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INTERNATIONAL CONFERENCE ON COSMIC RAYS AND THE EARTH STORM Part II

II-3A-7. Height and Motion of the Solar Radio Bursts at 200 Mc/s

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The results of positional observations made with an interferometer at 200 Mc/s at Tokyo Astronomical Observatory are discussed.

The height of a radio source is about 0.2-0.3 $R_{\odot}$ above the photosphere for type I, type III and type IV bursts, and it increases with a distance from the center. This is far above the plasma level expected from the normal coronal model. It is suggested that some kind of condensation exists above the active region of the sun. The frequency of type I bursts concentrates to the disc centre, while that of type III bursts rather increases near the limb. The difference will be briefly discussed.

The scattering range of positions in a group of type III bursts is roughly independent of the position of the burst on the disk, and is about equal to the scale height in the coronal condensation, mentioned above.

The source of type IV burst usually does not show an ejected motion, in contrast with the results at the lower frequencies. The source of type II burst often shows an ejected motion, it seems inconsistent with the plasma hypothesis.

Observations have been made with an interferometer at 200Mc/s at Tokyo Astronomical Observatory. The interferometer[1] has two antenna systems, narrow and wide separation with 50 and 338 wavelengths in E-W direction respectively and provides the positional accuracy of about 0′.3 for relative position and 1′ for absolute position determinations. Parameters of the antenna systems were determined by meridian transit observations of six intense discrete sources; Cas. A, Cyg. A, Tau. A, Vir. A, Hya. A and Her. A.

1) The height of the source

The height of source of radio burst is determined by comparing the radio position with the position of the corresponding optical phenomenon. For type I burst (or noise storm) the sunspot group is taken as the correspondence, while the chromospheric flare is taken for type II, type III and type IV bursts.

Sufficient data were obtained for type I and type III bursts to determine the heights statistically for different positions on the solar disc. For type II and type IV bursts only an average heights were determined.

The heights determined are 0.2 to 0.3 $R_{\odot}$ for all types of the bursts. This is considerably higher than the height of the plasma level for the normal corona (Baumbach-Allen model), and is rather consistent with the results at lower frequencies, which show a good fit with the density in the coronal streamer[2),3)] (Fig. 1). It suggests that some kind of condensation with the electron density ten times as high as the normal corona exists above the active region of the photosphere*.

The apparent heights of type I and type III bursts increase from center to limb and this variation strongly resembles with that of the turning point of the ray calculated for the condensed coronal model, mentioned above (Fig. 2).

The frequency of occurrence of type I bursts concentrates to the disk center, while that of type III bursts rather increases near the limb (Fig. 3). A slight difference in heights of the sources, as seen in Fig. 2, might cause such a difference, but it seems

* It is not the same region of the corona that emits the microwave slowly varying component.

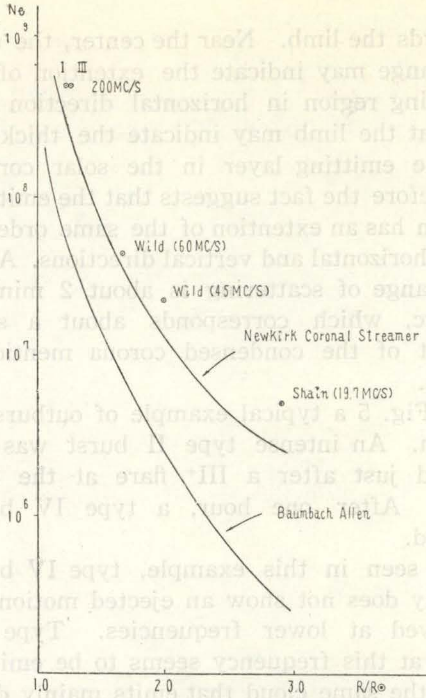

Fig. 1. Height of the source at various frequencies. Abscissa is the height above the photosphere and ordinate is frequency in critical electron density. Curves are electron densities for coronal streamer and normal corona.

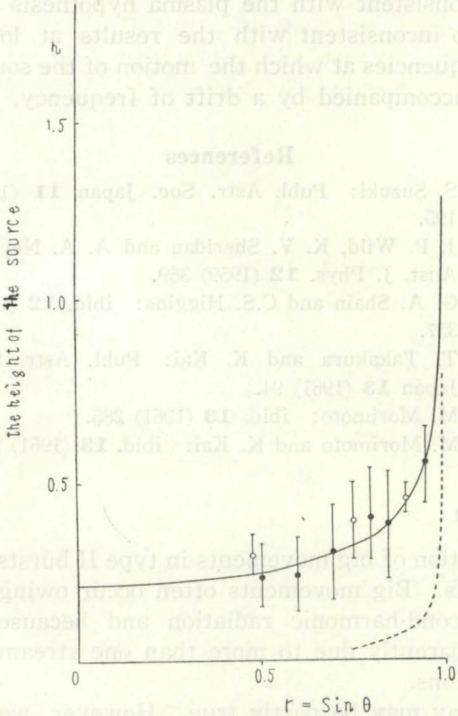

Fig. 2. Variation of the height across the solar disk. Dots are for type I bursts and circles are for type III bursts. Curves are for the turning point of the ray for condensed and normal coronal model.

