm V}$). Numerous calibrations between polarization and $p_{\rm V}$ have been proposed for main-belt asteroids [1, 2]. However, main-belt asteroids rarely exceed phase angle $> 30^\circ$ while near-Earth object can be observed at phase angle as large as 100°. These observation at higher phase angle to the NEOs allows for deeper characterization of the observed object, but there is currently a lack of observations of NEOs in polarimetry to accurately calibrate the albedo-polarization relationship at high phase angles.

In this presentation I will discuss the current state of NEO observations in polarimetry and how polarimetry could be used to obtain reliable information on the geometric albedo of NEOs. With a proper calibration of the polarization-albedo relation, one could reduce the uncertainty on a newly discovered object by a factor of 10 with one single polarimetric observation obtained at a phase angle $> 40^\circ$.

As an example, according to the current state of the albedo-polarization calibration at large phase angle and considering an H = 22.3 mag NEO (similar to 2021 PDC). Without any albedo information size estimation would be from 35 meters to 700 meters. However, one measurements of $P_{\rm r}$ at a phase angle of 40° would allow to obtain reliable information about the diameter of the object as follow:

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- $D < 80$ meters if $P_{\rm r} < 1\%$
- $80 < D < 120$ meters is $1 < P_{\rm r} < 4\%$
- $D > 120$ meters if $P_{\rm r} > 4\%$

while the typical uncertainties on $P_{\rm r}$ are generally lower than 0.1%.

I will also discuss the specific case of 2021 PDC and what a few observations in polarimetry obtained with the FORS2 polarimeter on the Very Large Telescope could provide. FORS2 on the VLT is currently the only instrument capable of obtained reliable polarimetric observations on the V=21.5 mag objects.

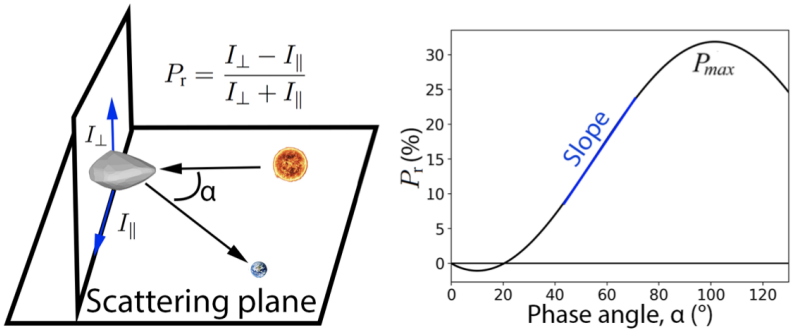

Figure 1: Left: Observation geometry with the sun-light scattered by the asteroid and then observed on Earth. The polarization is measured in the scattering plane and the plane perpendicular to it. Right: typical variation of the polarization as a function of phase angle (α). $P_{\rm max}$ corresponds to the maximum value of polarization usually occurring between 80 to 120°.

Preference for oral presentation.

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