REGOLITH OF LOW ALBEDO ASTEROIDS FROM PHOTOMETRIC DATA

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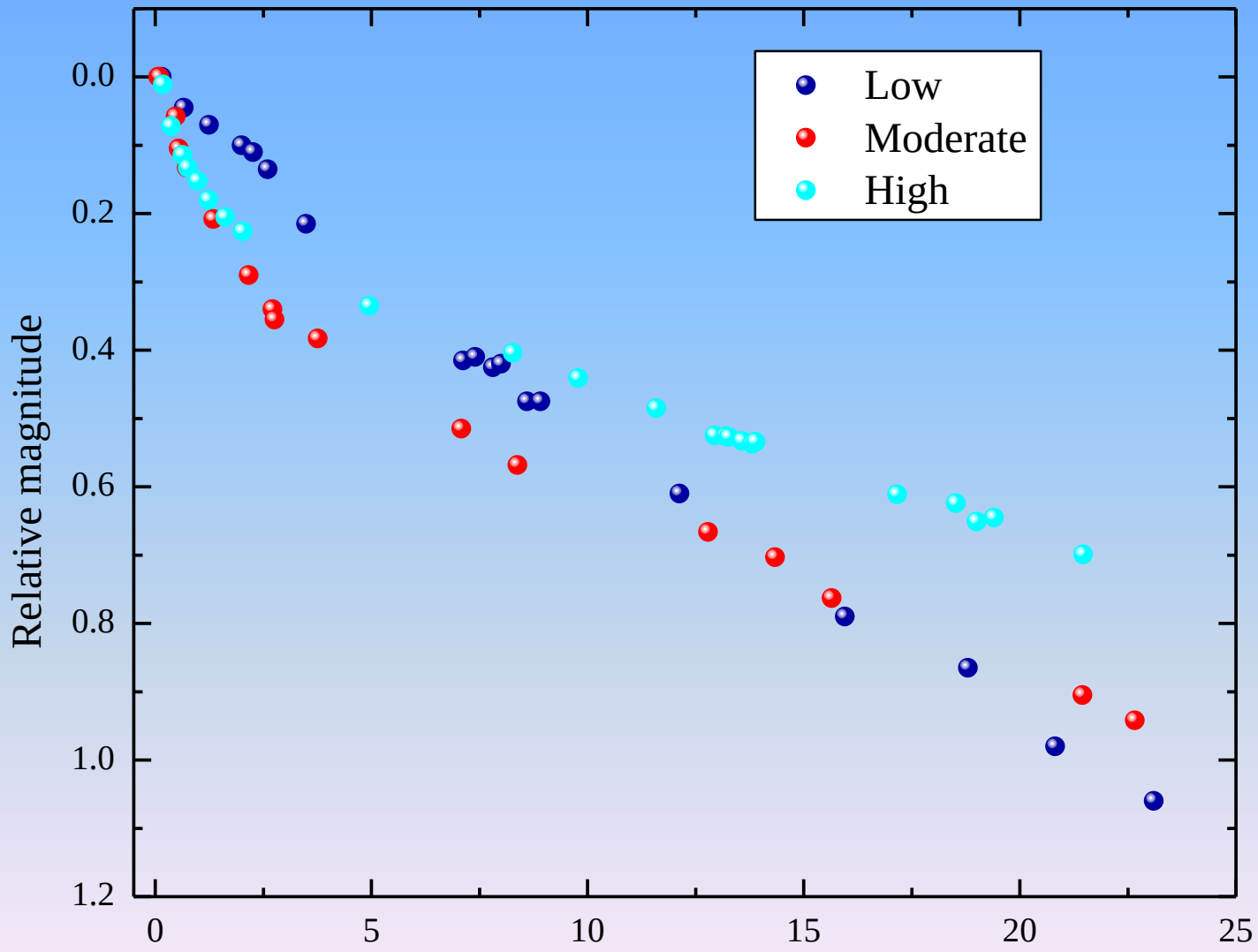
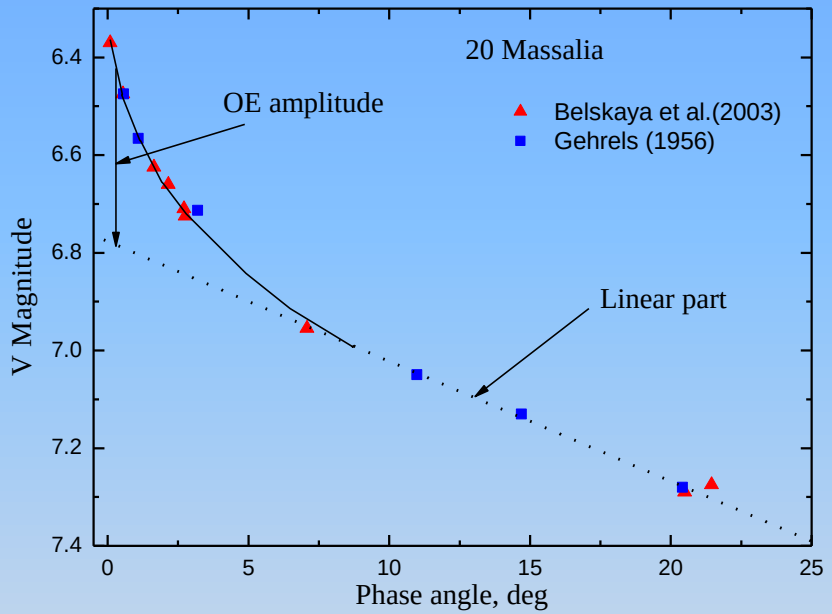
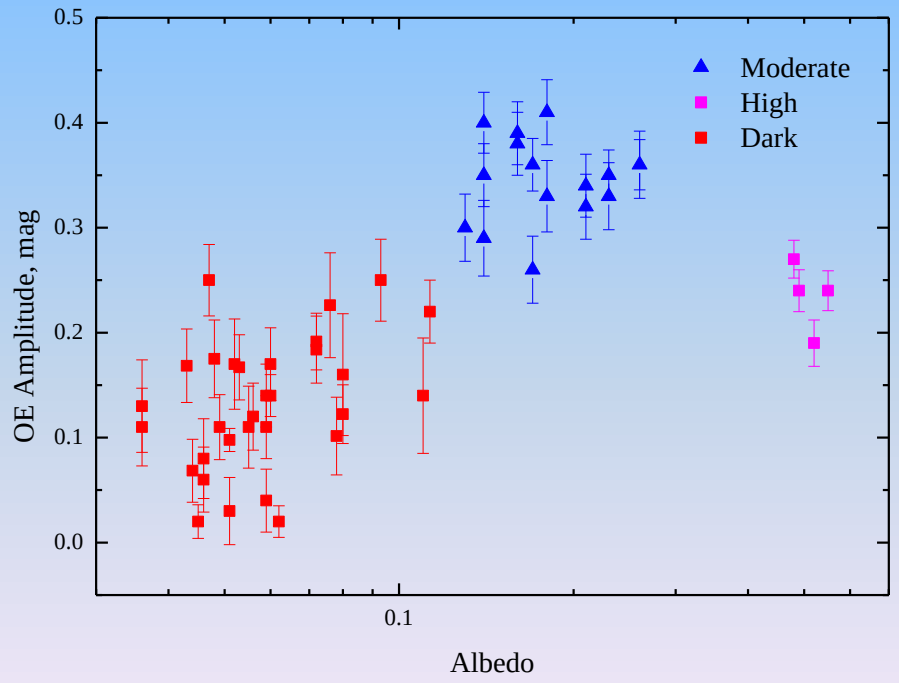
The magnitude-phase angle dependences of asteroids show noticeable differences for high, moderate and low albedo surfaces. It gives a possibility to distinguish between different asteroid types by using their phase curves.



