Perspectives of polarimetry for follow-up observations of Gaia's asteroids

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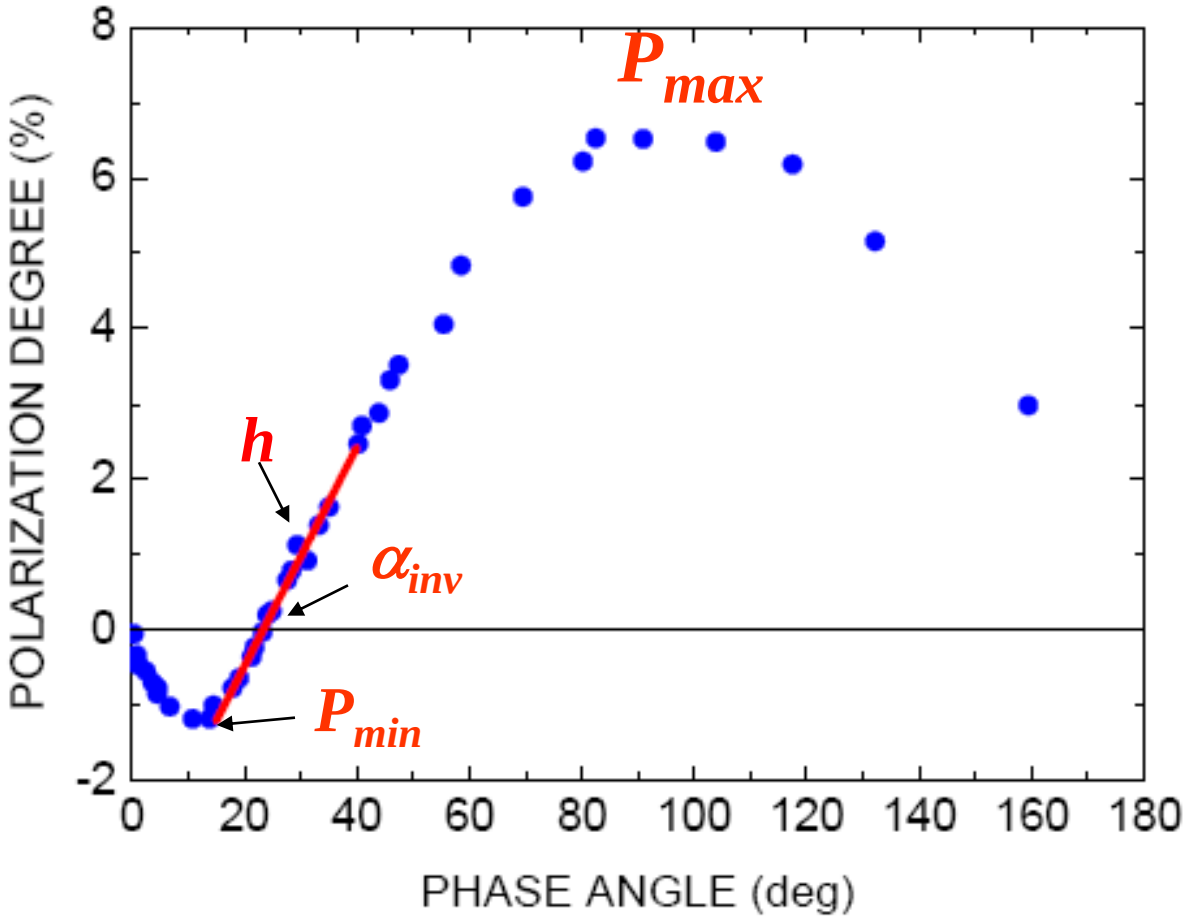
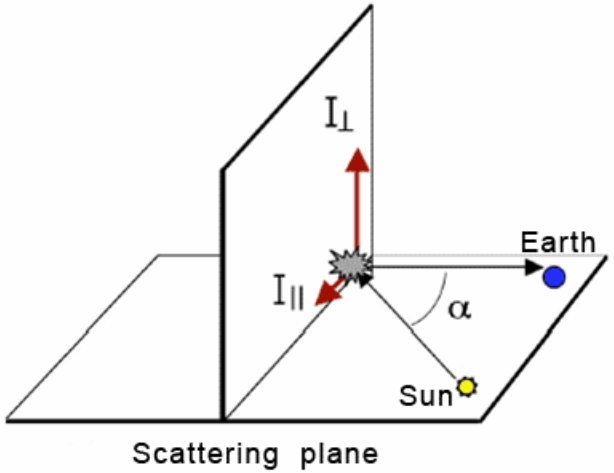
POLARIMETRY OF ASTEROIDS: PHASE ANGLE DEPENDENCE OF POLARIZATION DEGREE

