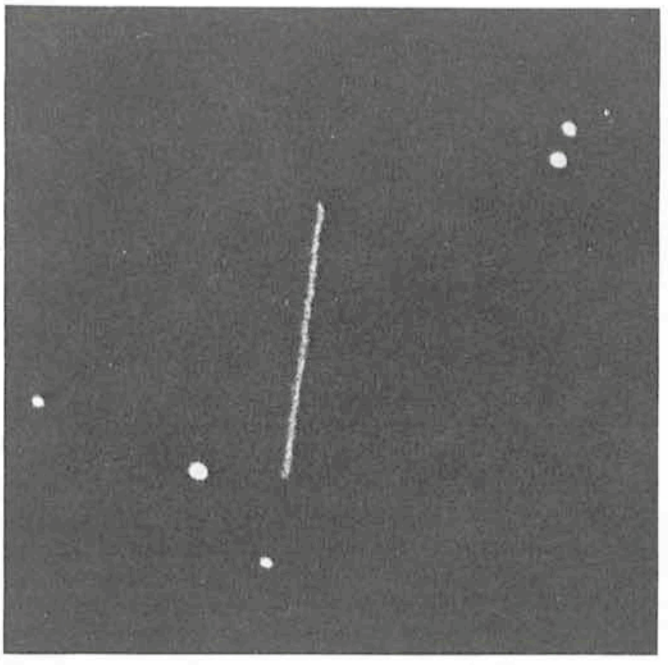

1978 CA: Trail on a 15-min exposure with the ESO Schmidt telescope on March 1, 1978.

1978 DA: Trail on a 15-min exposure with the ESO Schmidt telescope on March 8, 1978.

accuracy of this machine (of the order of one micron), the new Perth catalogue that furnished the astrometric standard stars and an improved computer programme, it is now possible to measure about 15 plates per day. The positions of 1978 CA and DA were telexed to Dr. Marsden, who computed the improved orbits the same day.

From then on, other astronomers took over. The two asteroids were moving rapidly and positions were obtained in Australia, Japan and the USA. Other observers measured the objects photoelectrically and radiometrically near their closest approaches on March 8 and 15, respectively. More details about these important observations are given by J. and A. Surdej and J. Degewij in the following articles.

The Orbits

1978 CA is an Earth-crossing minor planet and therefore belongs to the noble family of "Apollos" of which 21 are now known. It follows an orbit slightly larger than that of the Earth with a period of 435 days. The orbit is somewhat inclined to the Ecliptic (26°) and close encounters with the Earth may take place in March and September. Since the period of 1978 CA is close to 6/5 of one year, five orbital revolutions of 1978 CA will take six years and we may therefore expect to have another fly-by in 1984. However, whereas the minimum distance in 1978 was about 19 million kilometres, that in 1984 will be around 28 million kilometres, according to Dr. Marsden.

1978 DA flies in an orbit quite different from that of CA. Since it does not cross the Earth's orbit at 1 A.U.—its perihel is at 1.024 A.U.—it is called an "Amor" planet (a Mars-crosser). Of these 13 are now known. The orbit is rather elongated (the eccentricity is 0.588) and the period is 1,433 days, almost 4 years. We may therefore expect to see 1978 DA again in 1982. Actually, the orbit of 1978 DA is believed to change rapidly, and it is very probable that it was recently (or will soon become) an "Apollo" planet like 1978 CA.

Photometric Observations of 1978 CA and 1978 DA

Jean and Anna Surdej

By modern custom, as soon as a new minor planet has been discovered, it is given a provisional number including the year of its discovery followed by two letters. The first letter indicates the number of the fortnight (A = 1, B = 2, . . .), counted since the beginning of the year during which the first observation was made. The second letter (A = 1st, B = 2nd, . . .) is an incremental number ordering all the observations of minor planets within that fortnight. Since the first new asteroid was found on February 8, it was designated 1978 CA. The second asteroid, discovered on February 17, was named 1978 DA.

Until now, the origin as well as the physical and chemical properties of "Apollo" and "Amor" type asteroids are poorly known. Could, for instance, 1978 CA be the rest of an inactive comet nucleus? Furthermore, it is also not known whether "Apollo" and "Amor" type asteroids resemble certain classes of meteorites and whether they may be associated with the numerous minor planets circling the Sun between the orbits of Mars and Jupiter.