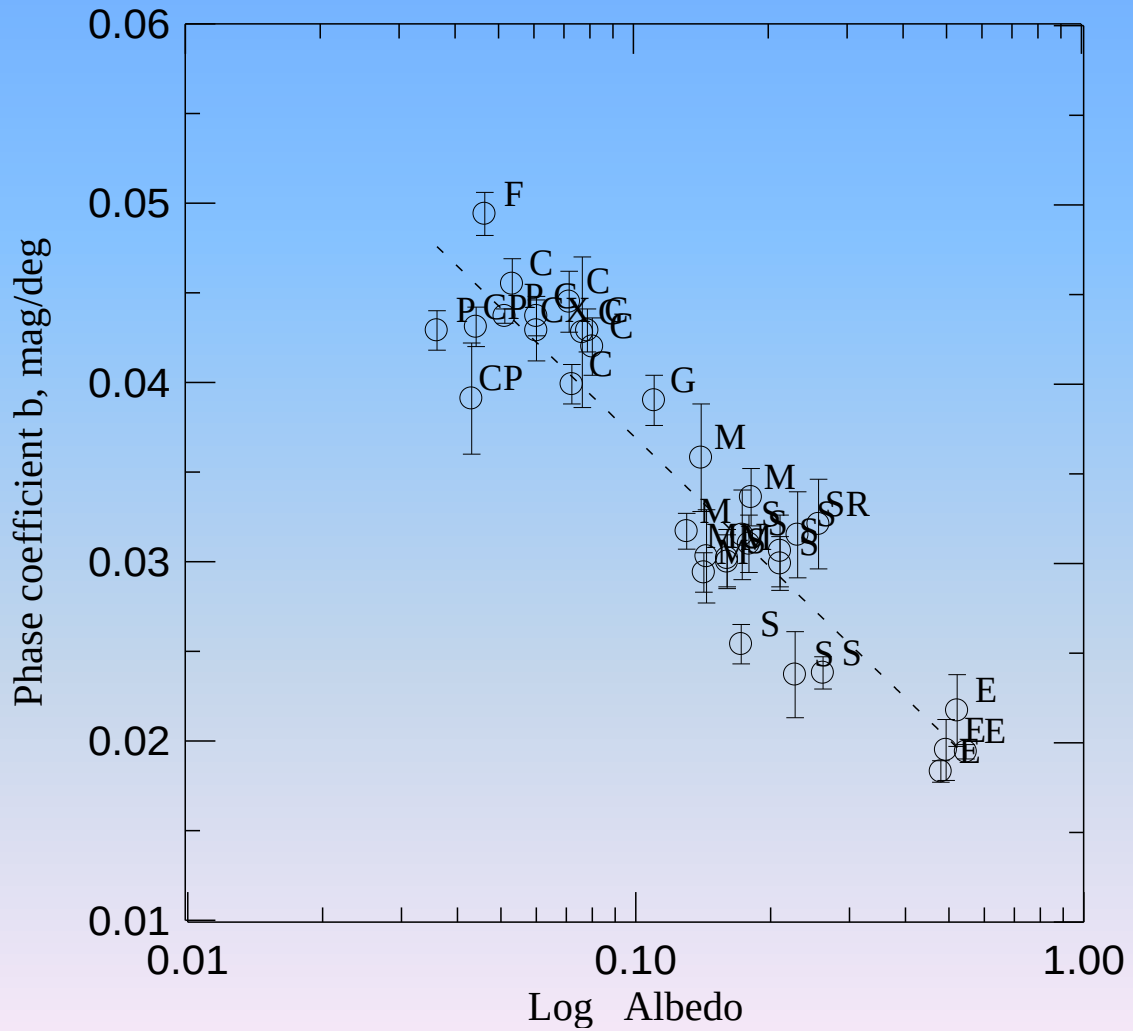
The parameters of magnitude-phase relations (linear phase coefficient, amplitude, width of opposition effect) also differ for high, moderate and low albedo surfaces.