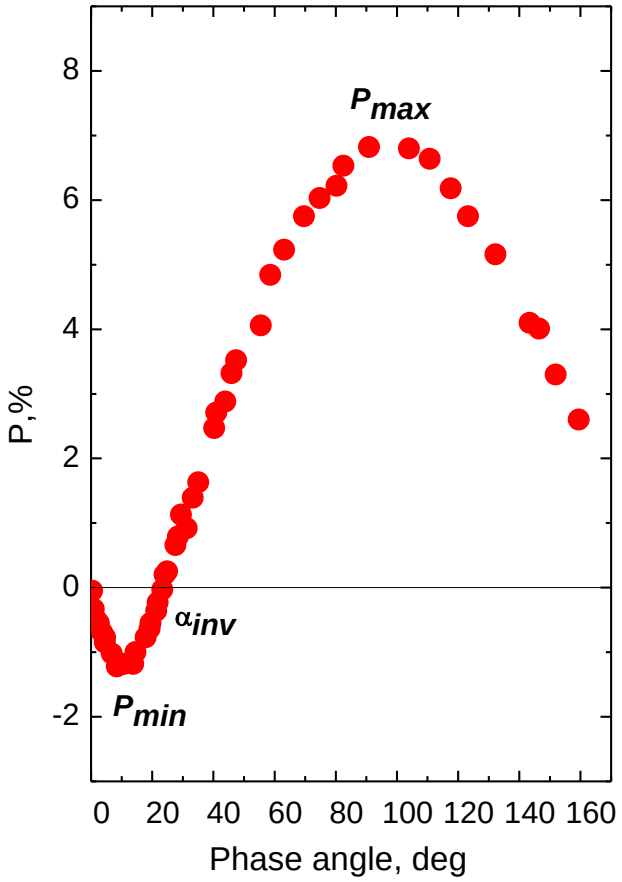


$$P_r = \frac{(I_\perp - I_{//})}{(I_\perp + I_{//})}$$



The term of ***negative polarization*** is used to indicate that the direction of polarization is opposite to that which is normally expected for reflected light, i.e. that the electric vector maximum lies in the plane of scattering.

POLARIMETRY OF ASTEROIDS: PARAMETERS



Typical values:

