INDICATIONS OF TWIST IN THE EPSILON RING OF URANUS

R. VASUNDHARA and J.C. BHATTACHARYYA

Indian Institute of Astrophysics, Bangalore 560034, India

A comparison of light curves during occultation of stars by ε ring of Uranus indicate that this ring assembly possesses stable fine structures. The light curves observed during several events show almost similar fine structure across its width. Nicholson et al. (1982) quantitatively compared the separation of the five optical depth maxima, and concluded that no systematic variation of the normalised spacing, either with ring segment width or with data of observation was apparent. We have investigated the possibility of this having structure of a twisted bundle of narrow lanes of condensed material similar to that of Saturn's F ring (Ref 4) and report the findings.

To test for the systematic shift of the features along the longitudinal plane of the rings we have resorted to the method of cross-correlation. A pair of light curves of the same event representing two nearby sections of ε ring are compared by sliding one past the other and computing the correlation product between them. For this purpose the region between inner and outer optical depth maxima have been divided into N equal segments. If y_A (I) and y_B (I) are the ordinates of the I^{th} point on the respective light curves, the normalised product.

$$P = \frac{1}{N-J} \cdot \sum_{I=1}^{N-J} \cdot y_A (I) \cdot y_B (I+J)$$ will be maximum for a certain

value of J = Jm, where the integer J denotes the shift of one light curve with respect to the other. The twist angle ϕ in degrees can be estimated from relation.

$$\phi = \frac{Jm \times 180}{N}$$

The technique is adopted in our analysis in comparing the ε ring profiles of three pairs of records chosen in such a way that the sampling points are closely located in time and space.

Fig. 1 shows the (P,ϕ) curves for three events examined for this investigation. Trace I shows the correspondence between two records of March 10, 1977, 'Immersion' event recorded by Bhattacharyya and Bappu (1977) and Millis et al. (1977). The projected separation between the two scanning lines was about 4000 km on the sky plane and the curve indicates that the two patterns are shifted by about 7°.

