SUDDEN DISAPPEARANCE OF A SOURCE OF S COMPONENT OF SOLAR RADIO EMISSION AT MICROWAVE FREQUENCIES ON NOVEMBER 30, 1959.

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Abstract.

A temporary marked decrease of microwave solar radio emission after a burst was observed at 1000, 2000, 3750 and 9400 Mc/s on November 30, 1959. Interferometric observations at 9400 and 4000 Mc/s show that the greater part of a strong source of slowly varying component of solar radio emission disappeared temporarily. In this paper the results of radio observations are described. The temporary disappearance of the radio source may be considered to be due to the absorption of radiation by the overlying surge like material.

A temporary marked decrease of microwave solar radio emission after a burst was observed at 1000, 2000, 3750, and 9400 Mc/s on November 30, 1959. Interferometric observations at 9400 and 4000 Mc/s show that the greater part of a strong source of S component of solar radio emission disappeared temporarily. At the same time a flare and surges were observed at Tokyo Astronomical Observatory.

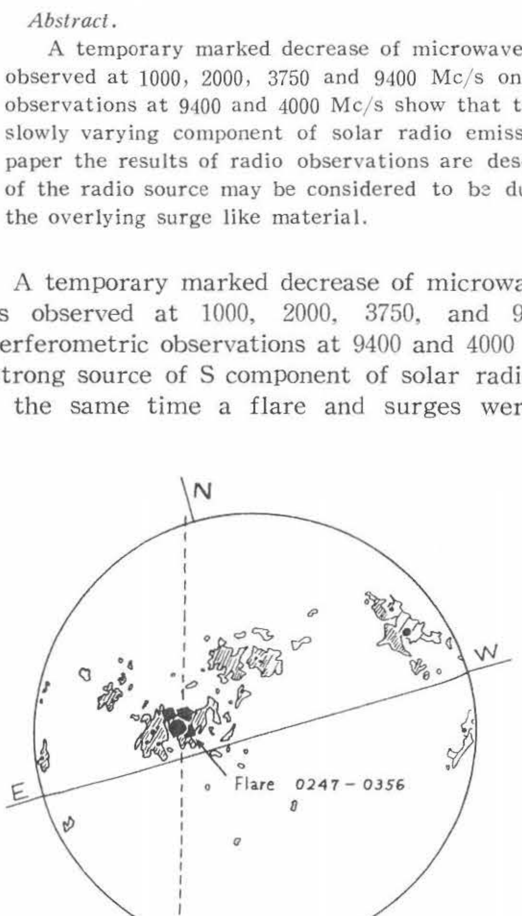


Fig. 1. The optical disk of the sun on Nov. 30, 1959, (the map of the sun published by the Tokyo Astronomical Observatory.) and the position line (— — — —) of the high peak in the records of interferometers.

This seems to be a very rare phenomenon.

Similar diminution of 10.7 cm solar radiation during flare on May 19, 1951 has been reported by A. E. Covington and H. W. Dodson. (1)

A brief summary of optical and radio observations has been reported elsewhere. (2) In this proceedings we will describe the results of our radio observations in some detail.

The positions of the flare and the sunspot group and calcium plage associated with the radio source are shown in Fig. 1 (the map of the sun published by Tokyo Astronomical Observatory).

A decrease of flux density was observed after a burst which had occurred at 02h 47m. Variations of intensity with time at 9400, 3750, 2000 and 1000 Mc/s are shown in Fig. 2. The depression of flux density was prominent at 3750 Mc/s and the max. depression for 2000 and 1000 Mc/s occurred

