THE SPATIAL STRUCTURE OF SOLAR MICROWAVE BURSTS

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Observations of five impulsive microwave bursts were made during July 15-18, 1978 using the VLA at 4.9 GHz with temporal and spatial resolutions of 10 s and up to 1" respectively. A series of 2-dimensional snapshot synthesis maps was made as a function of time, and compared with Hα photographs and magnetograms. Each flare was characterized by a single source of constant size, located on the magnetic neutral line between the Hα kernels.

MICROWAVE OBSERVATIONS AND DATA ANALYSIS

The observations were made at 4.9 GHz during July 15-18, 1978 using the Very Large Array (VLA), operated by NRAO, which provided up to 55 baselines, with a spatial resolution of up to 1". The procedure was to continuously observe an active region (McM 15403), recording the complex visibilities in both right and left circular polarizations with an integration time of 10 s. Five impulsive flares were observed, ranging in strength from 2-900 sfu, and with polarization $< 20\%$.

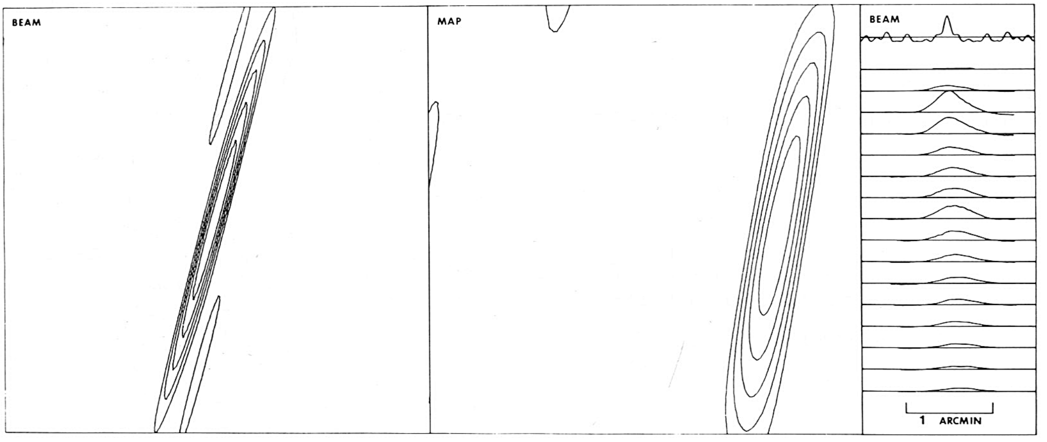
Snapshot synthesis maps in Stokes parameter I were constructed at 10 s intervals during each flare in order to determine the location and structure of the flares as a function of time. An example of the mapping procedure (for flare #1) is shown in Figure 1. It was found that all five flares were characterized by a single source which evolved with constant size. The sizes and brightness temperatures at the peak of each flare are listed in Table I, together with the position angle, PA, of best resolution (measured east from north).

COMPARISON WITH OPTICAL DATA

The VLA maps locate the microwave source in 2 dimensions with an error box of typically 2" x 16", on the assumption that the source structure was simple in both axes. The measured locations were compared with Hα photographs and magnetograms from Big Bear Solar Observatory,

M.R. Kundu and T.E. Gergely (eds.), Radio Physics of the Sun, 191-194.

https://doi.org/10.1017/S0074180900036834 Published online by Cambridge University Press



(a) (b) (c)

Figure 1: VLA maps of flare #1

(a) 2-dimensional synthesized beam.
(b) Map at the time of peak emission.
(The field of view in both cases is 2' x 2', and the contour interval is 10%, down to a minimum contour level of 50%.)
(c) Series of 1-D profiles of the flare through the axis of best resolution, made at 10 s intervals beginning at 14 24 33 UT.

Table I: Summary of microwave flare parameters.

Flare #	Date	UT	Flux(sfu)	Size (")	T_{peak} (K)	PA (°)
1	July 15	1425	900	13	4×10^9	78
2	July 15	1703	2	13	7×10^6	73
3	July 15	1950	60	12	4×10^8	58
4	July 17	2135	40	18	1×10^8	40
5	July 18	0019	200	12	1×10^9	-4

and the results are shown in Figure 2. In this figure, the microwave source locations and sizes are represented by circles, which are numbered using the same scheme as in Table I. The arrows represent the estimated position corrections to allow for projection effects assuming a source elevation of half the scale of the Hα loops. It is apparent that in all cases, the microwave source location is consistent with the magnetic neutral line between the Hα flare kernels.

We gratefully acknowledge the assistance of Dr. R.M. Hjellming during the observations. NRAO is operated by Associated Universities, Inc., under contract with the National Science Foundation. This work was supported by the U.S. National Science Foundation under grants ATM76-80782 and ATM79-06345.