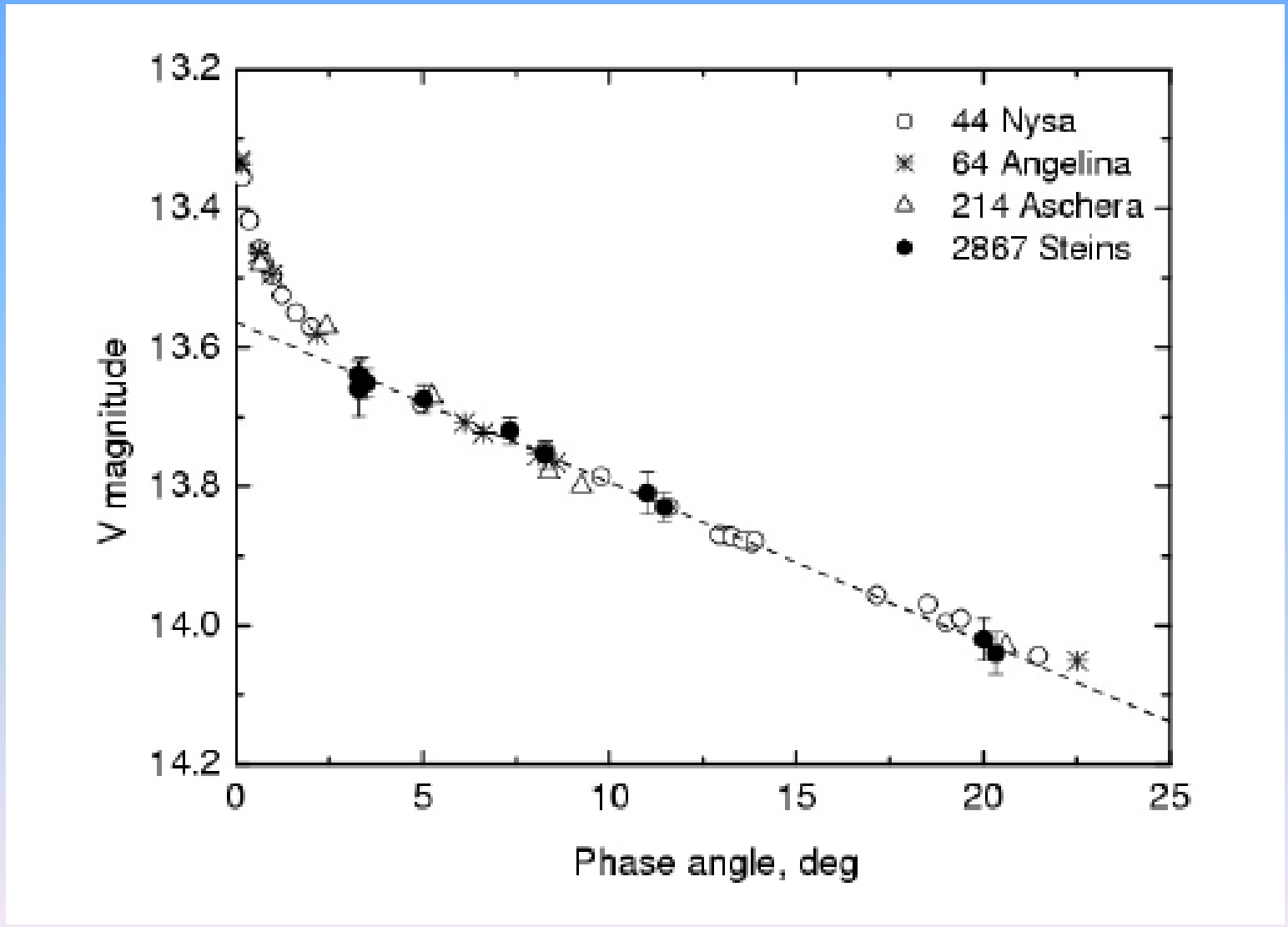


The phase coefficients defined in the range of 10-25 deg correlate with geometric albedo of asteroids, that allows to determine surface albedo of asteroids using only magnitude-phase relation.

$$b = 0.013 - 0.024 \log p_V$$



Photometric albedo of 2867 Steins, derived using the linear coefficient 0.023 mag/deg in the V band (*Dotto et al. 2009*) is 0.38, which is close to the value obtained from the Rosetta mission.