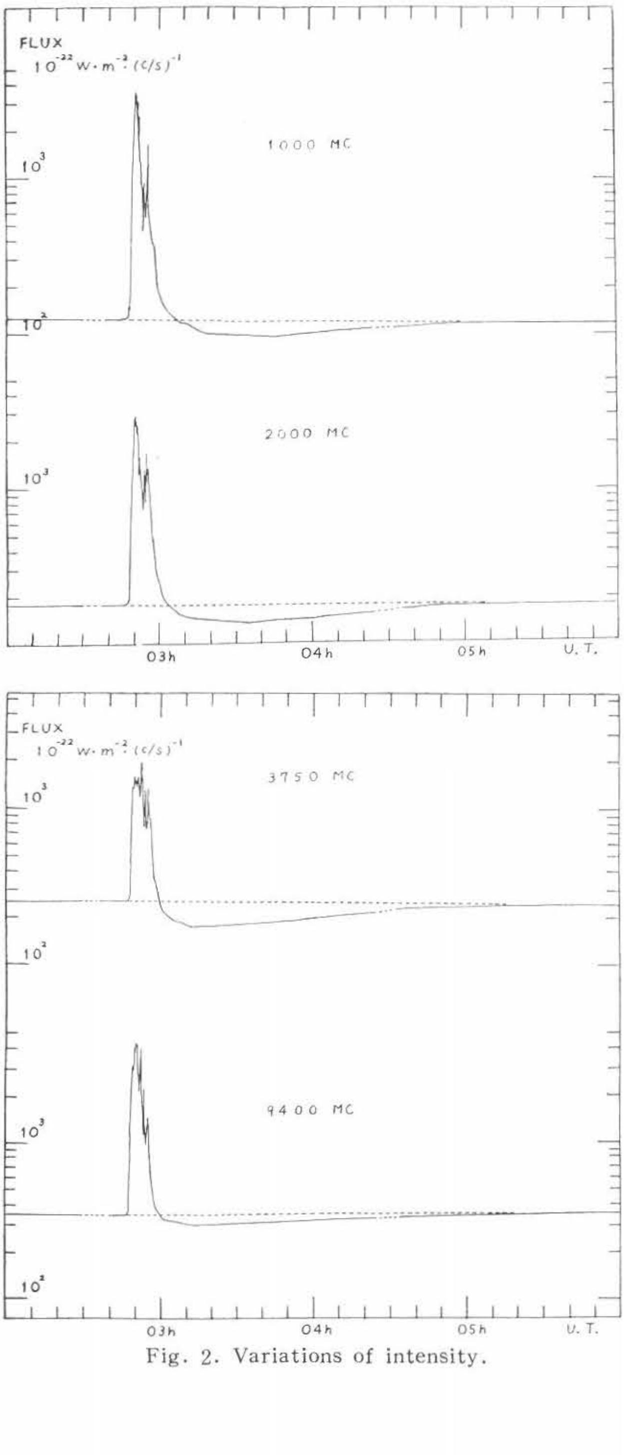


Fig. 2. Variations of intensity.

about 30 min. later than the max. depression for 9400 and 3750 Mc/s. Flux density had nearly recovered by 05h 20m at all frequeneies. Variations of % polarization at three frequencies are also shown in Fig. 3. % polarization at 1000 Mc/s was

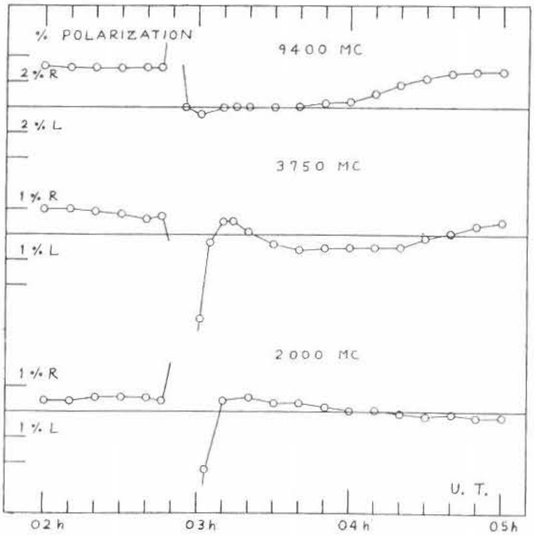


Fig. 3. Variations of % polarization.

very small, except during the burst. Numerical values are as follows;

Burst

Frequency (Mc/s)	9400	3750	2000	1000
Starting Time	02h47m	02h47m	02h47m	02h47.5m
Duration (min.)	12	12	18	20
Type	CD	CD	CD	CD
Time of Max.	02h50.3m	02h52,3m	02h50.3m	02h50.5m
Max. Intensity	4050	1750	2750	3450
Polarization (%)	24R	19L—6R—26L	60R—23L	60R—6L

Unusual decrease

Frquency (Mc/s)	9400	3750	2000	1000
Starting Time	02h59.5m	02h59.5m	03h05m	03h08m
Duration (min.)	130	130	115	110
Time of max. depression	03h15m	03h13m	03h40m	03h45m
Max. Intensity of decrease.	−46	−75	−41	−27
Flux Density at 02h40m (before the burst)	345	247	178	128

Time ; U. T.