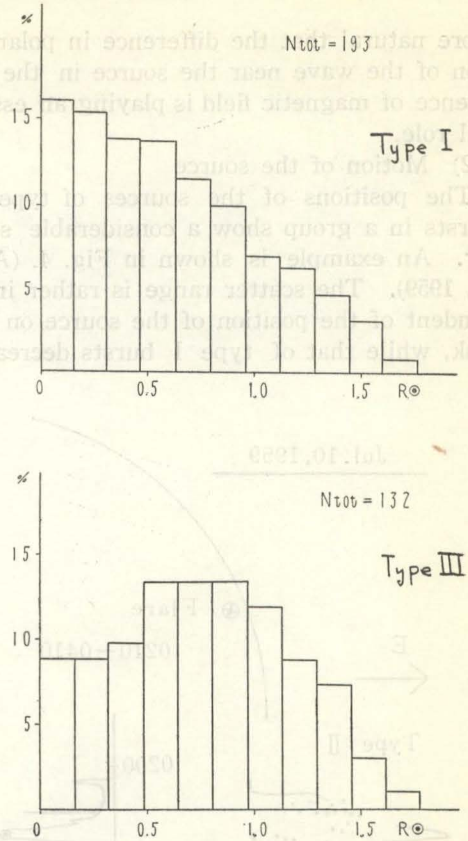

Fig. 3. The distribution of type III and type I bursts on the solar disk.

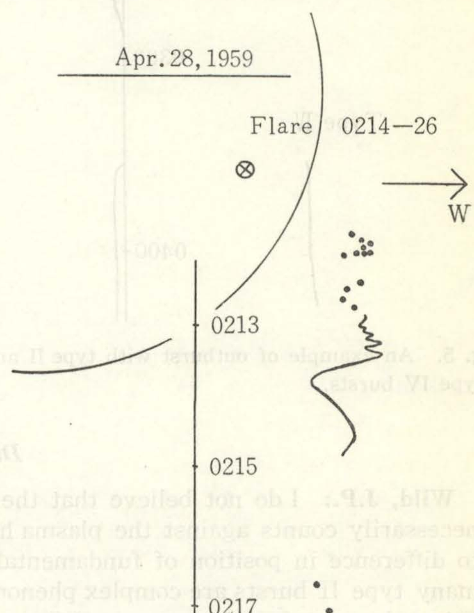

Fig. 4. An example of type III group. Abscissa is E-W position of the source and ordinate is time in U.T.

more natural that the difference in polarization of the wave near the source in the existence of magnetic field is playing an essential role.

2) Motion of the source

The positions of the sources of type III bursts in a group show a considerable scatter. An example is shown in Fig. 4. (Apr. 28, 1959). The scatter range is rather independent of the position of the source on the disk, while that of type I bursts decreases towards the limb. Near the center, the scatter range may indicate the extention of the emitting region in horizontal direction and that at the limb may indicate the thickness of the emitting layer in the solar corona. Therefore the fact suggests that the emitting region has an extention of the same order in both horizontal and vertical directions. Average range of scattering is about 2 minutes of arc, which corresponds about a scale height of the condensed corona mentioned above.

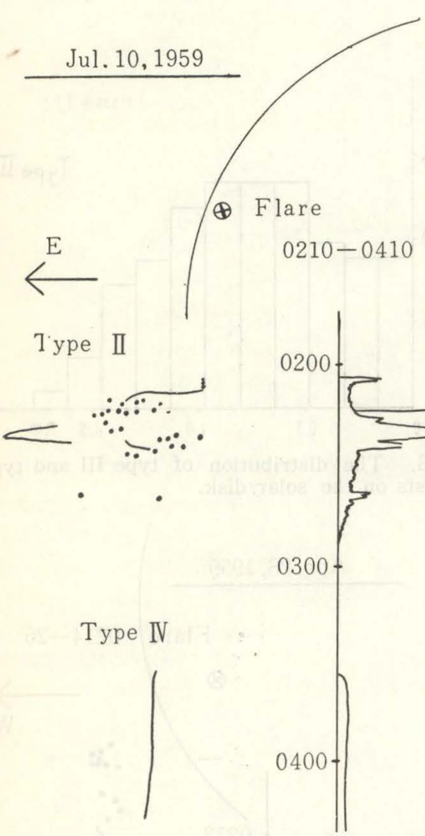

Fig. 5. An example of outburst with type II and type IV bursts.