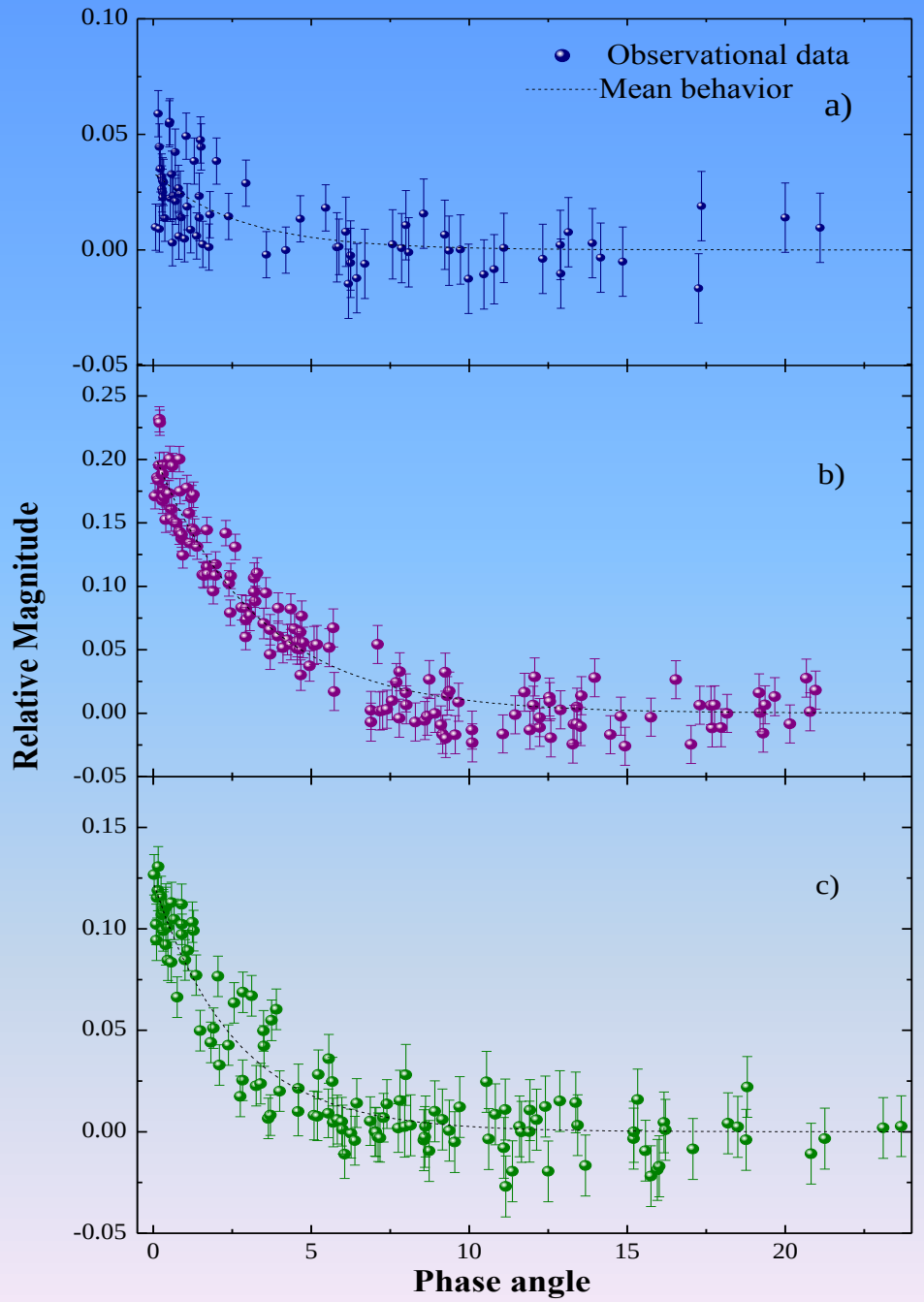


Asteroids of the same compositional type typically display similar magnitude-phase dependences. However, more detailed analysis of phase curves for low albedo asteroids shows diversity in their opposition effect behaviour. There are three main types of opposition behaviour :