Units of intensity ; 10^{-22}w, m^{-2} $(c/s)^{-1}$, —two polarizations.

The drift-curves obtained with 9400 and 4,000 Mc/s 8-element interferometers are shown in Fig. 4. Curve A is the average drift-curve before the burst (around

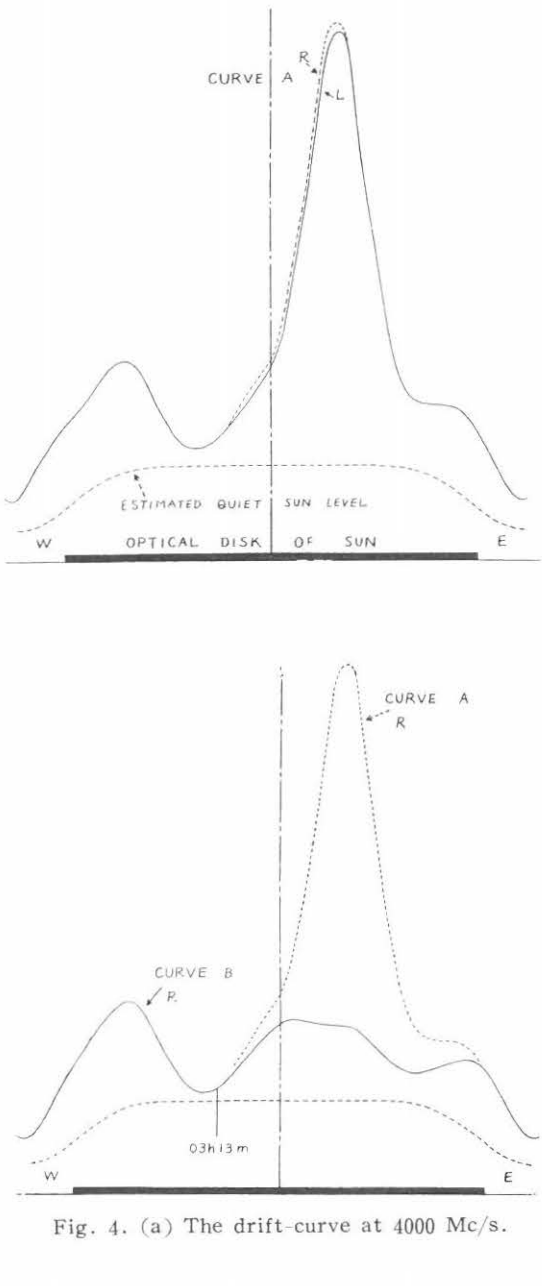
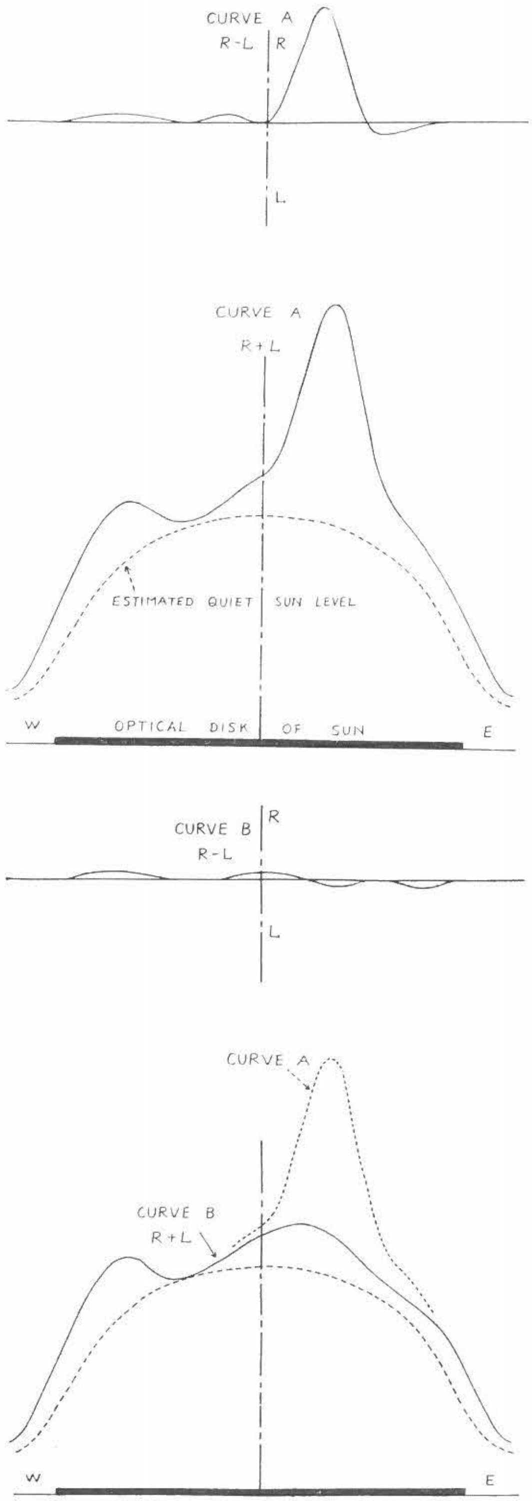


