The Close Encounter with 1978 CA and 1978 DA

It was a fine night on La Silla. Astronomers were working with all of the ESO telescopes, scrutinizing the southern skies with spectrographs and photometers and the big Schmidt was busy, taking deep photographs.

It was the night between February 7 and 8. After midnight, ESO astronomer Hans-Emil Schuster put a red-sensitive plate in the Schmidt telescope and settled down to guide during the 90-minute exposure time. The field was in the southern part of the constellation of Hydra (The Water Serpent) and it contained a prominent cluster of galaxies. Later in the morning, the plate was developed and Hans Schuster had a quick check of the image quality, before the plate was to be sent on to the "visiting" astronomer who had asked for it.

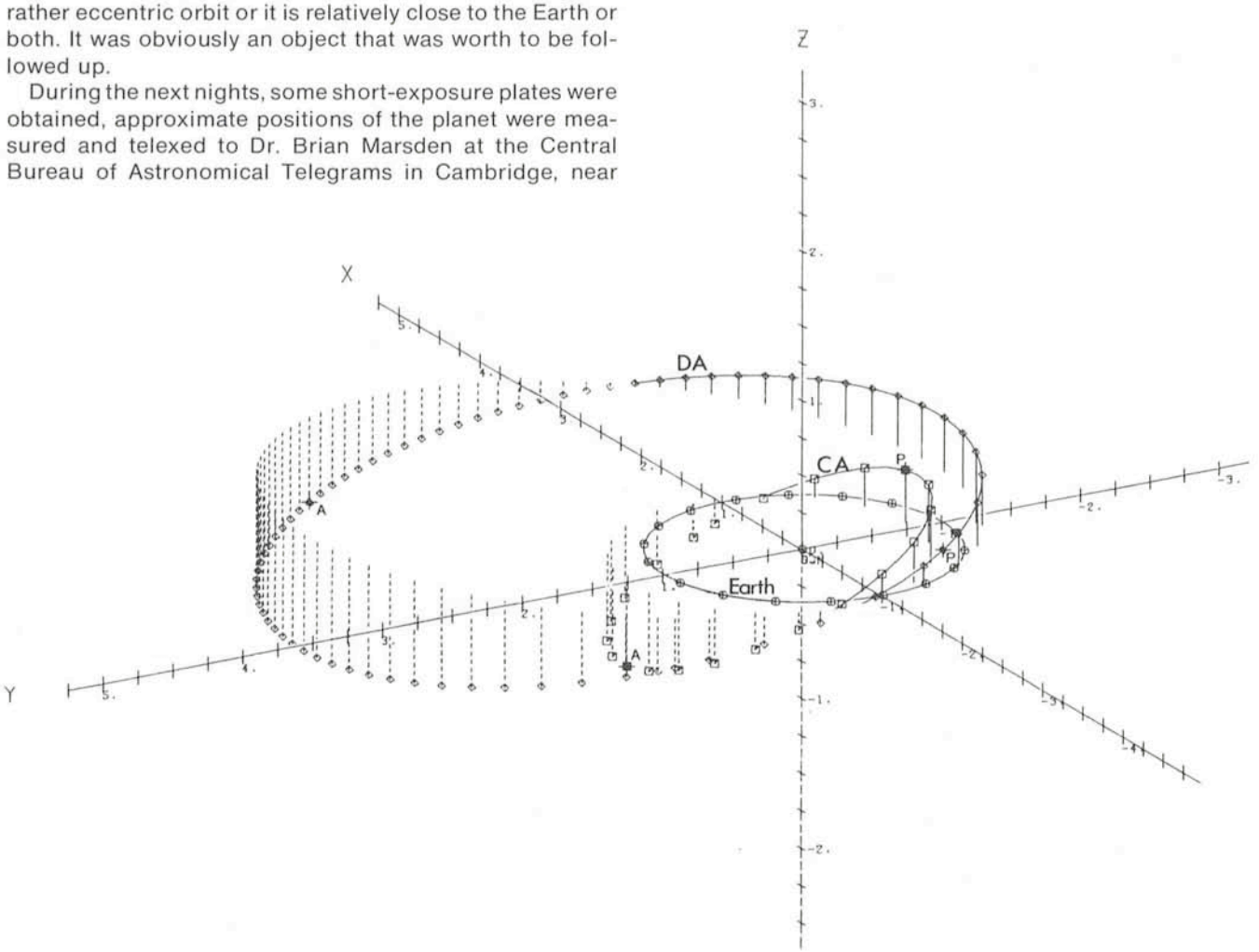
Down in the lower right corner, near the 6^m star HR 4130, he noticed a comparatively faint trail of a minor planet. During the $1^1/_2$-hour exposure, the small planet had moved about 1.8 millimetre towards the north. Trails of this length are not infrequent on long-exposure plates, but two facts caught the attention of the ESO astronomer; the distance from the Ecliptic (about 30°) and the direction of motion, almost due north.