Polarization minimum P_{min} = ***0.3-2.1%***

Phase angle of minimum α_{min} = ***5 - 12°***

Inversion angle α_{inv} = ***17 – 23 (14 – 28)°***

Polarization slope ***h = 0.04 - 0.35%/deg***

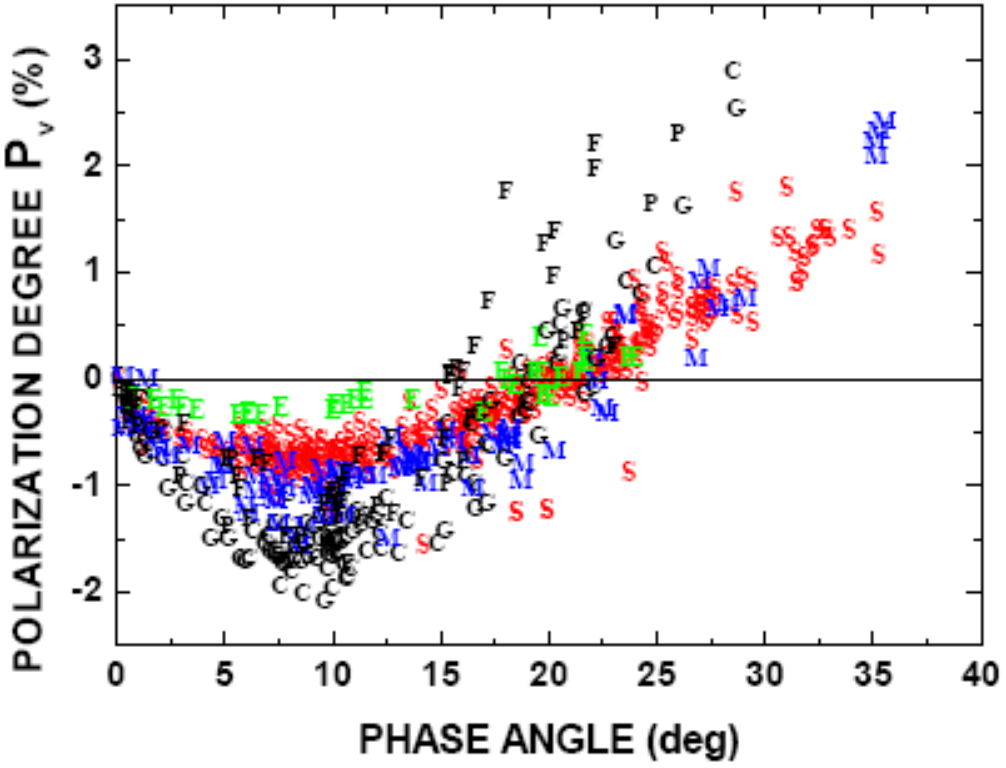
Polarization maximum P_{max} = ***3-10 %***

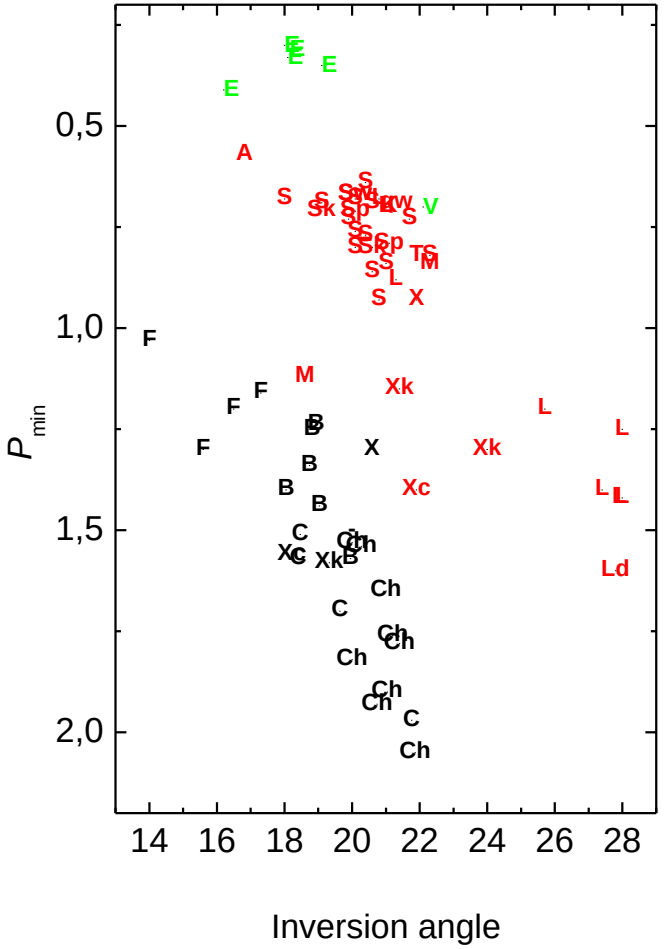
Phase angle of maximum α_{max} = ***90 - 110°***

