taken in exactly the same way as the stellar plates. Of course, the ETA spectrograph will remain in use if one prefers to expose calibration plates during observations. The movements of these new deckers will be controlled by accurate encoders.

We then arrive at the spectrograph shutter. The old mechanical shutter has been replaced by a motorized one which permits it to be linked to the exposure meter; if the shutter is closed, the exposure meter will be turned off. This avoids the accumulation of dark counts on top of the measured stellar signal. On cloudy nights (very rare) this is very useful if one is forced to make interruptions in the stellar exposure. The old exposure meter is still in use but will soon be replaced by a new one, identical to the one at the CES spectrograph which permits dark current subtraction. The photomultiplier tube will remain the same.

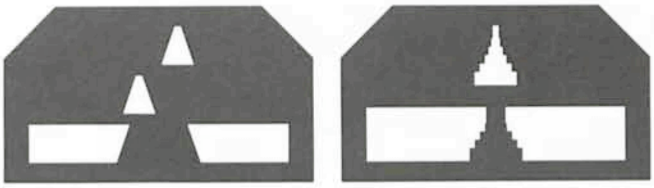

Fig. 2: *The two new deckers of the coudé spectrograph.*

The last modification planned for the spectrograph will be the motorization of the movements of cameras 1 and 2. This will be of help to night assistants when short exposures are done. Since the motors will in general move the cameras more gently than human hands, the danger of misalignments of the cameras' optics (mainly the mirror) will be reduced.

Fine Structure Lightcurve of (51) Nemausa

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From the beginning of the discoveries of minor planets in the last century their brightness has been a subject for study. For astronomers mainly interested in variable stars and stellar magnitudes, the minor planets could be a useful tool for transferring the magnitude scale uniformly over the sky. From the observational point of view, minor planets were like variable stars with light variations which could be computed from the distances to the Sun and the Earth. However, at that time the stellar magnitude scale was arbitrary and based only on subjective estimates. It was therefore necessary to determine the ratio of light corresponding to a difference of one unit of stellar magnitude. We owe the magnitude scale of our time to N. Pogson, who in his ephemerides of the brightness of 36 minor planets for the year 1857 (1) adopted a light ratio of 2.512 for the difference of one magnitude.

When F. Argelander in 1854 discussed the brightness of minor planets (2) he recommended minor planet magnitudes to be thoroughly investigated. He gave a list of diameters which are surprisingly accurate for the 18 S-type objects it contains. One of the reasons given by Argelander for studying the brightness of minor planets was that *all* information about the circumstances of an observation may possibly be used for increasing the accuracy of the position! It is exactly an improvement of the positions we have in mind by the lightcurve observations of (51) Nemausa.

(51) Nemausa was selected by B. Strömgren at the Copenhagen observatory in 1939 for the purpose of improving the fundamental star catalogues. Resulting from the requests for observations many series of precise photographic observations are now available and their residuals seem to indicate a systematic displacement of the observed photocentre towards the illuminated side of the body. This means that precision has reached a level where the diameter, of order $0\overset{\prime\prime}{.}15$, and the flattening of the body can no longer be ignored.

At present we do not even know which side of the body is facing the observer at a given moment, so a first step must be to determine the sidereal period of rotation and the axis of rotation with an accuracy which allows us to compute ephemerides for physical observations.

It is planned to secure very precise positions in the future by having (51) Nemausa observed by the astrometric satellite "Hipparcos", and by observations of occultations of stars which will have their positions observed by the satellite. The mission length of the satellite is expected to be less than the orbital period of minor planets but by the use of occultations this interval will effectively be extended. If size and shape of the planet are known, the occultation observations can be reduced to the centre of mass of the body and an occultation will provide a more accurate position than a direct observation. For this purpose all occultations of catalogued stars by (51) Nemausa until the year 2017 have been found by Gordon E. Taylor, Herstmonceux.