This normally means that either the planet is moving in a rather eccentric orbit or it is relatively close to the Earth or both. It was obviously an object that was worth to be followed up.

During the next nights, some short-exposure plates were obtained, approximate positions of the planet were measured and telexed to Dr. Brian Marsden at the Central Bureau of Astronomical Telegrams in Cambridge, near Boston, Massachusetts. Dr. Marsden calculated a preliminary orbit and could immediately confirm the suspicion that the new minor planet was rather close to the Earth. Improved orbital data later showed the distance to have been 42 million kilometres on February 8. The asteroid was given the name 1978 CA and was evidently rapidly approaching the Earth.

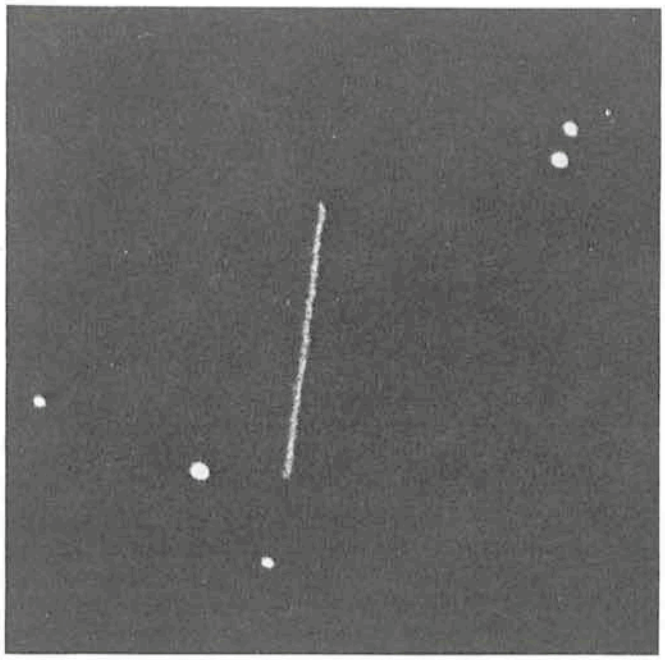
Further plates were obtained during the new moon period and the planet was followed towards north while its daily motion was rapidly increasing. On February 17, due to a minor mistake, the plate was off-set about two degrees to the east, so that 1978 CA was rather close to the *western* edge. Going over the plate, Hans Schuster noticed another very long trail, only 2 mm from the *eastern* edge! There was little doubt that this was yet another Earth-approaching planet, running due east. More plates were taken and a week later Dr. Marsden could confirm that 1978 DA (as the second planet was called) would also come rather close to the Earth.

All available plates were sent from La Silla to ESO/Geneva and were measured accurately on the ESO S-3000 two-coordinate measuring machine. Thanks to the

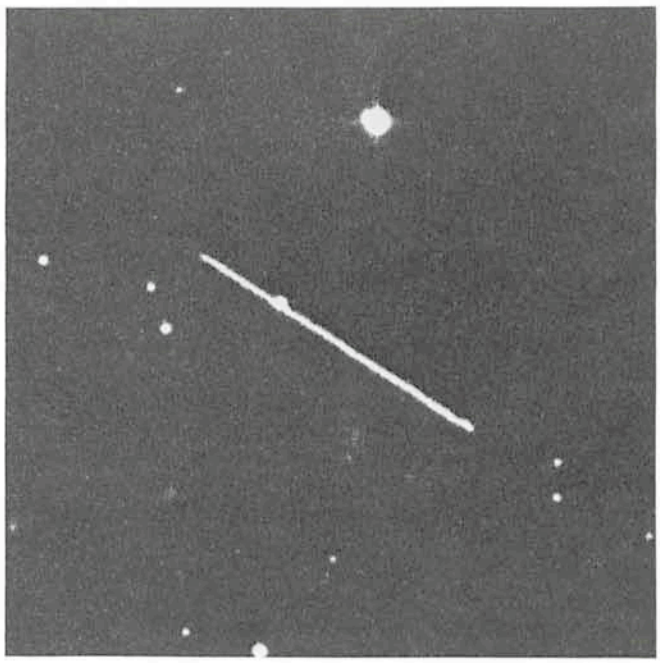


A projection of the orbits of 1978 CA and 1978 DA, as seen from the direction of ecliptical (longitude, latitude) = (150°, +20°). The vernal equinox is in the direction of the X-axis and the Y-axis is perpendicular to the X-axis in the ecliptical plane. The Z-axis points towards the ecliptical north-pole.

The planets are indicated at 20-day intervals. The motions are slower at the aphelia (A) than at the perihelia (P)—in particular for 1978 DA. Only the Earth is shown among the major planets to avoid overcrowding the figure, which was drawn by a Calcomp plotter attached to the ESO/HP system in Geneva. The units are Astronomical Units (A.U.).



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