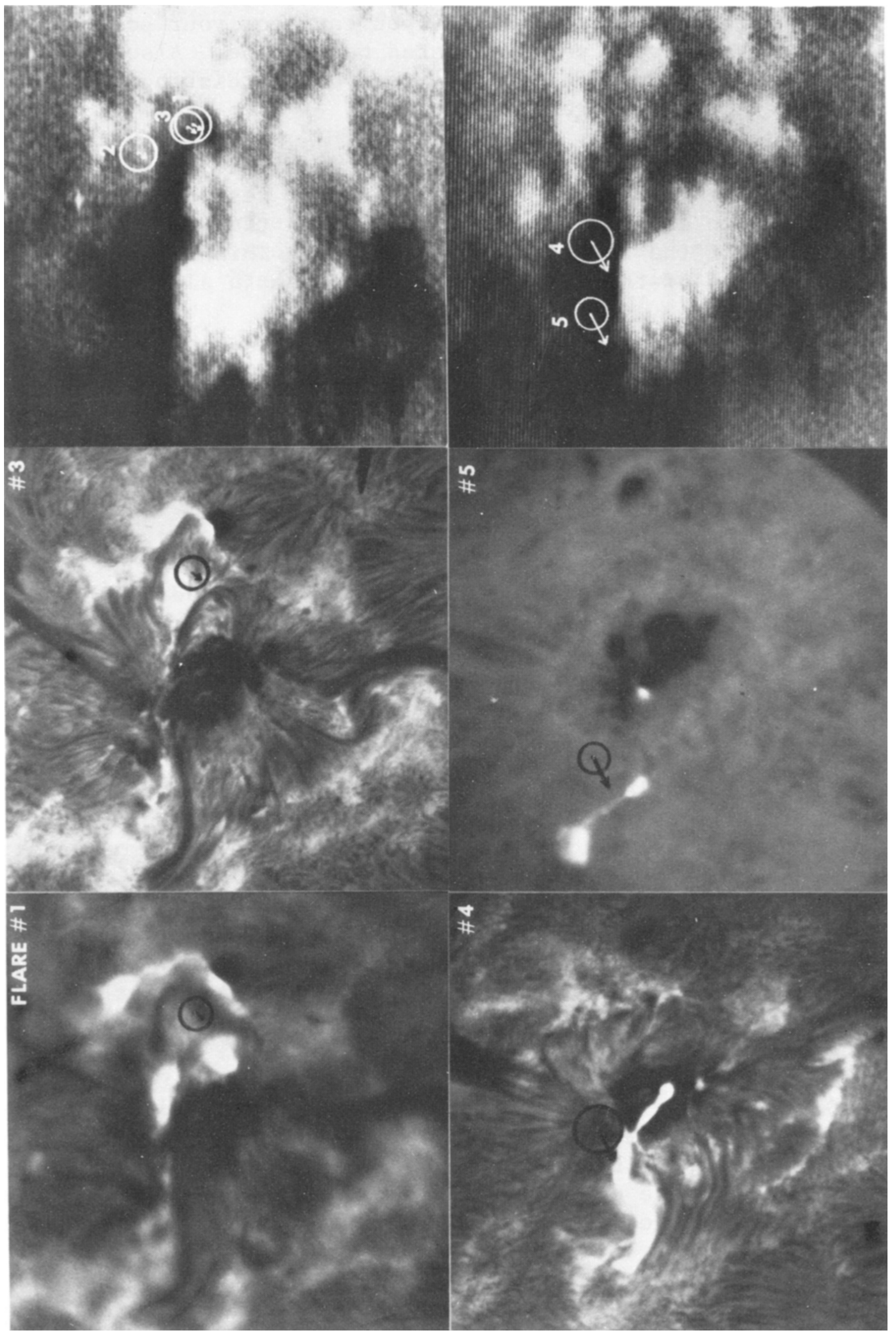


Figure 2: Locations of microwave sources with respect to optical and magnetic structure (see text). The leftmost pair in each row was taken in Hα at time of peak microwave emission (flare #5 is Hα-0.7A; all others are line center). The rightmost photographs are magnetograms.

DISCUSSION

Gergely: I would like to know how you can show your source position as a circle when you have a very elongated beam shape. Also, I don't think that if you have an unresolved source you can distinguish between expansion of the source and genuine motion.

Marsh: 1) By assuming that the source is single, i.e., that there are no hidden sources along the direction of poor resolution, we can locate the source to an accuracy corresponding to that at which we can measure the phase of the interferometer fringes. This is substantially less than the length of the beam. 2) The sources in all cases were resolved.

Lang: What is the angular separation of the Hα filaments.

Marsh: about 25".

Lang: What was the angular size of your source?

Marsh: 12" to 18" half width.

Lang: I don't see how you can locate a source of half width 18" and extent 36" between or on sources separated by 25".

Marsh: We were lucky to have the neutral line located perpendicular to the direction of best resolution.

Lang: I still don't believe your positional accuracy can be better than 10" at the 3 sigma level and the conclusion that the sources are located on neutral lines rather than spots must be an uncertain one, especially in view of assumptions involved in deducing the source size in the first place.

Marsh: You should not confuse source size with angular resolution. Our best resolution was a few arcseconds, and for the July 15 flares where projection effects were unimportant, our conclusion that the microwave source lies between the Hα kernels is independent of any assumptions about source size.

Kundu: What is the effective resolution of the one-dimensional profiles that you showed every 10-sec, for the first burst. If the resolution is ∿ 15", it is possible that you could not resolve it - in the sense that you saw a core of 5"-6" which later expanded to longer size. The phase will not change if the central core expands uniformly in all directions.

Marsh: The synthesized beamwidth was approximately 6". Examination of the visibility function, including the long baseline data, shows that nearly all of the power was contained in spatial components larger than 10", and this was true for the whole flare, including the impulsive phase.