Although occultations are rare events, an occultation of SAO 144417 has already been successfully observed in the U.S.S.R. on August 17, 1979. Due to the accuracy of the orbit and of the star, which happened to be a Southern Reference Star, the error of the prediction was only 90 km and the ground track was predicted long in advance of the event. The derived diameter was $D = 153 \pm 7$ km (3). The determination of size and shape of the body by the powerful tool of occultations is greatly facilitated by a good orbit and vice versa, – if size and shape are known, an occultation gives a position with an accuracy equal to that of the star, so the orbit can be much improved if the position of the star has the high accuracy of "Hipparcos".

One of the occultations found by G. E. Taylor is especially favourable and will occur on 1983 September 11. It is the occultation of the bright star 14 Psc of visual magnitude $5\overset{m}{.}9$ which will be visible in the densely populated eastern part of the United States. Hopefully, many observations at this rare occasion will be secured, so that a detailed profile can be determined, it may even happen that the silhouette could explain why the lightcurve has *three* maxima.

A campaign of photometric observations of (51) Nemausa has been initiated in 1980/81 and coordinated by H. J. Schober, Graz, with the ultimate aim to determine the pole, flattening and sidereal period (4). The observations now to be described continue this programme.

The observations were made with the ESO 1 m telescope and single-channel photometer during the two periods March 19–25 and April 2–5, 1982. The time was chosen well in advance of the date of opposition, May 3, 1982, in order to