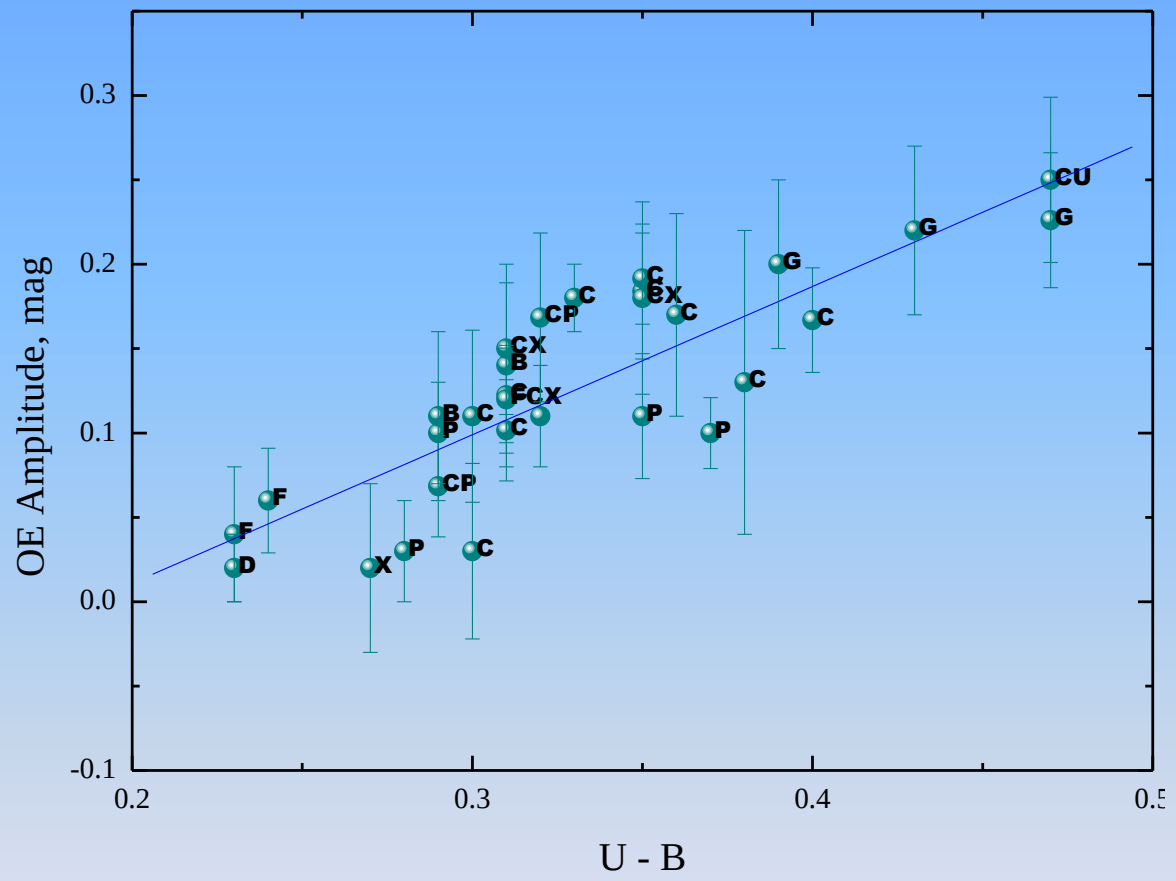
a) ~20% of all studied low albedo asteroids revealed practically linear phase angle dependences with the OE amplitude $\leq$0.06 mag;

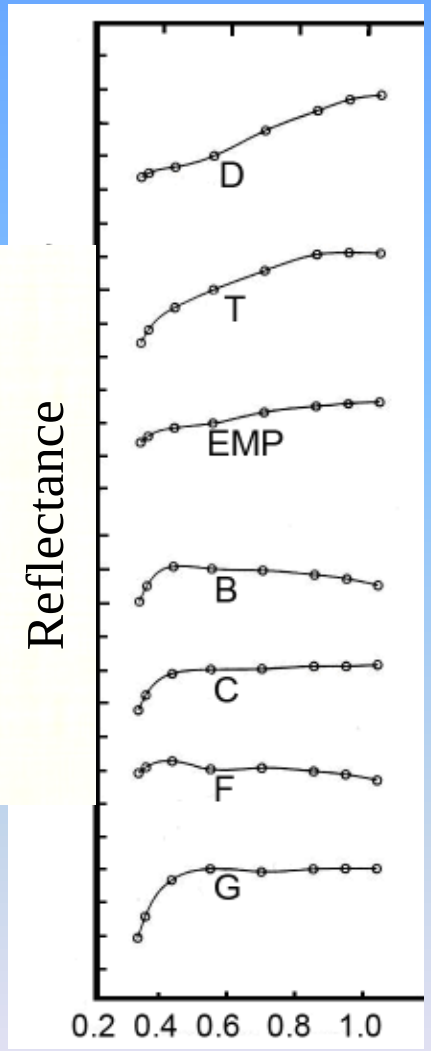
b) ~40% asteroids displayed wide opposition effect starting at the phase angle 6-7 deg with amplitude of 0.15-0.25 mag;

c) ~40% asteroids showed a narrower opposition effect starting at the phase angle of about 4 deg and reaching 0.1-0.13 mag.