Fig. 4. (a) The drift-curve at 4000 Mc/s.



(b) The drift-curve at 9400 Mc/s.
Curve A is the average drift-curve around local noon (02h 38m 52s). Curve B is the ♯12 W drift-curve at about 03h13m.

R ; right-handed circularly polarized component.

L ; left-handed circularly polarized component.

02h 39m) and curve B represents one near the max. depression (about 03h 13m). They show the E-W brightness distribution over the solar disk, and the peaks show the existense of the source of S component. The position line (5.2′E) of the high peak of curve A is shown in Fig. 1.

A comparison of curve A and curve B indicates that the greater part of the strong radio emissive region, where the flare was observed, disappeared suddenly. The drift-curve (R-L) at 9400 Mc/s shows that the source of polarized component over the sunspots also disappeared.

The records at 4000 Mc/s, shown in Fig 5. and 6, show that this radio emissive region had gradually reappeared.

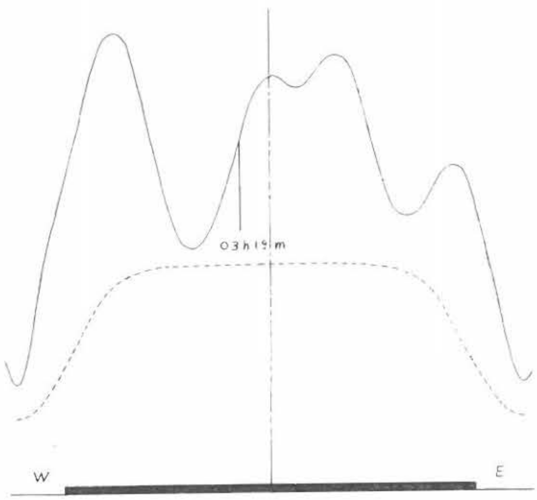


Fig. 5. The drift-curve (R) at 4000 Mc/s at about 03h 19m

The flux density emitted by this strong radio source before the burst may be estimated from the area of the high peak in curve A above the quiet-sun level to be about 103 units (1 unit $=10^{-22}$ W.m^{-2} (c/s)$^{-1}$) at 3750 Mc/s.

But, as seen in #14 W drift-curves (Fig. 5), there was a weak radio source northwest of the strong source and the flux from this region is estimated to be about 14 units. As it is considered that this weak source did not disappear, the flux from the strong radio source before the burst is estimated to be about 89 units (excess above quiet sun level).