$P_r(\alpha)$ depends on the physical properties of the topmost surface layer (*complex refractive index*, *porosity*, *roughness*, *particle size*, *heterogeneity)*

POLARIMETRY OF ASTEROIDS: ALBEDO DEPENDENCE

- Asteroids of similar surface albedos are characterized by very similar polarization phase curve behaviours





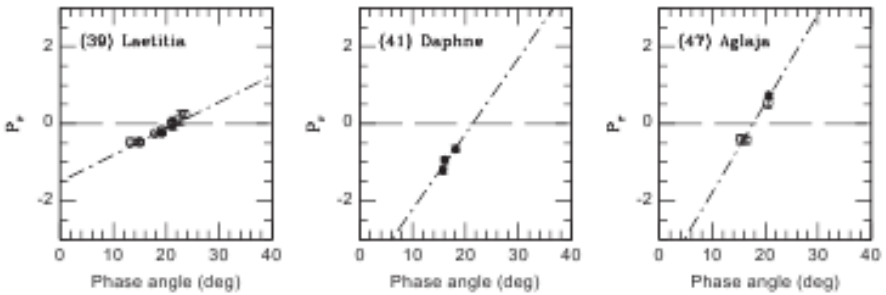
POLARIMETRIC METHOD OF ALBEDO DETERMINATION