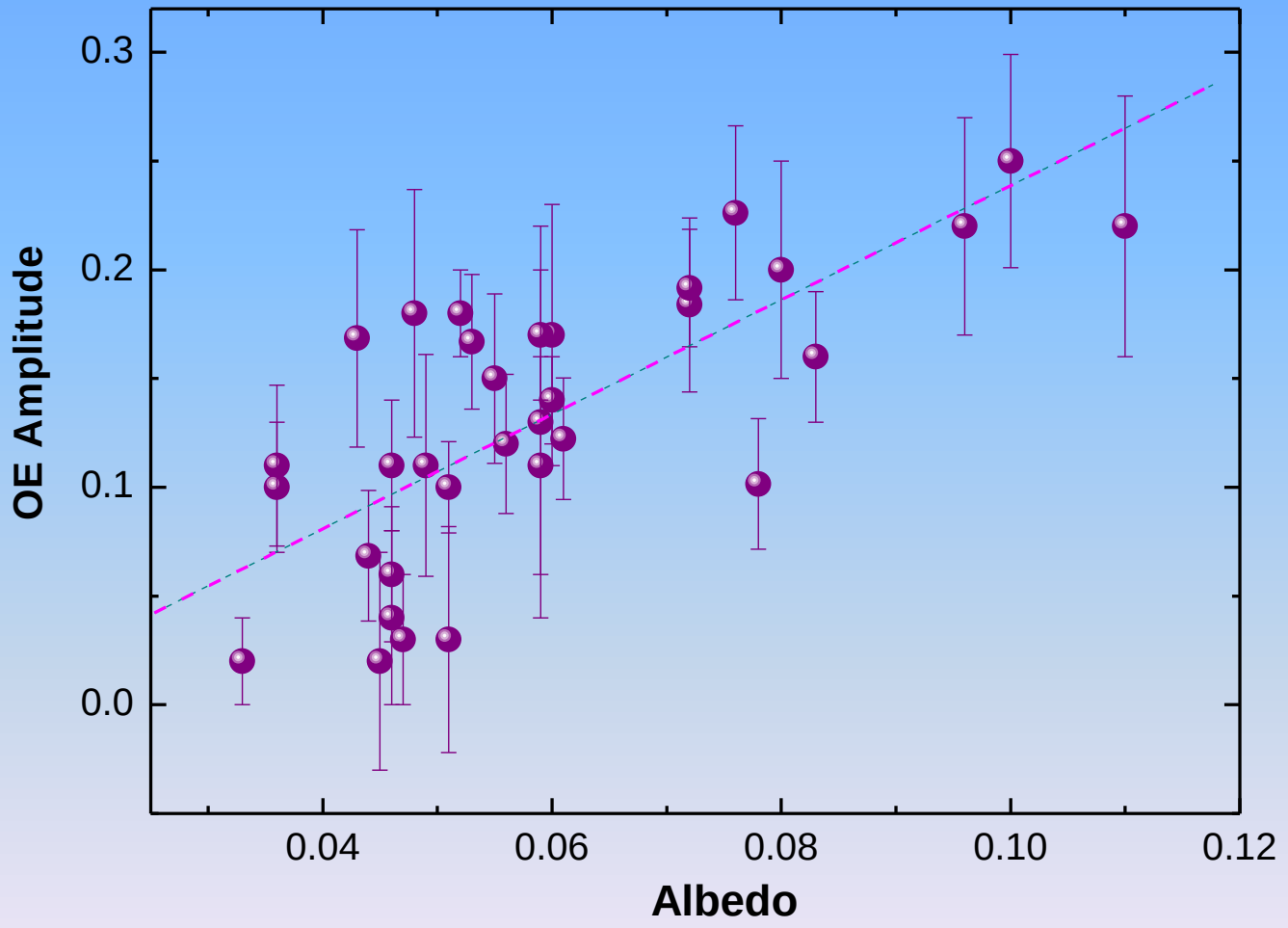
A linear correlation of the OE amplitude and U-B colour index has been found for low albedo asteroids. The smallest OE (if any) is observed for F and P types. The largest OE is inherent for G types.



