SMALL ASTEROIDS AND COLLISIONAL FRAGMENTS.
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In a cooperative program of the Universities of Arizona and Leiden, the 122-cm Schmidt telescope on Palomar Mountain was used in 1973, 1974 and 1975 to obtain photographic lightcurves of the outer Jovian satellites and of 170 small asteroids in the main belt. This lightcurve survey, undertaken to derive statistics about shapes and rotation periods, may provide the data concerning material strength in the kilometer-size domain. Also it may distinguish between an accretional or a fragmentational history followed by erosion with numerous nondestructive collisions.

The plates taken in 1973 were measured with a Sartorius iris photometer. The lightcurves of the comparison stars gave standard deviations between 0.11 and 0.20 (faint objects). Fourier analysis provided a fixed rejection level for periodicity. Twenty-two out of 96 objects showed evidence for sine waves in their lightcurves. The plates taken in 1974 and 1975 contain Jupiter and its outer satellites VI-XIII as well as asteroids. Variable background fog caused by Jupiter complicates the calibration of the magnitude scale and therefore only the derived periods are used in this preliminary reduction stage. A measuring machine called ASTROSCAN (Blansjaar and van Kuijenburg, 1975), made the measurements of about 170,000 images possible in a reasonable time. The measurements show an improvement over common iris measurements in the standard deviations by about 30%. This was mainly due to the small stellar images with grainy shoulders, which cause severe centering errors with the iris photometer. With the ASTROSCAN, the center of the image was found with off-line software, and the central density was used as a photometric parameter.

It is assumed that a periodic lightcurve with two maxima and two minima is caused by an object having of elongated shape, uniform reflectivity over its surface, and rotating around a fixed axis in space (the subject is generally reviewed in Gehrels, 1970). The relation between the amplitude of the lightcurve and the shape of the object is influenced by the inclination of the rotation axis. If we furthermore assume a Gaussian distribution of the inclination of rotation axes, then, with a sufficiently large sample, there is a direct relation between shape and amplitude. With these assumptions the total sample of 170 asteroids yielded 53 rotation periods and, in the present stage of the reductions, lightcurve amplitudes larger than 0.2 for 22 objects. Figure 1 gives the amplitude histogram for the asteroids numbered 1 to 25. This is a fully studied and completely reported sample with a mean size of about 100 km. The histogram for the belt objects of 1-km size is derived from iris photometer measurements of plates taken in November 1973. It appears that the distribution of the shapes of the 1-km belt asteroids lies between the distributions for the 100-km objects and the Mars crossers. For the Jovian satellites, only number VI (Himalia) showed a detectable lightcurve. Figure 2 gives the period histogram for the same bright asteroids. The histogram for the 1-km asteroids shows the period values for the objects...
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observed in 1973, together with preliminary values for 1974 and 1975. It is evident that the objects in the asteroid population with small sizes on the average rotate faster than the larger objects.

The observational tendencies could be explained by the following process: After a destructive collision between equally sized objects in the belt, it is assumed that the fragments have the same rather elongated shapes as the Mars crossers. The fragments not removed from the belt were exposed to persistent erosion by numerous semi-destructive collisions with smaller bodies. With this assumption the observations seem to lead to the conclusion that this erosion process makes elongated objects more spheroidal and that it accelerates the rotation. The Mars crossers, not exposed to the erosion process, have still their original shapes and rotation period.

Literature:


Harris, A.W. (1977), 'Comments on Asteroid Rotation', to be published.


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Fig. 1. Histograms for lightcurve amplitudes. The dashed line gives the shape of the upper histogram, and it is copied in the middle histogram. Other Mars crossers, not included in the lower histogram, are known from incidental measurements indicating amplitudes between 0.5 and 1.5. The shape distribution for the 1-km objects appears to lie between those of the 100-km objects and the Mars crossers.

Fig. 2. Histograms for rotation periods. The dashed vertical line indicates the mean of the distribution. The 1-km objects appear to rotate faster than the 100-km objects.