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

$$\log(p) = C_3 \log(h) + C_4$$

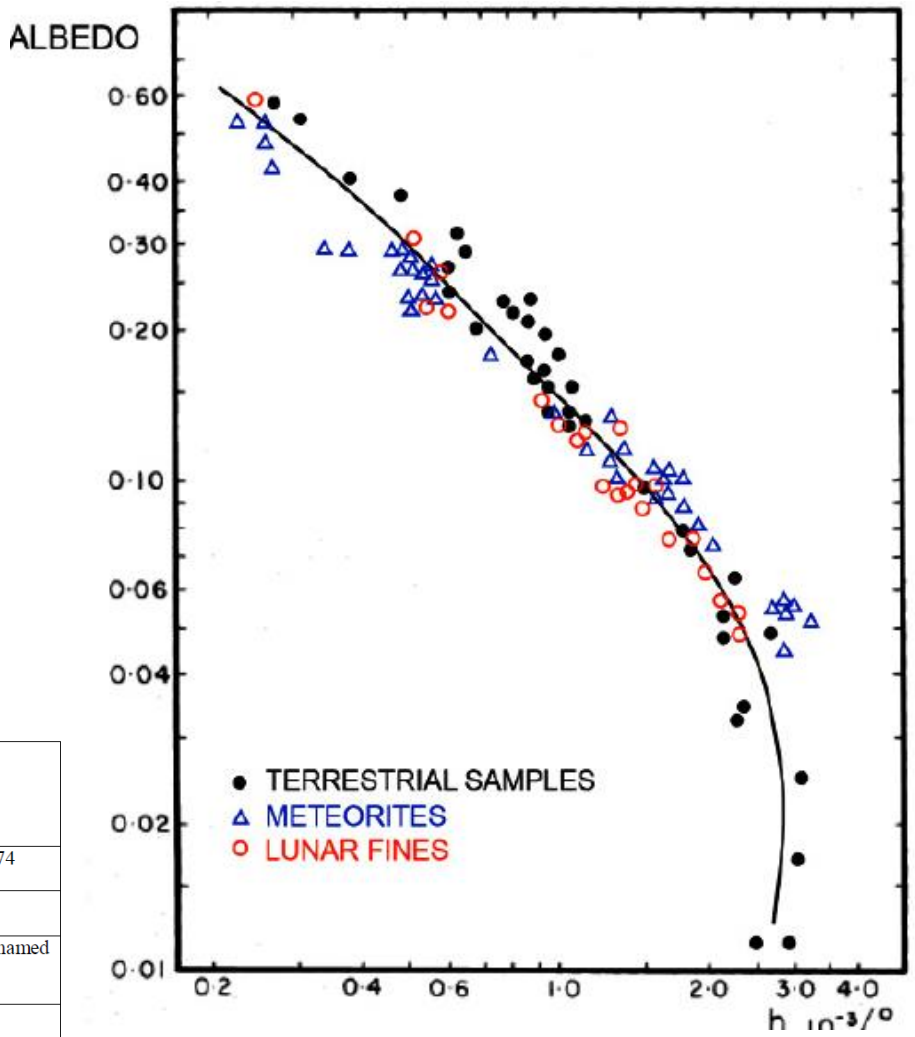
$$\log(p) = C_5 \log(P_{min}) + C_6$$

σ_p



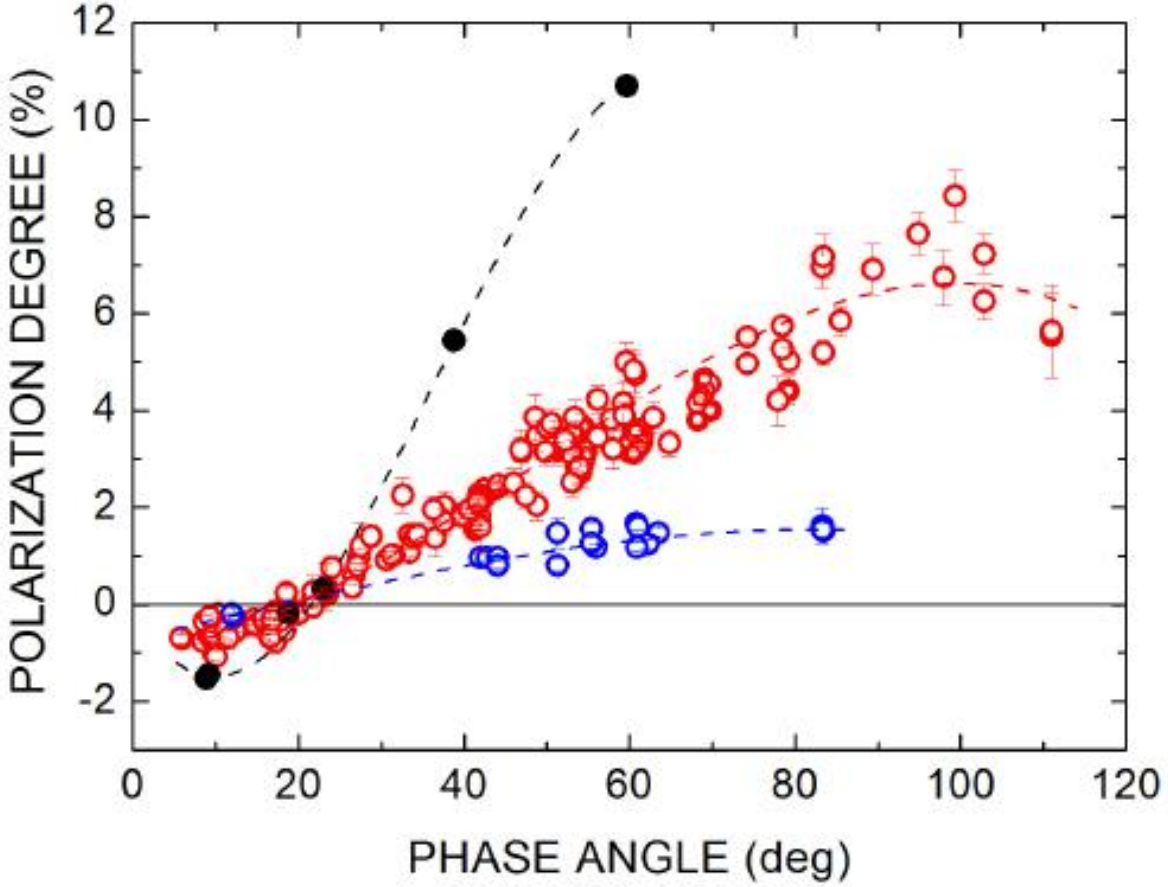
Cellino et al. 2012

Source of albedo data used for calibration	C_1	C_2	Albedo			References
			h=0.04	h=0.10	h=0.30	
Meteorites	-1.00	-1.78	0.415	0.166	0.055	Bowell and Zellner 1974
Meteorites	-0.92	-1.72	0.368	0.158	0.058	Zellner et al. 1977
IRAS/Occultations/ Space-based	-0.983 ±0.082	-1.731 ±0.066	0.440	0.179	0.061	Lupishko and Mohamed 1996
IRAS	-1.118 ±0.071	-1.779 ±0.062	0.608	0.218	0.064	Cellino et al. 1999
Occultations	-0.970 ±0.071	-1.667 ±0.083	0.489	0.201	0.069	Cellino et al. 2012
WISE	-1.207 ±0.067	-1.892 ±0.141	0.624	0.207	0.055	Masiero et al. 2012
Occultations	-1.124 ±0.032	-1.789 ±0.025	0.606	0.216	0.063	Cellino et al. 2014b