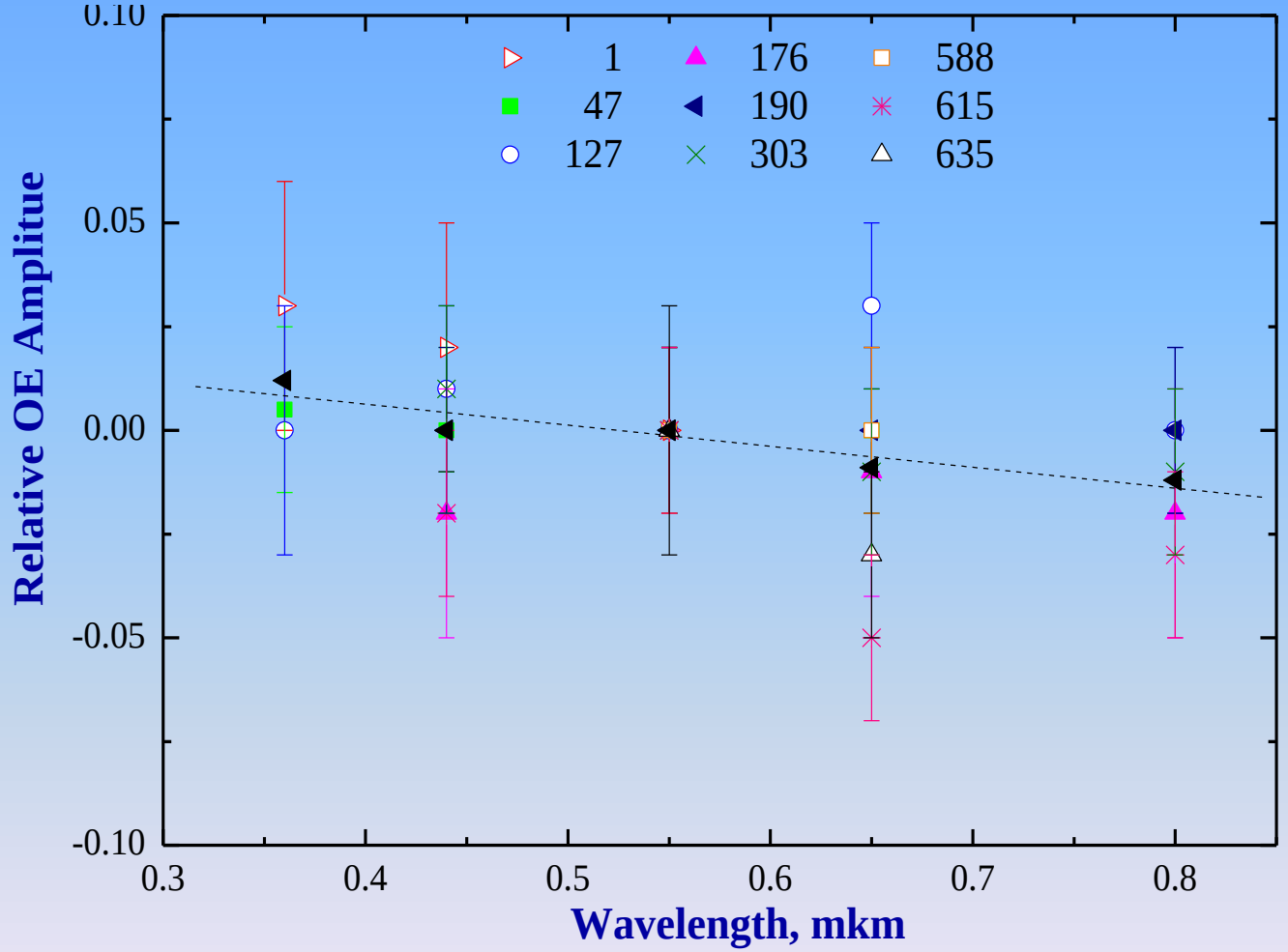


This correlation can be explained by an increase of a portion of light substance in the surface layer of asteroids, which increases both the opposition brightening and the UV spectral slope.

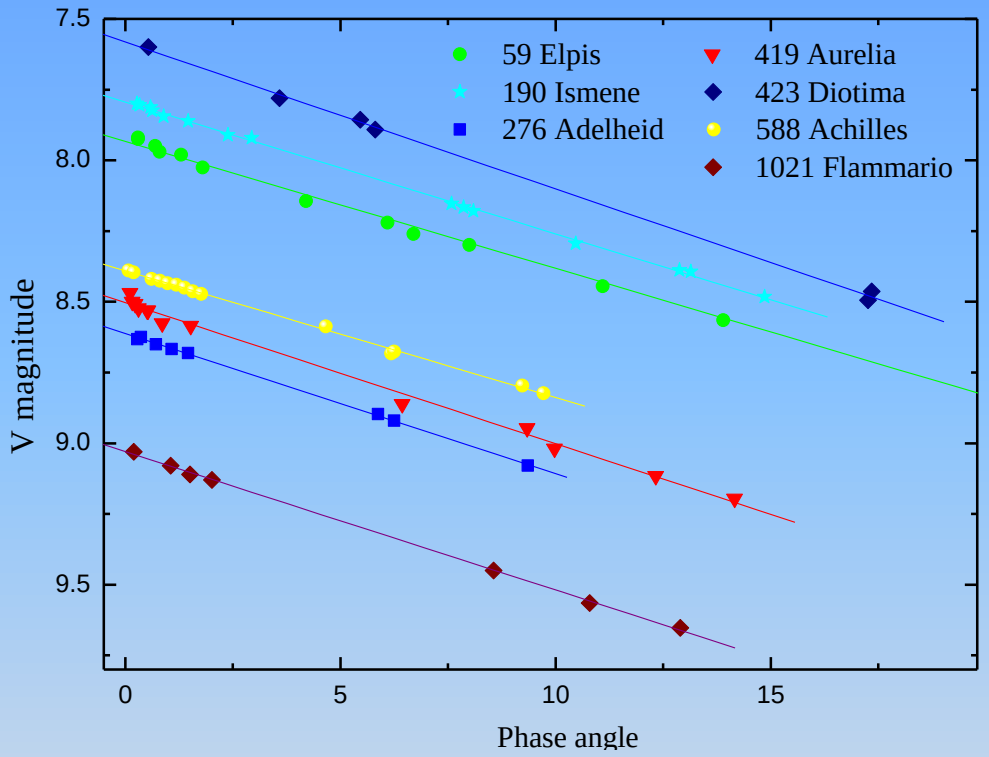
This assumption is confirmed by the observed correlation of the OE amplitude and albedo. The OE amplitude tends to increase when albedo increases. The trend is opposite to that expected for the shadow hiding mechanism and gives an evidence that a non-linear increase in brightness at small phase angles is caused by other physical mechanisms.