The Observations

Two nights at the ESO 1 m telescope were allotted to us on March 1 and 2, 1978 for UBV photometric observations of 1978 CA and 1978 DA.

On March 1, when 1978 CA (see the photo above left) was crossing the sky at such a high speed rate as 3°5 per

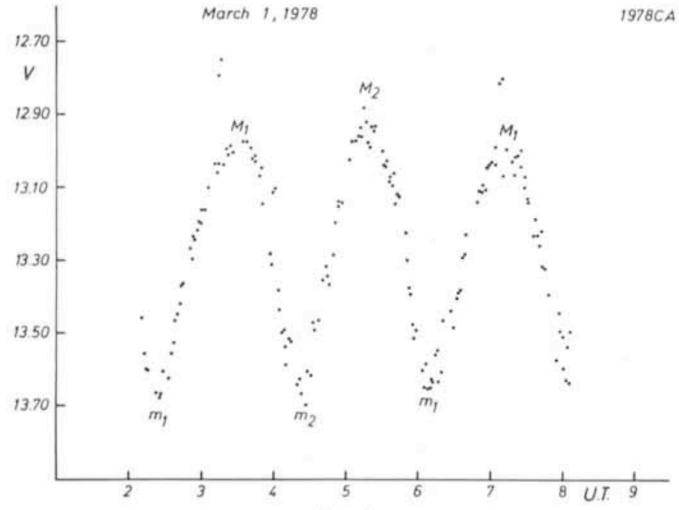

Fig. 1.

day, a complete, periodic light curve could be recorded within 3 hours and 45 minutes. Figure 1 shows these photometric observations in the equivalent Johnson V filter. Such a smooth light curve, nearly symmetric, and with large variations ($\Delta V \simeq 0.8$ mag) is easily interpreted as due to the scatter of sunlight by a spinning, elongated object (rock, ...) around a fixed axis in space (see below!). Roughly, the light minima (m_1, m_2) reflect the two smallest projected areas of the tumbling asteroid, while the light maxima (M_1, M_2) correspond to the two largest areas as seen by a terrestrial observer. The extremely short period of rotation, $P \simeq 3^h 45^m$, places 1978 CA as the third fastest rotator among all known solar objects. "How short are the nights and days!" would have exclaimed Saint-Exupéry's "Le Petit Prince".

The colour indexes of 1978 CA appear redder than one would expect from a Sun-like star, $(B\text{-}V) \simeq 0.90$ and $(U\text{-}B) \simeq 0.48$. The reader will notice the three humps located at around 3.2^h, 4^h and 7^h U.T. in the light curve of 1978 CA. These are associated with the frequent encounters of field stars very close to the trajectory of 1978 CA. As a matter of fact, one encounter even turned out to be a real occultation!

Observations performed on March 2, 1978 resulted in the light curve of 1978 DA (see Figure 2). Because some time was lost when identifying this fast-moving asteroid and because 1978 DA turns around its axis much slower than 1978 CA, we were not able to monitor the light changes

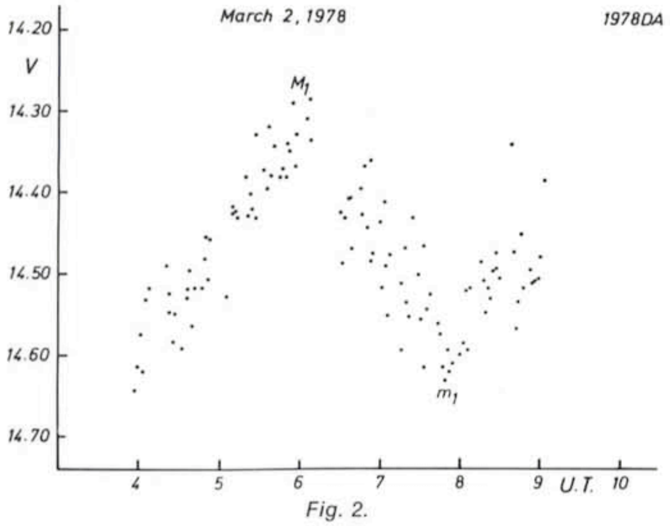

Fig. 2.

during one full cycle of rotation. The colour indexes were found to be B-V = 0.83 and U-B = 0.41.

