The authors are thankful to Dr P. D. Singh of Universidade de Sao Paulo (Brazil) for his keen interest in the work.

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1. Fraser, P. A. and Jarmain, W. R., *Proc. Phys. Soc.*, 1953, A66, 1153.
2. Akerlind, L., *Arkiv for Physik*, 1962, **22**, 41.
3. Herzberg, G., *Spectra of Diatomic Molecules*, 2nd edition, Van Nostrand, New York, 1950.
4. Nicholls, R. W. and Jarmain, W. R., *Proc. Phys. Soc.*, 1956, A69, 253.
5. Meggers, W. F. and Wheeler, J. A., *Nat. Bur. Stand. J. Research*, 1931, 6, 239.
6. Jarmain, W. R., Nicholls, R. W., Parkinson, W. and Robinson, D., *Proc. Phys. Soc.*, 1956, A69, 713.

ONSET OF EQUATORIAL SPREAD-F DURING POST-MIDNIGHT PERIOD

THE presence of diffuse traces on bottomside ionograms (spread-F) is a common feature noticeable during night time at stations within a well defined belt of 40° wide centred on the dip equator[1–3]. The morphology of this phenomenon, referred to as equatorial spread-F, has been studied by several workers using published ionospheric data and ionogram data at various equatorial stations[1,4–10]. It is well known that the first post-sunset onset of equatorial spread-F is closely associated with the rise of the equatorial F-region during that period, the onset occurring around the time of the reversal of the vertical uplift. However, there is no agreed opinion as to the relative importance of the factors associated with the post-sunset onset of equatorial spread-F, *i.e.*, the vertical velocity of the layer and altitude attained. The VHF scatter observations of Farley *et al.*[11] indicate that the bottom of the F-region is to be above some thershold altitude for the occurrence of spread-F in the post-sunset period. The recent detailed studies made by us, both for high and low sunspot activity conditions, however showed the absence of any particular threshold height for the onset of equatorial spread-F, suggesting that the layer height does not uniquely control the post-sunset onset of equatorial spread-F.

In this brief communication, we examine another aspect of equatorial spread-F that has not received due attention namely, its sudden onset during post-midnight period. The study is based on the ionogram data at Kodaikanal (10° 14′ N; 77° 28′ E, Dip. 3·5° N) for a four-year period from 1957 to 1960, corresponding to high sunspot activity conditions (mean sunspot number ≈ 178). Careful examination of the ionogram data showed that on occasions there occurs a sudden onset of the spread-F condition in the post-midnight period, with spread-F whatsoever in the preceding part of the night or with spread-F of short duration that is mainly confined to the post-sunset period. These instances however are very rare with the observation of only 12 clear cut events over the four-year period examined. In Fig. 1 is shown the nocturnal behaviour of h′F (minimum virtual height of the F-region that is widely accepted to represent the height of the bottom of the F-region) on these 12 nights. The level of geomagnetic activity, represented by the 3-hourly planetaryg eomagnetic index Kp, is also shown. The data presented in Fig. 1 exhibit two interesting

