Most of the ideas expressed here were formulated while I was on the staff of the Department of Biochemistry of the University of Melbourne, where in 1953 I initiated a programme of investigation of the biochemistry of tumours. I wish to thank Prof. V. M. Trikojus, professor of biochemistry, and Prof. S. Sunderland, dean of the faculty of medicine, University of Melbourne, for their encouragement. I am grateful to the Anti-Cancer Council of Victoria for financial assistance for the work carried out with the collaboration of Miss M. Branster.

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A REMARKABLE SOLAR RADIO EVENT

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ON November 4, 1957, a large increase in solar radio noise was observed on a frequency of 200 Mc./s. at the receiving station 'Nera' of the Netherlands Telecommunications Services. The increase started rather abruptly at 0848 U.T. and lasted for more than 5 hr., the greatest intensity being reached at about 0930 U.T., when it amounted to approximately 900 times the noise level of the quiet Sun. The smoothed intensity level showed considerable fluctuations with periods of the order of a few minutes. No solar flare has been reported as occurring near the onset of the radio event, nor was a sudden ionospheric disturbance observed. The phenomenon manifested itself over a considerable frequency-range in the metre wave-length band. It was also observed at 169 Mc./s. by the observatories at Humain (Belgium) and Nançay (France), but it was altogether absent on the decimetre-centimetre wave-length range and on a wave-length near 6 metres. The radiation was 100 per cent left-handed circularly polarized. The position of its source, as determined at 1125 U.T. with a two-element interferometer operating on a frequency of 250 Mc./s., was about 0.1 solar radius east of the centre of the solar disk. During a period of 2 hr., centred around local noon, no systematic displacement of the source of enhanced radiation was observed.

The lack of correlation with a solar flare or associated effects, and the absence of disturbances on the decimetre-centimetre wave-lengths, must be considered as rather exceptional for so large a 200-Mc./s. event. However, the extraordinary character of this great radio phenomenon was particularly apparent from records obtained with a negligible time-constant. Some were recorded with a high-speed recording paper

(5 mm./sec.). These records revealed short-period fluctuations of intensity, with a period of some 0.2-0.3 sec., of a type not observed before at the Nera Observatory, altogether different from the kind ordinarily occurring during a noise storm. Part of this variability, strongly reminiscent of the ionospheric scintillations of radio sources (Fig. 1, 1), showed an oscillatory type of intensity fluctuation (Fig. 1, 2). In other parts of the record there was a preponderance of decreases in intensity, short dips of a fading character, which were also present on records obtained by the Nançay Observatory on 169 Mc./s. (for copies of which we are indebted to M. A. Boischot). During the later stages of the radio event dips and oscillations of a longer duration, of the order of 0.1 min., occurred. These could also be identified on slow-speed records obtained at 200 Mc./s. simultaneously at Nera and at Paramaribo (Surinam) with time-constants of, respectively, 1 sec. and 0.3 sec. This proves that the latter variability (which was also of a very uncommon type) certainly cannot be ascribed to ionospheric effects. No ionospheric scintillation of radio sources of any importance was observed at the Jodrell Bank Experimental Station or at the Mullard Radio Astronomy Observatory on November 4. Ionospheric scintillations of so short a period have never, in fact, been observed in Cambridge (Dr. A. Hewish, private communication). The very short-period fluctuations of intensity must also, therefore, be ascribed to solar conditions.

All these facts together justify the conclusion that the radio phenomenon which occurred on November 4 is of a new, so far unknown type of great rarity. It should be noted that this peculiar type of variability is revealed only by a recording instrument

Fig. 1. 1. Scintillations of the radio source Cas A on 200 Mc./s.
2. High-speed record of solar radio emission on 200 Mc./s.
3. Slow-speed record of solar radio emission on 200 Mc./s.

with a time-constant no greater than a very small fraction of a second. With slow-speed recording paper one then simply obtains a very blurred record (see Fig. 1, 3), which might suggest some kind of interference. In the present case, however, the possibility of interference is ruled out, both by the confirmation from the other observatories, and by the

regular pattern of the interferometer curve. The true nature of the intensity fluctuations can only be ascertained by high-speed recording. This is perhaps the reason, together with its extreme rarity, why this type of radio event has not been reported before. It differs from the so-called 'non-selective fading', observed by Payne-Scott and Little¹ on 62 and 98 Mc./s., in that the intensity fluctuations have a much shorter period.

The occurrence of fluctuations in intensity of the type shown in Fig. 1, 1, suggests that, in special circumstances, solar coronal gas may give rise to scintillation effects, possibly analogous in mechanism to ionospheric scintillations, but more varied in character. Irregularities in the solar corona may be responsible for focusing and defocusing effects and perhaps to absorption effects. It is of interest to consider the possibility that the occurrence of storm-bursts during an ordinary noise storm may be due to a focusing mechanism.

The radio event of November 4 occurred quite unexpectedly. The importance of observing such rare phenomena as completely as possible makes it very desirable that solar radio instruments should be operated on a routine basis, however specialized in type.

We are indebted to Dr. R. Coutrez of the Hainaut Observatory and to Dr. Boischoit of the Nançay Observatory for providing us with copies of their records; and to the Jodrell Bank and Mullard Radio Observatories for information on the scintillation of radio sources on November 4.

¹ Payne-Scott and Little, *Austral. J. Sci. Res.*, A, 5, 32 (1952).

SOLAR ACTIVITY AND THE IONOSPHERE

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THE recent unprecedented high levels of solar activity, as indicated by sunspot numbers and described by Dr. M. A. Ellison¹, have been accompanied by equally exceptional conditions in the ionosphere. During the sunspot cycle there is no appreciable change in the amount of visible light or heat radiation emitted by the Sun, but in other parts of the spectrum this is no longer true. As compared with June 1954, when solar activity was at a very low level, the intensity of the ultra-violet and X-radiation which is responsible for the existence of the E-layer of the ionosphere had increased by a factor of 3.2 in September 1957, 3.6 in October and 3.1 in November. These values all exceed the previous maximum of 3.0 in May 1948 and are the highest recorded values since ionospheric measurements were begun at Slough in 1931.

The figures quoted above are based on the critical frequency of the E-layer. Unfortunately there is, as yet, no adequate theory on which similar estimates of the intensity of the F2-layer ionizing radiation could be based. However, in November 1957 at Slough, the mean value of the electron density at the peak of the F2-layer rose to $2.6 \times 10^6 \text{ cm}^{-3}$, a value which exceeds the previous highest value, for November 1947, by 9 per cent. In October 1957 the

density was much lower than in November but, after making an appropriate allowance for the normal seasonal changes in the F2-layer, it may be concluded that the mean intensity of the ionizing radiation in October exceeded that in November, thus confirming the conclusion reached using the E-layer results.

The large changes in the intensity of the ionizing radiation which are associated with the sunspot cycle lead to corresponding variations in the structure and the electron density of the layers of the ionosphere. The complicated ways in which these layers change are of great importance during investigations into the chemical constituents and the atomic processes which determine the electrical properties of the upper atmosphere. These changes are not, however, solely of academic interest, because the electron density controls the critical frequencies of the layers which are responsible for the reflexion of radio waves; a wave which is normally incident on an ionospheric layer will not be reflected for frequencies greater than the critical frequency. At very oblique angles of incidence, the greatest frequency at which a wave will be reflected will be 3-3.5 times the critical frequency for reflexion at the F2-layer and 5 times for the E-layer.