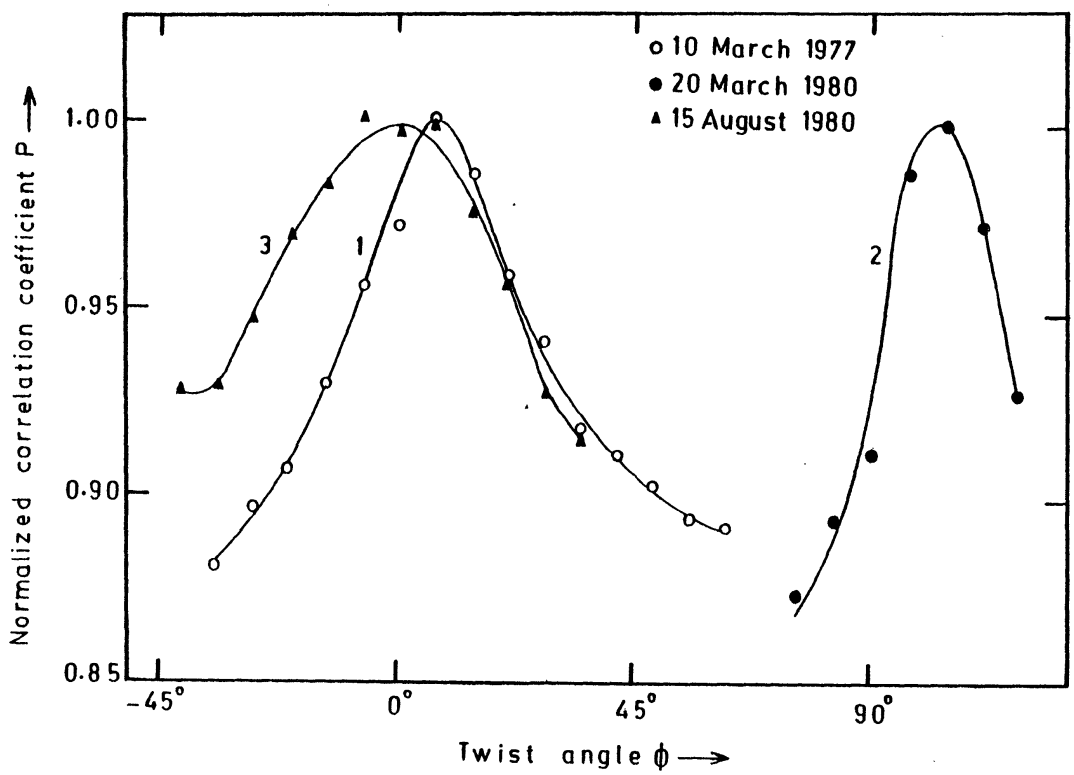

Figure 1

Trace II shows the (P,ϕ) curve for immersion and emersion occultation profiles of March 20, 1980, by Elliot et al. (1981). The occultation points lie on either side of the periapse, the large shift angle is in conforming with the large linear distance between the occulting points. Trace III shows the (P,ϕ) curve for August 15, 1980 occultation, emersion profiles recorded by Nicholson et al. (1982) and B. Sicardy et al. (1982). The distance between the two scans across the ring being very small, the two light curves match very closely, the (P-ϕ) curve indicating no shift of the features. Fig. 2 shows the relation between the angular shift and the distance between scanning points. Table I summarises the results. The angular shift ϕ, and the corresponding distance S, between the two comparison lines along the ring plane are shown. The pitch of the helix as estimated from the data, is shown in the last column.

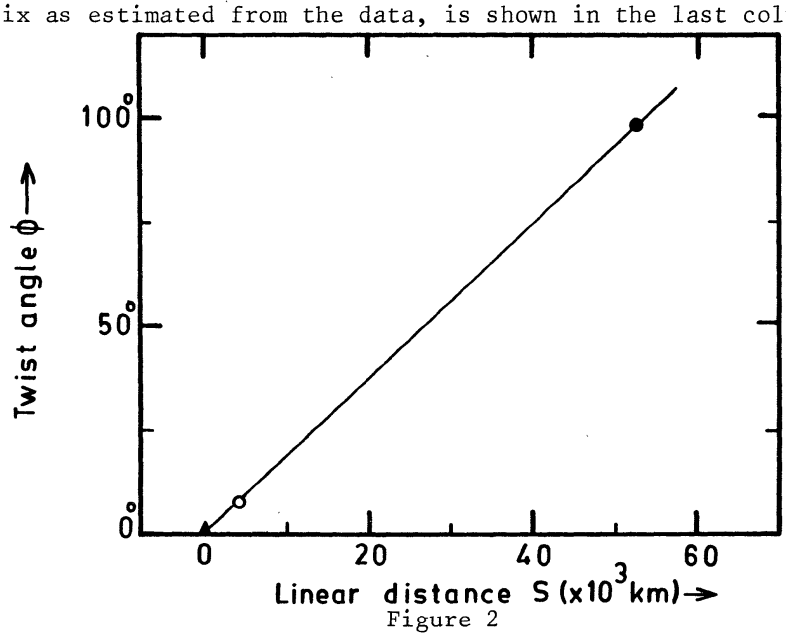

Figure 2

Table I

Event	Date	5 (km)	ϕ (degrees)	h (in 1000 km)
1	10-3-77	3925	6.92	204.1
2	20-3-80	52362	98.33	191.7
3	15-8-80	30	0	-

The comparison indicates that Uranian ε ring subsections may have a twisted structure similar to that of the Saturnian F-ring.

REFERENCES

1. Bhattacharyya, J.C. and Bappu, M.K.V. 1977. Nature 270, 503.

2. Elliot, J.L., Frogel, J.A., Elias J.H., Glass, I.S, French, R.G., Mink, D.J. and Liller, W. 1981. Astron. J. 86 (1), 127.

3. Millis, R.L., Wasserman, L.H. and Birch, P.V. 1977. Nature 267, 330.

4. Morrison, D. 1981. Mercury, Vol. X, No. (6), 162.

5. Nicholson, P.D., Matthews, K. and Goldreich, P. 1982. Astron J. 87, 433.

6. Sicardy, B., Combes, M., Brahic, A., Bouchet, P., Perrier, C. and Courtin, R. March 1982 submitted to Icarus.