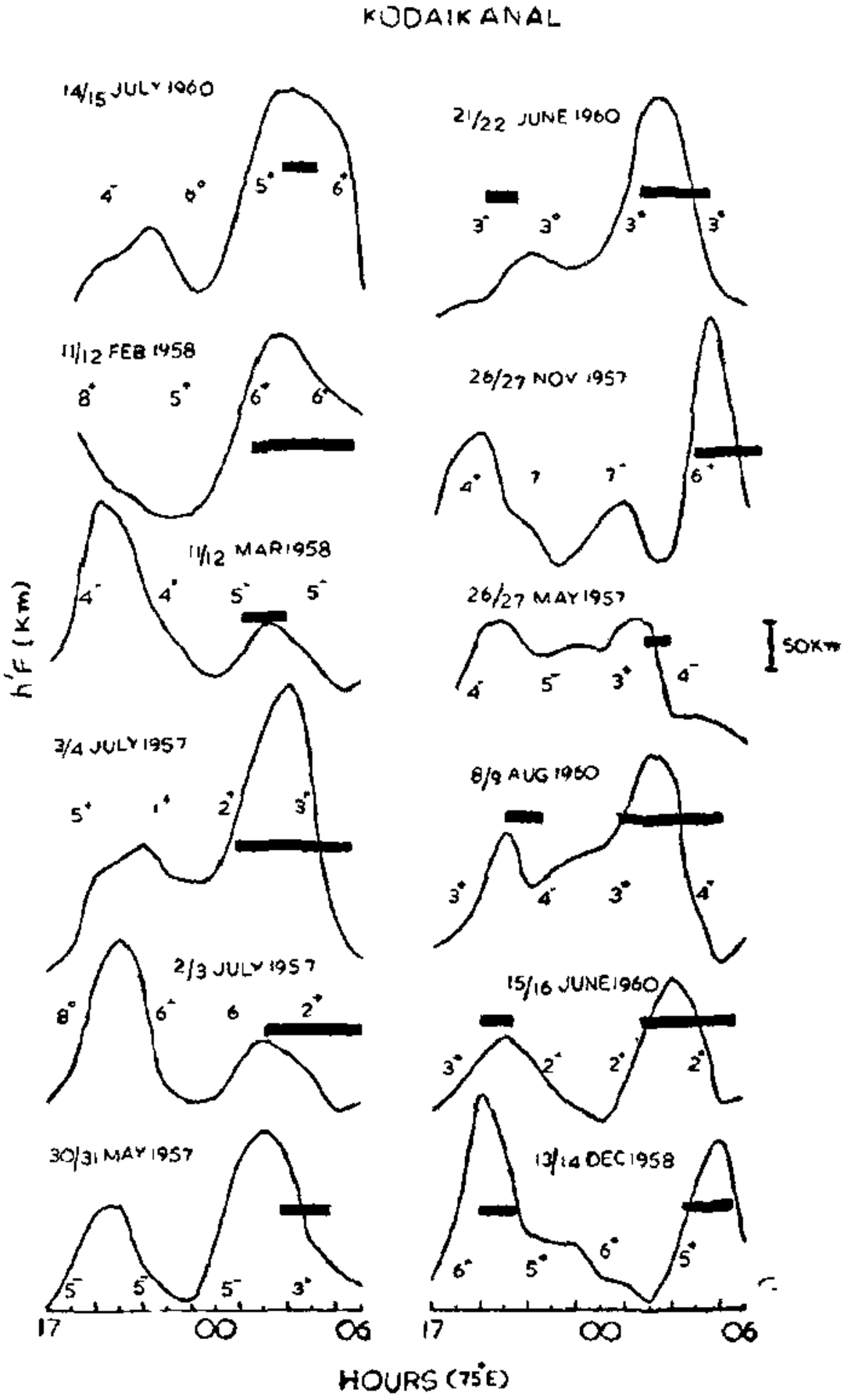

FIG. 1. h F variation at Kodaikanal on nights with a sudden onset of spread-F in the post-midnight period. The shaded areas on the plots indicate the presence of spread-F. Values of the 3-hourly planetary geomagnetic index Kp are also shown.

features. Firstly, on almost all the nights, the sudden onset of spread-F in the post-midnight period is closely associated with a significant increase in the height of the F-region, the onset occurring either before or after the time of reversal of the vertical uplift. There does not appear to be any particular threshold height for the onset of spread-F in the post-midnight period, as it occurred, on individual occasions, at heights ranging from 270 to 560 Km. Secondly, all the nights (with the sole exception of the one of 15/16 June 1960) correspond to either disturbed geomagnetic conditions or preceded by disturbed conditions (Kp $>$ 3°).