Zellner et al. 1977

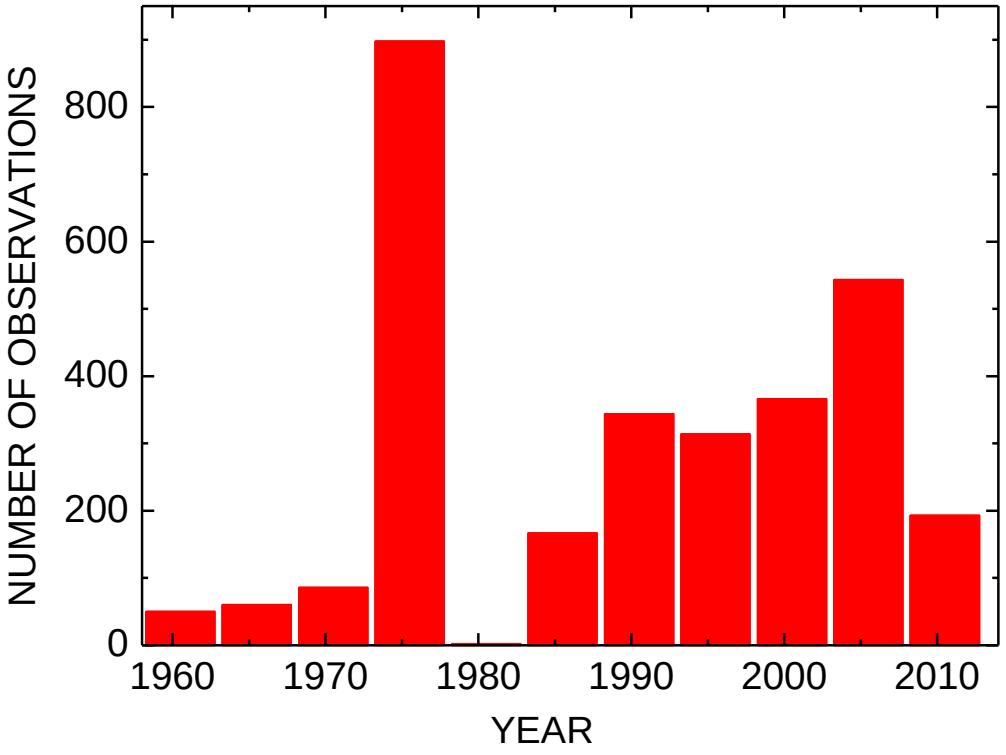
POLARIMETRY OF NEAR-EARTH ASTEROIDS

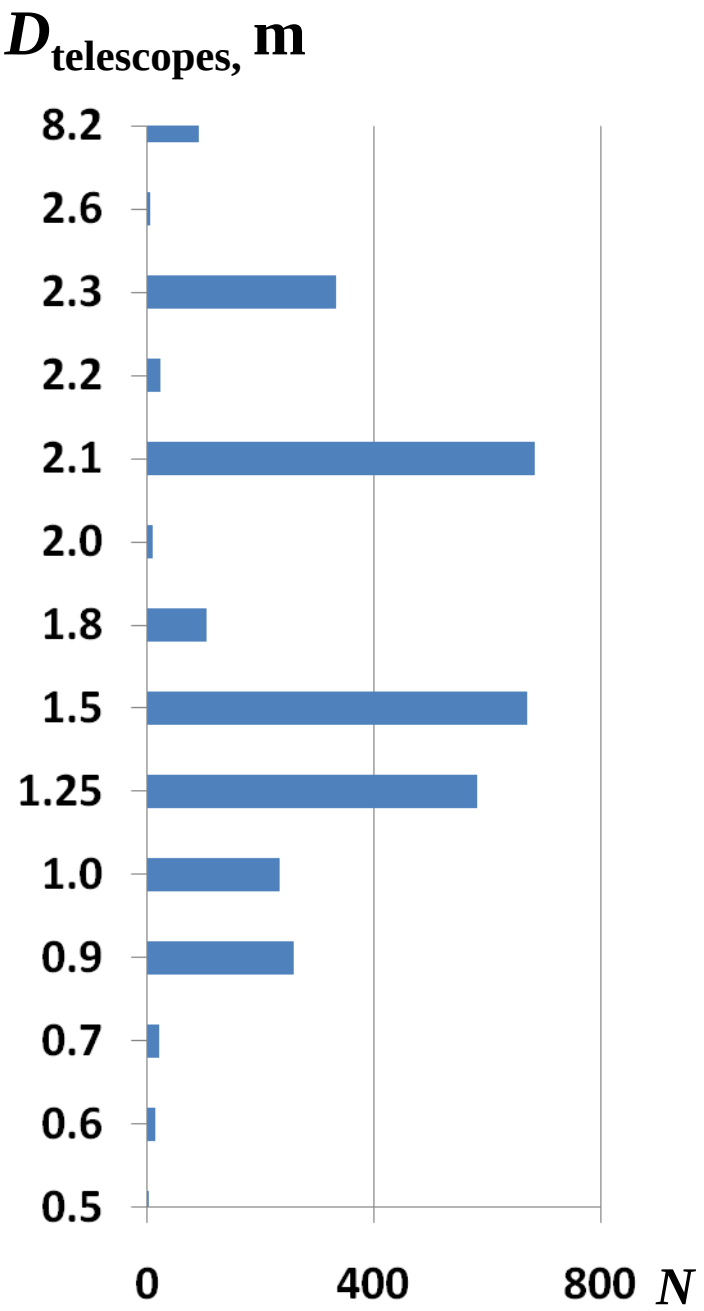


Even a single measurement of polarization at phase angle $\alpha>40°$ can be sufficient to obtain an overall albedo estimation and discriminate between **low**, **moderate** and **high** albedo asteroids.

POLARIMETRY OF ASTEROIDS: AVAILABLE DATA AND TELESCOPES

- ~450 asteroids
- ~150 polarimetric albedos
- ~80 asteroids with measured P_{min} & α_{inv}
- ~15 asteroids observed at α>40°





http://www.psi.edu/pds/resource/apd.html

SUMMARY

- Polarimetric observations can provide complementary data to derive physical properties of asteroids discovered by GAIA.

- NEAs are the best targets for follow-up polarimetry. Observations at the phase angles $\alpha>40°$ will give a prompt assessment of an asteroid's geometric albedo.

- Guaranteed telescope time is needed

~1-2 nights per month at 2-m class telescopes

~1-2 hours per month at 8-m class telescopes (FORS/VLT)