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A PHOTOMETRIC SURVEY OF OUTER BELT ASTEROIDS [1]

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ABSTRACT

Since 1989 we have been conducting a research program devoted to the study of the Trojans and outer belt asteroids (Hilda and Cybele groups), in order to characterize their rotational properties and shapes. As an outcome of several observational campaigns we determined rotational periods and lightcurve amplitudes for 23 distant asteroids, using both CCD and photoelectric photometry. In this paper we compare the rotational properties of main belt asteroids and Trojans, based on the preliminary results of this survey.

INTRODUCTION

In the last decade the information on the spectral and photometric properties of the distant asteroids has strongly increased, leading to the formulation of specific questions, the answer to which will enable to draw a comprehensive picture of this class of bodies. Recently numerous observational campaigns, undertaken by American and European groups, have given some intriguing results. In particular, French (1987) and Hartmann et al. (1988) have noted that the Trojans, and possibly the Hildas, display larger lightcurve amplitudes compared to those of main belt asteroids in a similar size range. This empirical evidence has been taken as an indication that the outer belt asteroids have a more elongated shape. Zappalá et al. (1989) performed a study of the rotational properties of the distant asteroids and checked, by means of a formal statistical analysis, their compatibility with those of the main belt. These authors comfirmed the occurence of a deviation in the distribution of the lightcurve amplitudes of the outer belt asteroids, when compared with that of the main belt. However, until now no general consensus has been reached on the statistical significance of this deviation. Furthermore, no plausible mechanism explaining the observed elongated shapes has been proposed yet.

In order to characterize the rotational behaviour of the outer belt asteroids with a better statistical significance, we started in 1989 a systematic observational survey of the asteroids belonging to the Trojan, Hilda and Cybele groups (Mottola et al., 1990; Gonano et al., 1991). This survey has so far yielded high quality new photoelectric and CCD lightcurves of 23 outer belt asteroids (see Table 1), collected at different observatories in Italy, Germany, USA and Chile.

The high photometric accuracy of the collected data and their good time-sampling allowed us to compute reliable amplitudes, periods and Fourier coefficients for most of the lightcurves.

[1] Based in part on observations collected at the European Southern Observatory, La Silla (Chile).

Table 1. List of the observed outer belt asteroids

Asteroid	Group	Asteroid	Group	Asteroid	Group
617 Patroclus	Tro	3564 Talthybius	Tro	1180 Rita	Hil
1143 Odysseus	Tro	3596 Meriones	Tro	1748 Mauderli	Hil
2207 Antenor	Tro	3708 1974 FV1	Tro	1902 Shaposhnikov	Hil
2759 Idomeneus	Tro	4035 1986 WD	Tro	4196 1982 SA 13	Hil
2893 Peiroos	Tro	4086 1985 VK2	Tro	87 Sylvia	Cyb
2895 Memnon	Tro	4348 1988 RU	Tro	909 Ulla	Cyb
3317 Paris	Tro	4709 1988 TU2	Tro	1280 Baillauda	Cyb
3540 Protesilaos	Tro	1989 CK1	Tro		

PRELIMINARY RESULTS OF THE SURVEY

In this paper we compare the distributions of the rotational periods and the lightcurve amplitudes of Trojan asteroids with the distributions of a selected sample of main belt asteroids. As a reference group we chose a sample of main belt asteroids in the diameter range 40 - 150 km from the Asteroid Photometric Catalogue (Lagerkvist et al., 1989). Particular care has been devoted to the selection of the reference sample, in order to limit the incidence of the observational bias present in the catalogue (see discussion in Binzel et al., 1989). The sample of Trojan asteroids we used for the analysis of the rotational period distribution is based on the present results of our observational survey and also includes several objects observed by French (1987), Hartmann et al. (1988), Zappalá et al. (1989), Hartmann and Tholen (1990) and by others.