The consistent increase in the F-region height noticed with the onset of spread-F in the post-midnight period bears a resemblance to the well-known post-sunset rise of equatorial F-region. This suggests tha the sudden onset might be due to a sudden reversal in F-region vertical drift from its usual downward direction during the night time period. The fact that most of the events were noticed to occur during geomagnetically disturbed conditions lends support to this, as the recent observations of Fejer *et al.*[14] and Rastogi and Woodman[15] show that such night time anomalous reversals in F-region vertical drift occur during disturbed conditions, in association with sudden onsets of equatorial spread-F. However, these observations are for conditions of low to moderate sunspot activity conditions and it is yet to be seen whether su h reversals do occur under high sunspot activity conditions. On the other hand, the statistical analysis of Bowman[16] suggests that the occurrence of equatorial spread-F, in the early morning period, is due to travelling ionospheric disturbances that originate in the auroral zones during disturbed conditions. Very recently, Bowman[17] presented one individual event, corresponding to high sunspot activity conditions, where in the occurrence of a sub-storm was accompanied by conspicuous increases in F-region height and sudden onset of spread-F, at stations (75° W longitude) from high midlatitudes to down to the dip equator, with a delay suggesting the propagation of a travelling ionospheric disturbance with a speed of about 740 m sec.$^{-1}$. Alternatively, it is therefore quite possible that the sudden onsets noticed might be due to travelling ionospheric disturbances. Further detailed event-wise studies are very much required to gain insight into the physical mechanisms involved and their relative role, in the sudden onset of equatorial spread-F during the post-midnight period (under high sunspot activity conditions) pointed out here.

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August 30, 1978.

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1. Wright, R. W. H., *J. Geophys. Res.*, 1959, 64, 2203.
2. Lyon, A. J., Skinner, N. J. and Wright, R. W. H., *J. Atmos. Terr. Phys.*, 1960, **19**, 145.
3. Singleton, D. G., *J. Geophys. Res.*, 1960, **65**, 3615.
4. Bhargava, B. N., *J. Meteor. Geophys.*, 1958, **9**, 35.
5. Booker, H. G. and Weels, H. G., *Terr. Mag. Atmos. Electr.*, 1938, **43**, 249.
6. Marasigan, V., *J. Atmos. Terr. Phys.*, 1960, **18**, 43.
7. Huang, Y. N. and Yeh, C. Y., *Ibid.*, 1970, **32**, 1765.
8. Chandra, H. and Rastogi, R. G., *Ann. Geophys.*, 1972, **28**, 709.
9. Skinner, N. J. and Kelleher, R. F., *Ibid.*, 1972, **27**, 181.
10. Sastri, J. H. and Murthy, B. S., *Ibid.*, 1975, **31**, 285.
11. Farley, D. T., Balsley, B. B., Woodman, R. F. and McClure, J. P., *J. Geophys. Res.*, 1970, **75**, 7199.
12. Sastri, J. H. and Murthy, B. S., *Ann. Geophys.*, 1978, **34**, 47.
13. —, Subramanyam, V., Sasidharan, J. and Srirama Rao. M., *Curr. Sci.*, 1978, **47**, 451.
14. Fejer, B. G., Farley, D. T., Balsley, B. B. and Woodman, R. F., *J. Geophys. Res.*, 1976, **81**, 4621.
15. Rastogi, R. G. and Woodman, R. F., *Ann. Geophys.*, 1978, **34**, 31.
16. Bowman, G. G., *Planet. Space Sci.*, 1975, **23**, 899.
17. —, *J. Atmos. Terr. Phys.*, 1978, **40**, 713.

REACTION OF HALOGENOANILINES WITH ACRYLIC ACIDS

The present communication describes a one step synthesis of some halogeno-2, 3-dihydro-4 (1H)-quinolones obtained by heating chloro- and bromo- anilines with acrylic acid and methyl acrylic acids in the presence of PPA. The halogeno quinolones are of importance because many of them are reported to possess analgesic and antibacterial[2] activity.

The general method[1,2] of preparation consists in heating the halogenoaniline (1 mole) with acrylic or methyl acrylic acid (1 mole) in the presence of PPA at 100°–140° for 3–7 hr. In some cases the acrylamides were isolated either alone or along with the quinolones. In all these experiments a large amount of tarry matter was obtained and the different compounds were purified only after column chromatography over neutral alumina (Table I).