Short Research Communications :

DISCOVERY OF A NEW SATELLITE OF URANUS

J. C. Bhattacharyya and K. Kuppuswamy

Indian Institute of Astrophysics, Bangalore 560 034

(Received March 29, 1977)

On the night of 10th March, 1977, a near-grazing occultation of the star SAO 158687 by Uranus was expected to be visible at Kavalur Observatory (Marsden 1977). The star has a visual magnitude of 8.8 compared to approximately 6.0 for Uranus. The difficulty of observing the photoelectric light curve of a star fainter than the occulting body by 3 magnitudes was solved by choosing our spectral window in the near infrared. Since the spectral type of the star is K5, the use of an infrared filter greatly reduced the difference in the two brightnesses. A Kodak Wratten 89B filter together with dry ice refrigerated EMI 9558B photomultiplier with extended S-20 photocathode surface was employed to achieve this objective. In this combination the star brightness as measured by the photoelectric device was about a third of the brightness of the entire planet. We followed the event and made a continuous recording for about two hours around the predicted occultation time, when we expected a shallow dip in the intensity due to extinction by differential refraction in the atmosphere of Uranus (Baum and Code 1953). This was eventually observed but in addition, about 40 minutes before the closest approach, we found a sharp dip in the photoelectric record which lasted for 8.9 seconds. We had been following the event visually also in the 20cm guide telescope attached to the 102cm telescope and noticed the sudden disappearance of the star followed by reappearance, synchronous with the photoelectric drop and rise. This event was immediately suspected to be due to occultation by one of the planet's satellites. However, on subsequent calculation of the positions of the known five satellites, we found that none of these are likely to come to the position where we noted the occultation. Only a satellite with an orbit much closer to the planet than that of any known satellite could be responsible for this phenomenon. We, therefore, deducted that it must be due to a hitherto unknown satellite with an orbit which is smaller than that of Miranda, the nearest known satellite of Uranus.

Since the positions of the star and the planet are known with good accuracy we could locate quite precisely the position of this new body, with respect to the planet centre. Taking the most recent positions of Uranus and that of the star, we find that the position of this new body is 4".1 from the planet's centre at a position angle of 349°. Assuming a circular orbit and correcting for foreshortening due to orientation of the axis of the orbit (assumed same as that of the planet), we arrive at a value of 53000 km for its radius. The orbital period, following Kepler's law, is found to be approximately $9^h.5$. The orbital velocity at the moment of occultation is directed almost opposite to the apparent retrograde motion of the planet, thereby reducing the speed of the satellite shadow cone with respect to the observer. This is found to be 2.74 km/sec yielding the length of the chord joining the immersion and emersion points as 24 km.

The fact that the reduction of starlight is only 53% against a total extinction in case of a complete eclipse provides a possible clue to the estimation of the diameter of this new body. The discs of K5, III or V stars, of apparent visual magnitude 8.8 subtend an angle 3.5×10^{-4} arc secs (Allen 1973). An occulatation geometry covering approximately half of the stellar disc by one edge of a spherically smooth satellite satisfies the observed reduction in starlight. The size of the first Fresnel zone at the limb of the satellite is about 1.5 km and expected immersion and emersion times of $0^s.5$ are in conformity with the observed record. Taking these into consideration we estimate the satellites equatorial diameter to be 70 km. Comparing the brightnesses and diameters of other Uranus Stellites the visual magnitude is estimated to be around 19.0.

A brief resume of these findings were cabled on March 11,1977 to the IAU Central Bureau for Astronomical Telegrams at Cambridge, Massachusetts, and has appeared in IAU Circular No. 3048 issued on March 14, 1977.

Note added in proof :

On further detailed analysis of the occultation records, several additional minor features are seen to be present. A few of these features have also been noticed by other observing teams in India and elsewhere. It appears that the planet is encircled by belts of satellites of varying dimensions.

References :

Allen, C.W. 1973, *Astrophysical Quantities* (Athlone Press, London).
Baum, W.A. and Code, A.D. 1953, *A.J.*, **58**, 1208.
Marsden, B.G. 1977, IAU Circular No. 3040, 23rd Feb.