

# Asteroid polarimetry as a tool to distinguish rare taxonomic types

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## Abstract

The majority of asteroids observed so far show polarimetric phase angle behaviours close to the average phase curve of the corresponding class. Using polarimetric data it is possible to distinguish several types of asteroids which are difficult to distinguish based on spectral data alone.

## 1. Introduction

Polarimetric measurements can be an effective tool for asteroid taxonomy. It was shown that with respect to spectral reflectance data, polarimetry provides a complementary approach to asteroid classification [1,2]. Extensive observational campaigns in the last decade considerably increased the number of asteroids with known polarimetric measurements (e.g. [3-5]). We have analysed the available data to compare the polarimetric parameters of the main composition classes.

## 2. Results

We looked through all data [5,6] and selected the measurements in the V and R filters, and also in the G-filter which is close to the V filter. We consider only those measurements of linear polarization having an accuracy  $\leq 0.2\%$  (with a few exceptions for  $P_r \geq 2\%$  for which  $\sigma \leq 0.3\%$  was accepted). The final data-set includes measurements for 337 asteroids. We have plotted the combined polarization phase curves for main compositional types of asteroids. For the purpose we consider only those asteroids for which classifications are unambiguous and compatible in various taxonomic schemes. We found that the majority of asteroids measured so far show polarimetric behaviour very close to the average

polarization phase curve found for the corresponding taxonomic class. There are less than 10% asteroids whose polarimetric properties noticeably deviate from the average polarization phase curve. The obtained average polarization-phase dependences for a particular compositional type are shown in Fig.1 and Fig.2. Different polarimetric behaviors for different asteroid classes are well-seen. Moreover, asteroids of similar albedos (e.g. P and F, K and L, A and V types) may have different polarization curves.

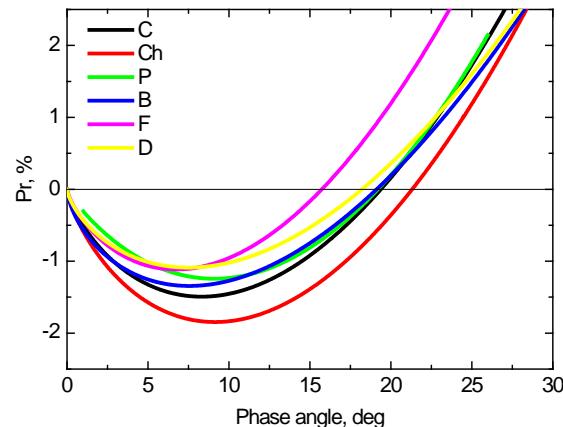


Figure 1: Average polarization-phase curves for low albedo taxonomic types.

**Low-albedo types.** Polarimetric properties of the F-type asteroids are completely different from other classes due to their unusually small inversion angles (Fig.1). The Ch and Cgh classes are characterized by the deepest negative polarization branches. Asteroids of the C and P classes have similar inversion angles but different depth of negative polarization which can be used to distinguish between them. The D-type asteroids show the smallest depth of negative

polarization like F-asteroids, but larger inversion angles.

**Moderate-albedo types.** Asteroids of the S-complex have rather homogeneous polarimetric properties. The M-type asteroids have deeper and wider negative polarization branch compared to the S- and K-type asteroids. Asteroids of K- and L-types show different polarization curves and can be distinguished on the basis of polarimetric behaviour alone (Fig.2). Deep negative branch with extremely large inversion angle is a distinct feature of the majority of measured L-type asteroids.

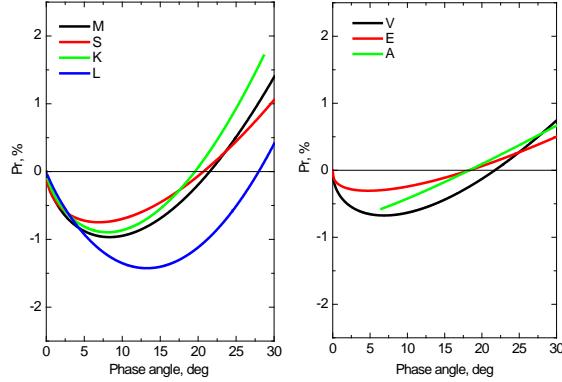


Figure 2: Average polarization-phase curves for moderate (left) and high-albedo (right) taxonomic types.

**High-albedo types.** The measured E-type asteroids show very similar polarization phase-angle behaviors while the diversity within the A class is evident. The average phase curve for the A-class is not well-defined due to lack of observations at small phase angles. The V-type asteroid (4) Vesta has a wider negative polarization branch compared to E and A-classes.

### 3. Conclusions

We have shown that using polarimetric data it is possible to refine asteroid taxonomy. The polarimetric data allow to distinguish low, moderate and high-albedo types within the X-complex, and Ch, F, L, K asteroids characterizing by particular polarimetric properties. The observed similarity of the polarization phase curves for asteroids belonging to the same taxonomic class suggest that polarimetric behaviour is intimately related to surface composition.

### References

- [1] Goidet-Devel, B., Renard, J. B., and Levasseur-Regourd, A.-C. Polarization of asteroids. Synthetic curves and characteristic parameters. *Planet. Space Sci.*, Vol. 43, 779-786. 1995.
- [2] Penttilä, A., Lumme, K., Hadamcik, E., and Levasseur-Regourd, A.-C. Statistical analysis of asteroidal and cometary polarization phase curves. *Astron. Astrophys.*, 432, 1081-1090, 2005.
- [3] Cellino, A., Bagnulo, S., Tanga, P., Novakovic, B., and Delbò, M. A successful search for hidden Barbarians in the Watsonia asteroid family. *MNRAS*, 439, L75-L79, 2014.
- [4] Fornasier, S., Beskaya, I.N., Shkuratov, Yu.G., Pernechele, C., Barbieri, C., Giro, E., and Navasardyan, H. 2006. Polarimetric survey of asteroids with the Asiago telescope. *Astron. Astrophys.*, 455, 371-377, 2006.
- [5] Gil-Hutton, R., Cellino, A., Bendjoya, Ph. Polarimetric survey of main-belt asteroids. IV. New results from the first epoch of the CASLEO survey. *Astron. Astrophys.*, 569, id.A122, 6 pp., 2014.
- [6] Lupishko D. F. 2014. Asteroid Polarimetric Database V8.0. NASA Planetary Data System, EAR-A-3-RDR-APD-POLARIMETRY-V8.0.