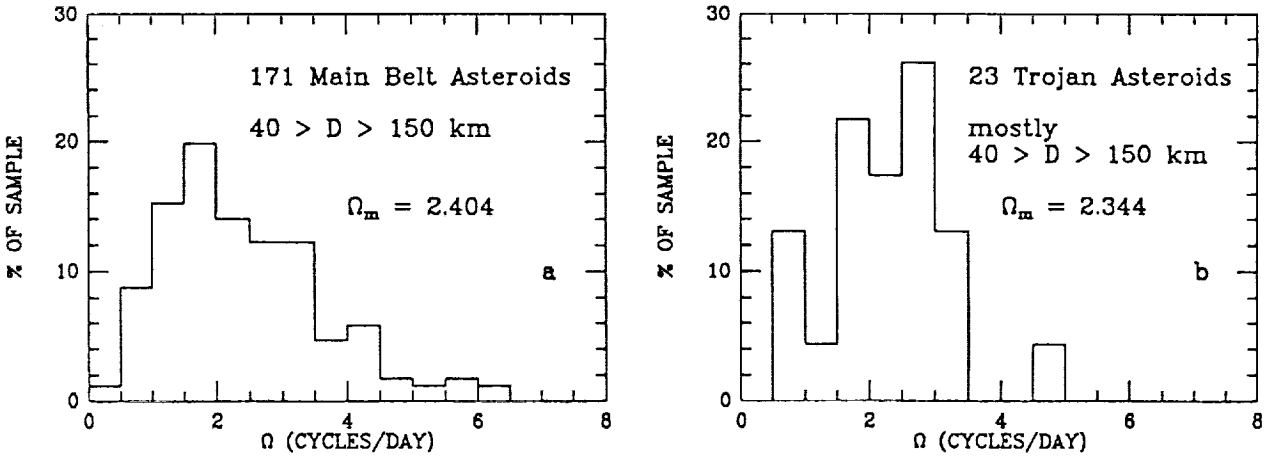

Fig. 1a) Histogram of the rotation rates for a sample of main belt asteroids, where the range of 0 to 8 revolutions/day has been divided into 16 equal bins. b) The same as a) but for the Trojan asteroids with known rotational period.

Figures 1a and 1b show the histogram of the rotational frequencies of a reference group of 171 main belt asteroids and that of 23 Trojans, respectively. By applying the Kolmogorov-Smirnov

test, we have checked the null hypothesis that the two observed distributions derive from the same population. The result of the test is that the two distributions cannot be distinguished at the 90% confidence level.

We similarly compared the distribution of the lightcurve amplitudes of 16 Trojans observed during this survey and of a reference group of 175 main belt asteroids (see Fig. 2a, b). To account for the fact that the main belt asteroids are normally observed at larger solar phase angles than the distant Trojans, we have reduced the observed amplitudes of the MBA group to zero phase angle by using the Amplitude-Phase relationship (APR) described by Zappalà et al. (1990). Also in this case the Kolmogorov-Smirnov test gives $Q \ll 90\%$, indicating that no systematic difference between the two distributions is detected with this data sample. It is interesting to note that the distribution of the amplitudes we measured for the Trojans in this survey has a mean value (A=0.21 mag), which is very close to that of the main belt asteroids (A=0.22 mag) in this diameter range.