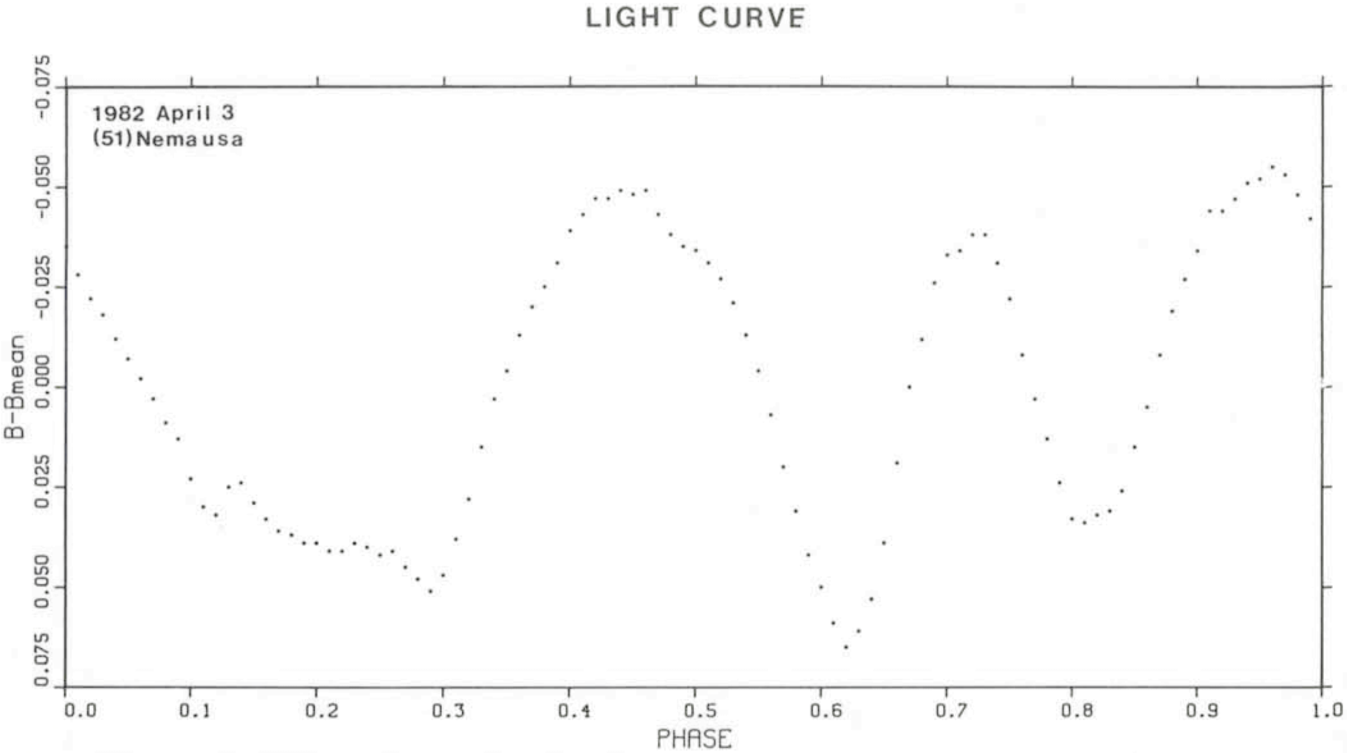

Fig. 1: *Lightcurve of minor planet (51) Nemausa. The B magnitude is given relative to the mean over a period of rotation. The phase is zero at the arbitrary date 1982 April 3 3^h30^m U. T.*

facilitate a continuous count of cycles since the previous opposition by making the time interval to be bridged as short as possible. The planet was stationary on March 22, so the daily motion was small at the time of observation; this makes the observed synodic period an approximation to the sidereal period. However, a disadvantage of observing far from opposition was that only a part of a revolution could be covered during a night.

The quick off-set facility of the telescope controle system was used to make differential photometry between (51) Nemausa and two nearby comparison stars, HD 133352 and HD 134088. The observations, generally in B, of the planet, star and sky background were stored on magnetic tape. The total number of observing hours was $22^h.2$ and the number of Nemausa observations was 4,123 of which 48 were rejected. The integration time was generally 10 sec giving the possibility to detect rapid variations. The comparison stars were chosen sufficiently close in position and colour that errors due to different airmass will not exceed $^m.001$. The mean error of a single differential observation is $\pm$ $^m.005$.

Also a number of observations were made in order to obtain UBV magnitudes of the comparison stars and of (51) Nemausa, using E-region standard stars.

The 4075 differential observations were analysed by a rigorous least squares adjustment solving for: (1) the synodic period of rotation, (2) one hundred equidistant points defining the lightcurve by interpolation, (3) the linear phase coefficient, (4) the colour index B−V, and finally, (5) the difference between the magnitudes of the comparison stars.

The main results of the 4,075 differential observations are the period $7^h.7845 \pm 0^h.0011$ and the lightcurve shown on Fig. 1. The lightcurve gives the B magnitude relative to its mean value over a period as a function of phase. The phase is arbitrarily chosen as zero at the epoch 1982 April 3 3^h30^m U.T. which is near the mean epoch of all observations. The curve clearly displays the strange three maxima already found by Chang and Chang (5); the period found in that work was $7^h.785$ the accuracy of which is confirmed by the present results. Three points on the lightcurve, viz. phases $0^P.98$ to $1^P.00$, were unfortunately not covered by the observations and are here the results of an interpolation. Except for the neighbourhood of these points the statistical error of the points on the lightcurve is of the order of $\pm$ $^m.001$ so the fine structure features at for instance the phases $0^P.29$ and $0^P.48$ are real. There are, however, systematic effects in the residuals at the $^m.005$ level which may probably be due to the changing phase and aspect.

The differential observations determine the linear phase coefficient (in B) with a high formal accuracy $^m.0358 \pm$ $^m.0002$ mag/deg. This result may, however, be affected by unknown systematic effects due to the changing aspect angles.

The UBV magnitudes of Nemausa were obtained in two different ways. First the direct standard photometry of Nemausa was reduced for the phase angle and lightcurve variations. Secondly the UBV magnitudes of the comparison stars were combined with the results of the 4075 differential observations. The two methods gave consistent results. For the mean of B over a rotation period we obtain $\overline{B}$ (1,0) = $8^m.556 \pm$ $^m.007$. The colour index seems to be constant during the half period over which V magnitudes were obtained, B−V = $^m.788 \pm$ $^m.005$. No differential photometry was made in U, but standard photometry of Nemausa gave U−B = $^m.494 \pm$ $^m.007$. The mean value of the phase angles of all the observations is $14^\circ.6$ and the mean of the times of observations is April 2.71 corresponding to the position: $\alpha = 15^h02^m$, $\delta = -7^\circ$ (1950.0), by which the aspect is determined. The mean errors given for the magnitudes are based on the internal scatter of the measures.

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