In Fig. 5 a typical example of outburst is shown. An intense type II burst was observed just after a III^{+} flare at the east limb. After one hour, a type IV burst started.

As seen in this example, type IV burst usually does not show an ejected motion, as observed at lower frequencies. Type IV burst at this frequency seems to be emitted from the same cloud that emits mainly decimeter waves. On the other hand, the source of type II bursts, often observed at the early phase of the outburst, shows a remarkable ejected motion. This motion seems to be inconsistent with the plasma hypothesis and also inconsistent with the results at lower frequencies at which the motion of the source is accompanied by a drift of frequency.

References

1) S. Suzuki: Publ. Astr. Soc. Japan **11** (1959) 195.
2) J. P. Wild, K. V. Sheridan and A. A. Neylan: Aust. J. Phys. **12** (1959) 369.
3) G. A. Shain and C.S. Higgins: ibid. **12** (1959) 357.
4) T. Takakura and K. Kai: Publ. Astr. Soc. Japan **13** (1961) 94.
5) M. Morimoto: ibid. **13** (1961) 285.
6) M. Morimoto and K. Kai: ibid. **13** (1961) 294.

Discussion

Wild, J.P.: I do not believe that the observation of big movements in type II bursts necessarily counts against the plasma hypothesis. Big movements often occur owing to difference in position of fundamental and second-harmonic radiation and because many type II bursts are complex phenomena apparently due to more than one stream being shot out from the sun in different directions.

Morimoto, M.: The later part of what you say may be partly true. However, we have certainly some examples that the source of type II burst moved *continuously* to a certain direction. We think it is more natural to interpret it as the source at 200 Mc/s actually moved.

Biermann, L.: The connection between active regions on the sun and coronal condensations was discussed in some detail at the I. A. U. symposium on the solar corona in Cloudcroft, N. M., last week. The evidence is that this connection is quite a regular one, hence the fact, that the densities derived from the type III bursts are regularly considerably higher than those derived from any of the standard models of the corona, is easily understood.

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II-3A-8. The Sizes of the Sources of Solar Radio Bursts at 40 and 60 Mc/s*

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§1. Introduction

A swept-phase interferometer has been used in conjunction with the Depto radio spectrograph and the swept-frequency interferometer to study the angular sizes of the sources of the bursts of radio emission from the Sun. Measurements are made at either 40 or 60 Mc/s, at the discretion of the operator, and with aerial spacings $a=1$ km (long base) or $a=\frac{1}{4}$ km (short base).

The parameter measured is the visibility, ξ, of the fringes, defined by $\xi=(P_{\max.}-P_{\min.})/(P_{\max.}+P_{\min.})$. $P_{\max.}$ and $P_{\min.}$ are the maximum and minimum envelopes of the interference pattern of the source. If the relative attenuation of the feeder lines of the two aerials is α nepers, $\xi \cosh \alpha$ is the ratio of the moduli of the Fourier components of the source distribution at angular "frequencies" $(a/\lambda) \cos \theta_0$ and 0 (Wild and Sheridan 1958). The effect of foreshortening ($\theta_0 \neq 0$) is neglected here.

The observational material discussed in this paper consists almost entirely of pairs of visibility measurements ($\xi_S \cosh \alpha$, $\xi_L \cosh \alpha$) made with the two aerial spacings within half a second of each other. A full assessment of all the available data has yet to be made, and this report is preliminary in nature.

* This paper was read by J. P. Wild.

§2. Bursts of Types II and IV

Visibilities for eight Type II bursts, and for the Type IV continuum following the 3+ flare of 15 November 1960, are plotted in Fig. 1. The Type IV measurements were averaged over a 45 min. period, during which the source position remained essentially fixed; this period commenced about 30 min. after the start of the flare. If this latter event is typical of Type IV, the location of the points in the $\xi_S-\xi_L$ plane suggests that sources of Type II and Type IV emission are characterized by differently-shaped bright-

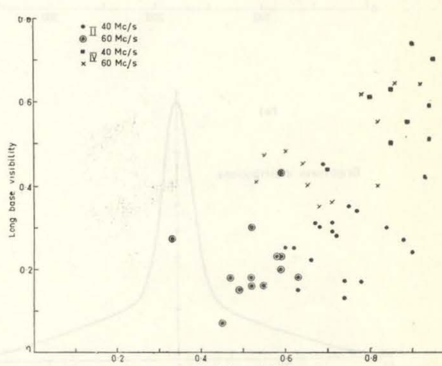

Fig. 1. Plot of long base vs. short base visibilities for eight Type II bursts and the Type IV continuum of 15 November 1960. Visibilities have been corrected for attenuation in the aerial feed lines.