SHORT COMMUNICATIONS

VELOCITIES OF SHOCK FRONTS IN SOLAR CORONA GENERATING TYPE II RADIO BURSTS AT METRE WAVELENGTHS*

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At the time of intense solar flares, various types of enhanced radio emission from the Sun have been observed. Using such techniques as the swept frequency technique first developed by Wild and his associates, these enhanced emissions have been classified into five types. Of particular interest to radio astronomy at metre wavelengths is the slow drift type II bursts. A comprehensive study of these bursts has been made by Roberts (1959). It is now supposed that at the start of a flare an explosion occurs in the lower regions of the solar atmosphere ejecting a column of gas which travels radially outward from the region of the flare. This column of gas is bounded by a shock front which moves forward relative to this gas. This shock front is assumed to excite plasma oscillations in the solar corona giving rise to type II radiation. Velocities of these shock fronts have been determined by various workers.

The authors have observed at 29 Mc/s a number of sudden cosmic noise absorptions (SCNA) during flares of importance 3 or 3±, details of which are being published elsewhere. In each of these SCNA phenomena a characteristic feature has been the appearance of an intense outburst of solar noise lasting a few minutes just about the time of the maximum phase of the SCNA. These outbursts have characteristics of a type II burst as far as single-frequency records can be expected to reveal. A photograph of two such SCNA's occurring on July 29, 1958 and September 14, 1958 are shown in Figure 1.

It is believed that during an intense solar flare X-rays of shorter wavelengths than usual are emitted simultaneously with the optical radiation, and these are responsible for the intense ionization of the lower ionospheric layers, causing the SCNA events. This can also be seen from the coincidence of times of start and maximum phase of the SCNA's and the corresponding optical flares as reported by the authors elsewhere. In the present work, it is assumed that the shock front causing the type II burst starts in the region of the solar flare at the same time as the emission of the X-rays which give rise to the SCNA, and moves outward radially with a finite velocity. The time difference between the beginning of the SCNA and the start of the type II burst can therefore be used to calculate the velocity of the shock front. In arriving at this velocity it is assumed that the radiation at 29 Mc/s is emitted at a level in the corona where the electron

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density is appropriate for the excitation of plasma oscillations at this frequency. This level is at a height of $0 \cdot 58\,R_0$ above the photosphere, according to the Baumbach-Allen model of the solar corona where R_0 is the radius of the Sun's optical disk ($0 \cdot 6957 \times 10^6$ km). The commencement of the SCNA as well as the start of the type II radio burst are fairly sharply indicated on the record, and the time lag between the two commencements can be measured to within ± 10 s. This leads to an error of about ± 1–3% in the values for the velocities of the shock fronts.

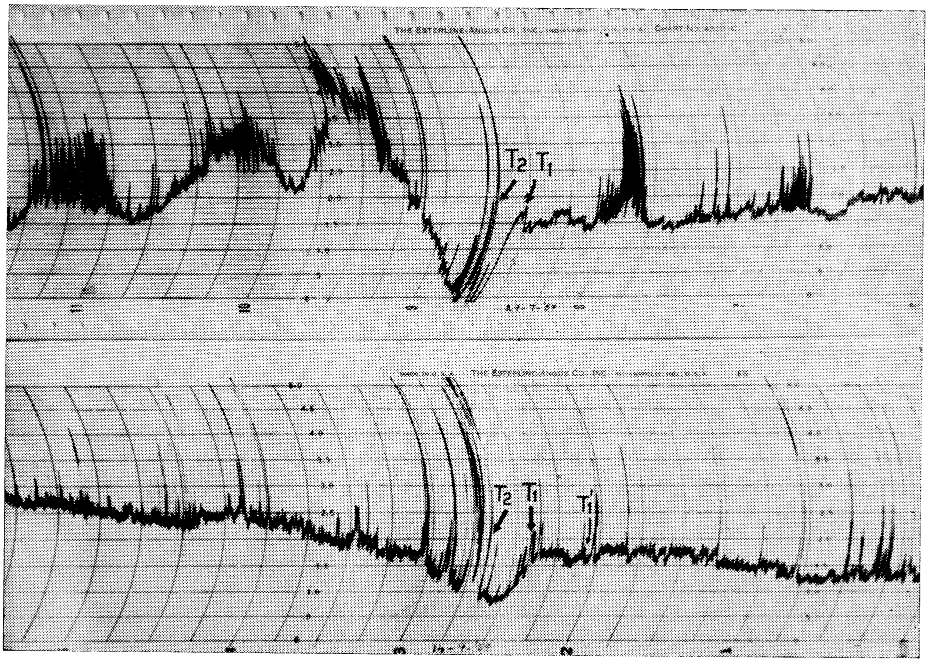

Fig. 1.—Sudden cosmic noise absorptions observed on July 29, 1958 and September 14, 1958. T_1, Beginning of the SCNA ; T_2, start of the type II event ; T'_1, start of optical flare.

Table 1 gives the times of start of SCNA and the time difference, T s, between the beginning of the SCNA and the start of the type II event and the corresponding velocity V of the shock front in km/s. It has been observed that in the case of the SCNA's marked with an asterisk there is a slight fall in the level of the record coinciding with the commencement of the optical flare followed by a steep fall of large intensity later. These correspond to the type C of the classification made by Bhonsle (1960). For calculating the velocities of the shock fronts the time of occurrence of the start of this rapid fall is taken into account. This can be seen from the event of September 14, 1958 shown in Figure 1. This is in contrast with the other cases where the sudden fall coincides with the start of the optical flare.

These velocities are in fair agreement with those reported for type II travelling disturbances obtained by using the swept frequency techniques

(Roberts 1959). However, experiments on the frequency drift of type III bursts have shown that the type III sources are generated at levels far higher than those predicted on the Baumbach-Allen model of the solar corona. Reporting this, Wild, Sheridan, and Neylan (1959) have shown that the coronal streamer model

Table 1

VELOCITY OF SHOCK FRONTS IN SOLAR CORONA CAUSING TYPE II BURSTS

S. No.	Date	Start of SCNA (U.T.)	T (s)	V (km/s)
1	3. iii.58	10 10	710	567
2	23. iii.58	09 51	568	709
3	5. v.58	04 10	474	851
4	6. vi.58	04 36	521	774
5	29. vii.58	03 00	616	655
6	16.viii.58*	04 45	379	1063
7	14. ix.58*	08 53	900	448
8	19. x.58*	07 27	379	1063
9	3. xii.58	07 02	805	501

* Indicates slight fall in record.

proposed by Newkirk yields results in better agreement with the experimental observations. The velocities, calculated on this model of the corona, for the shock fronts exciting the type II bursts would have values nearly twice those given in Table 1.

References

Bhonsle, R. V. (1960).—*Proc. Indian Acad. Sci.* A **51**: 189.
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Wild, J. P., Sheridan, K. V., and Neylan, A. A. (1959).—*Aust. J. Phys.* **12**: 309.