Asteroid Models

Finally, we shall present below a rapid view on a model which allows an explanation of the light curve of 1978 CA. Simulating the rotation of an asteroid by a three-axis ellipsoidal model and describing the scattering properties of a small surface element by an adequate relation (Hapke-Irvine's), Figure 3 presents several light curves computed at different positions of an asteroid along a hypothetical trajectory. The ellipsoid was turned around its shortest axis and, for the given example, the adopted axis ratio a:b:c was taken to be 5:3:1. Furthermore, all light changes shown in Figure 3 neglect the distance effects (the geocentric Δ and heliocentric r distances were taken as 1 A.U.

Generally, the shape of a light curve will depend not only on the adopted geometrical form of the asteroid, the reflection law of sunlight, etc., but also on the configuration of the observations. For instance, the light curve labelled No. 1 in Figure 3 is that reflected by the spinning ellipsoid as it is viewed pole-on rather than when the pole axis is appreciably inclined to the line of sight (light curves Nos. 9, 10 and 11).

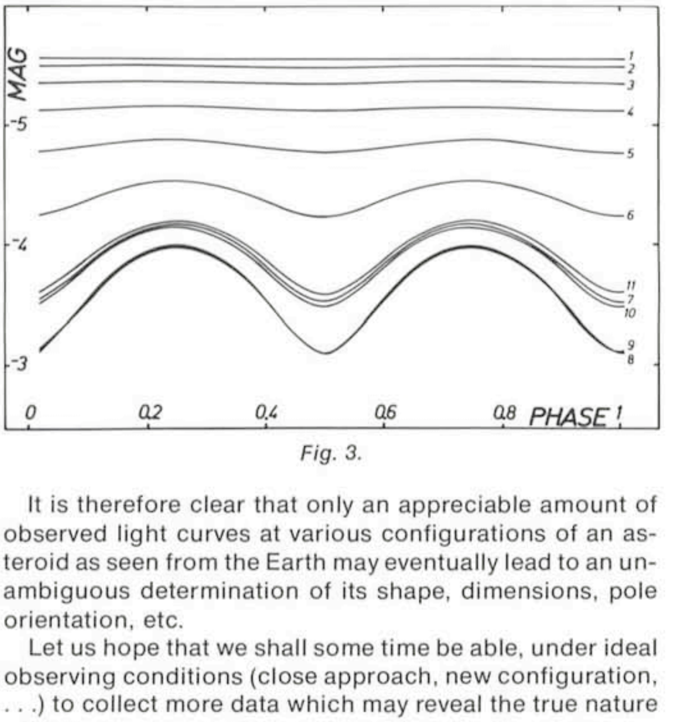

Fig. 3.

It is therefore clear that only an appreciable amount of observed light curves at various configurations of an asteroid as seen from the Earth may eventually lead to an unambiguous determination of its shape, dimensions, pole orientation, etc.

Let us hope that we shall some time be able, under ideal observing conditions (close approach, new configuration, ...) to collect more data which may reveal the true nature of these very unusual asteroids!

List of Preprints Published at ESO Scientific Group

January – April 1978

19. G. CONTOPOULOS: Higher order resonances in dynamical systems. January 1978. Submitted to: *Celestial Mechanics.*
20. A. C. DANKS, J. W. HARTSUIKER: uvbyR Surface photometry of the 30 Doradus region II. February 1978. Submitted to: *Astronomy and Astrophysics, Suppl. Series.*
21. J. BREYSACHER, B. E. WESTERLUND: Wolf-Rayet stars in the Small Magellanic Cloud. March 1978. Submitted to: *Astronomy and Astrophysics.*
22. I. J. DANZIGER, P. G. MURDIN, D. H. CLARK, S. D'ODORICO: Spectra of supernova remnants in M33. March 1978. Submitted to: *Monthly Notices of the Royal Astronomical Society.*