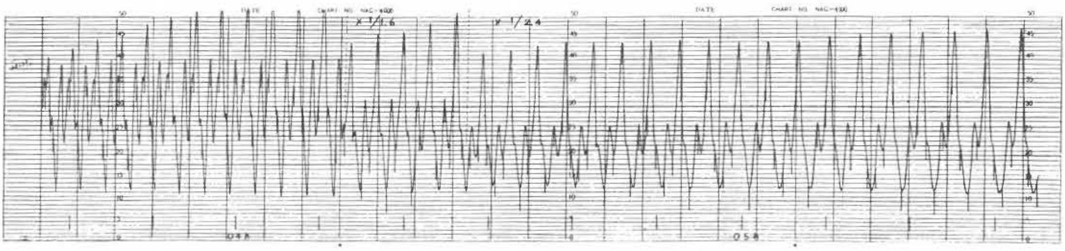


Fig. 6. The drift-curves at 4000 Mc/s from 03h40m to 05h30m. The sensitivity of the receiver was changed twice.

At 9400 Mc/s, this value is roughly estimated from the curve A to be about 55 units. Accordingly, at these frequencies, the radiation from the strong radio source at max. depression is reduced to about 20% of the intensity before the burst, as the observed decrease in flux is 75 units at 3750 Mc/s and 46 units at 9400 Mc/s, which is also calculated from the area between curve A and curve B.

The temporary disappearance of the radio source may be interpreted to be due to the absorption of radiation by the overlying surge like material, [1] which is presumable from the optical observations, and we may be able to estimate the order of the electron density and temperature of the overlying absorbing cloud if we assume that the burst was over at about 03h. The averaged brightness temperature of the radio source before the burst at 9400 and 3750 Mc/s is 1.7×10^5 °K and 1.7×10^6 °K respectively*, assuming that the area of the source is about $5'\times3'$, which is estimated from the extent of the calcium plage. (We estimated the quiet sun radiation for this area to be about 2 units and 4 units at 3750 and 9400 Mc/s respectively.) If we assume that about 83% of the area of the source was covered by the absorbing cloud and the brightness temperature of its part was reduced to about 10^4 °K, the observed decrease in flux at max depression at these frequencies will be explained. So the temperature of the cloud may be considered to be less than 10^4 °K. If we assume that the temperarure of the cloud is 5×10^3 °K and the thickness of the cloud is 10^4 km, the electron density of the cloud is calculated to be $\sim10^9/cm^3$, as the optical depth at 9400 Mc/s needs to have the value of about 4.

At the time of max. depression at these frequencies the decrease in flux at 1000 and 2000 Mc/s is about 50% and 70% respectively of the max. value of decrease and the max. depression at these frequencies occurred about 30 min. later than the one at higher frequencies. It may be explained by assuming that the effective size of the source of S component at lower frequencies is larger than the one at higher frequencies and the cloud spreads with decreasing density. If we assume that the effect of the burst had almost vanished, the effective area at 1000 Mc/s may be considered to be about twice the area at 9400 and 3750 Mc/s. At the time of max. depression at 9400 and 3750 Mc/s, the part over the sunspot of the source (the source of polarized component) was covered by the cloud. If, at these frequencies, the part over the sunspots is brighter than other parts, due to the effect of the magnetic field, the difference in the area will be produced, and it may be also considered that the electron density is high at the center of the source and decrease gradually outward.

We may also be able to explain the difference of time of max. depression by the difference in the effective height of radio source and an upward motion of the cloud. But the above discussion seems to be more natural. The variations of % polarization at 3750 Mc/s show that the source of left-handed circularly polarized component i.e. the east part of the source reappeared earlier than the west part. From the fact that the unusual decrease ef flux was over almost simultaneously at four frequencies, it is supposed that the cloud did not stay over the radio source, becoming transparent, but moved aside or fell to the photosphere.

This is the first time that we have ever observed such a phenomenon. But as it is by no means rare that the surge-like material is ejected during flare, there may have been many bursts, the source of which was partially covered by the absorbing cloud.

References

1) A. E. Covington and H. W. Dodson, J. R. Astr. Soc. Canada, **47**, 5. 207. 1953
2) T. KAKINUMA and E. HIEI, Pub. Astr. Soc. Japan, **12**, 1, 1960.

* These values are not so critical to the results.