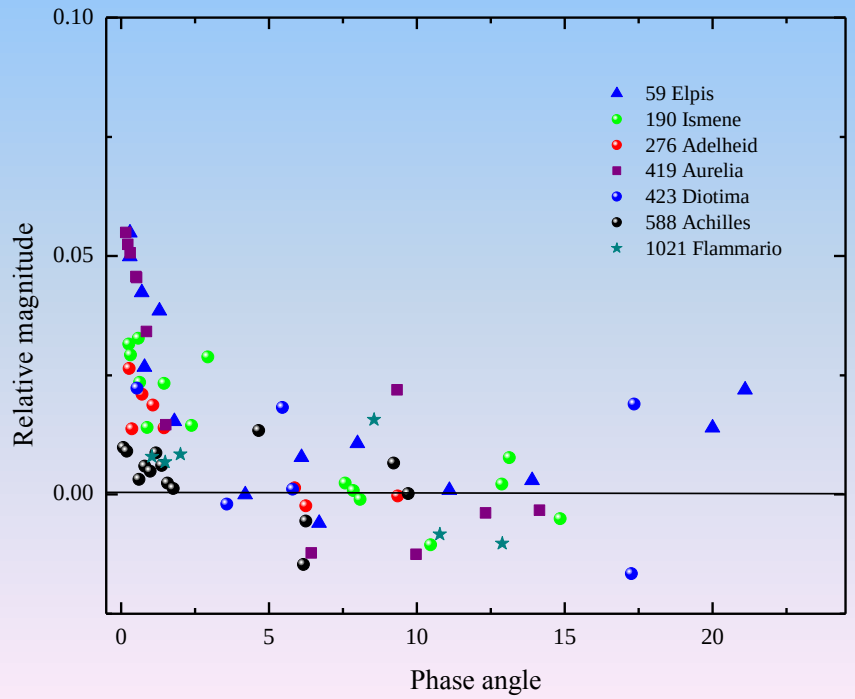


Analysis of possible dependence of the OE amplitudes on wavelength in UBVRI spectral range for nine low albedo asteroids showed only small variations and a slight trend to the OE decrease with increasing wavelength.

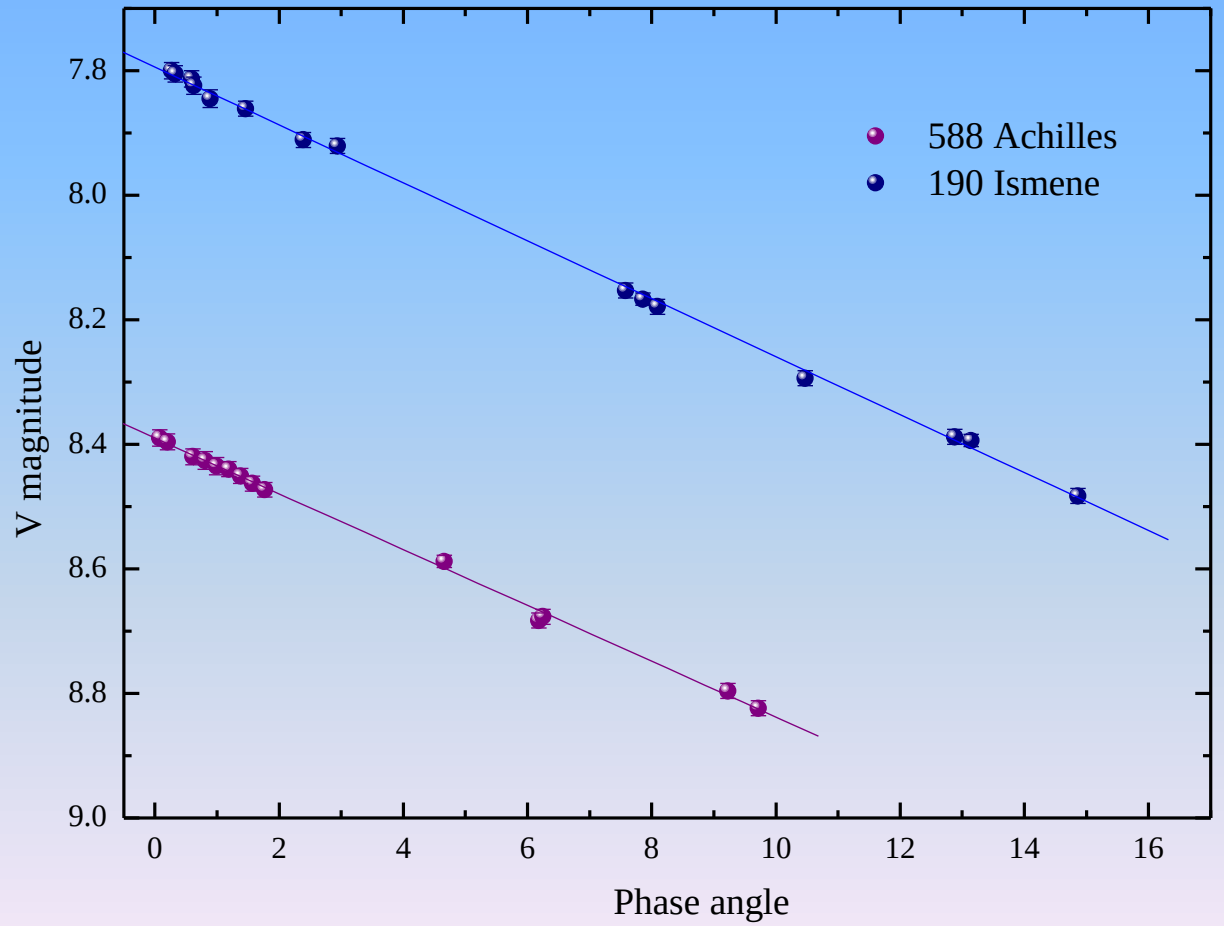


The asteroids with very small OE amplitude (if any) present additional interest for investigations of their regolith properties. At present only seven such asteroids are known.





Two asteroids from this dataset belong to Hilda group (190 Ismene) and Trojans (588 Achilles). We have performed new observations of Trojans. The magnitude-phase relations 884 Priamus and 1143 Odysseus did not show OE amplitude larger than observational errors. An absence of OE is probably typical for these distant asteroid groups.



Conclusions

1. Low albedo asteroids show considerable diversity in the opposition effect behaviour which implies different surface properties.
2. Correlation of the opposition effect amplitude and the UV spectral slope has been found for dark asteroids.
3. The opposition effect amplitude tends to increase when albedo increases which is opposite to that expected for the shadow hiding mechanism. The darkest asteroids do not show non-linear opposition brightening in their magnitude phase dependences.