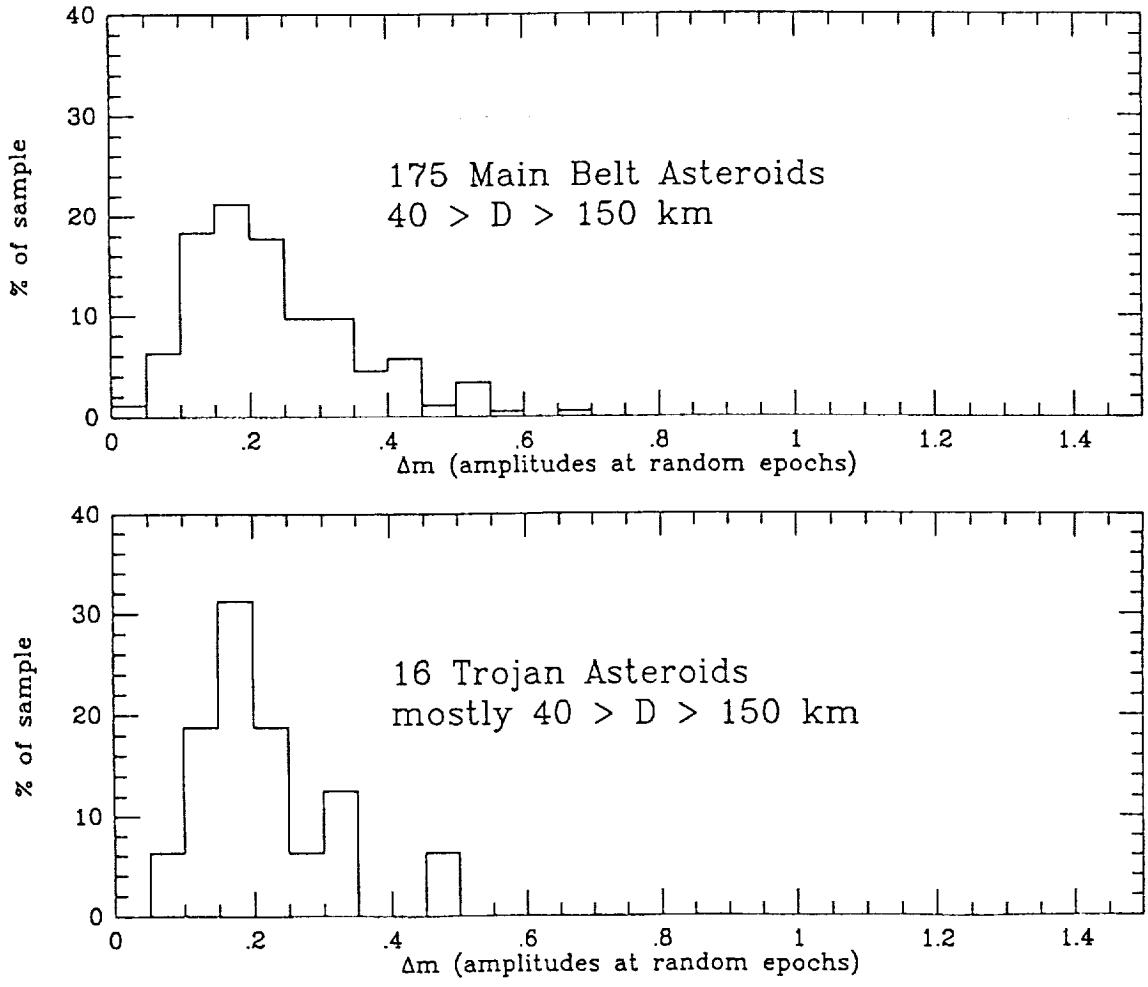

Fig. 2a) Histogram of the lightcurve amplitudes for a sample of main belt asteroids. b) The same as a) for the Trojan asteroids observed during the survey.

In this sense our sample taken by itself does not provide evidence for the presence of anomalously elongated shapes among the Trojans. The survey is still ongoing and its completion will allow to perform a statistically more significant comparison between the rotational periods and lightcurve amplitudes of main belt and Trojan asteroids, which is presently not achievable due to the low number of reliable observations available for the distant asteroids.

REFERENCES

Binzel R.P., Farinella P., Zappalà V., and Cellino A. (1989). In Asteroids II (R.P. Binzel, T. Gehrels, M.S. Matthews, eds.), pp. 416-441. University of Arizona Press, Tucson.

French L.M. (1987) Icarus, 72, 325-342.

Gonano M., Di Martino M., Mottola S., and Neukum G. (1991) Adv. Space Res., Vol. 11, No. 12, 197-200.

Hartmann W.K., and Tholen D.J. (1990) Icarus, 86, 448-454.

Hartmann W.K., Tholen D.J., Goguen J., Cruikshank D.P., and Binzel R.P. (1988) Icarus, 73, 487-498.

Lagerkvist C-I., Harris A., and Zappalà V. (1989). In Asteroids II (R.P. Binzel, T. Gehrels, M.S. Matthews, eds.), pp. 1162-1179. University of Arizona Press, Tucson.

Mottola S., Gonano M., Rebhan H., and Neukum G. (1990). In Asteroids, Comets, Meteors III (C-I. Lagerkvist, H. Rickman, B.A. Lindblad, M. Lindgren, eds.), pp. 151-154. Uppsala universitet, Uppsala.

Zappalà V., Di Martino M., Cellino A., Farinella P., De Sanctis G., and Ferreri W. (1989) Icarus, 82, 354-368.

Zappalà V., Cellino A., Barucci M.A., Fulchignoni M., Lupishko D.F. (1990). Astron.Astrophys., 231, 548-560.