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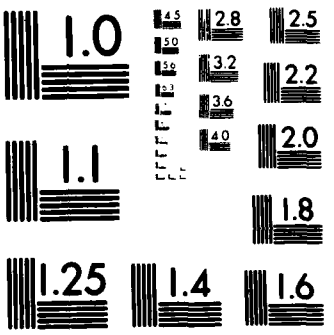

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Technical Document 129

SOME RESULTS OF COORDINATE MEASUREMENTS OF LOCAL RADIO SOURCES ON THE SUN

Translated by CM Bigger from an article by VN Borovik
and AV Temirova
Edited by MP Bleiweiss

3 October 1977

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SOME RESULTS OF COORDINATE MEASUREMENTS OF LOCAL RADIO SOURCES ON THE SUN

VN Borovik and AV Temirova

Solar Data (Solnečnye Dannye) February 1973, pp 62-66, Published by the Main Astronomical Observatory of the USSR Academy of Sciences

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Determining the height of local sources (l.s.) of polarized and nonpolarized solar radio emission is one of the important tasks of astrophysics. These measurements can be accomplished either as a result of a solar eclipse or with the aid of a high-resolution radio telescope. Antennas of the varying profile type* (VPA), for example, the Large Pulkovo Radio Telescope (LPRT) and the radio telescope under construction in the northern Caucasus, the "RATAN-600", which has a diameter of 600 m, have high resolution in one direction. It is well known that measurements of circularly polarized radio emissions, accomplished with the aid of a VPA, are complicated by the presence of large cross-polarized lobes (ref 1-3) making coordinate measurements of the source difficult.

Observations of the circular polarization of l.s. of the slowly varying solar radio emission (S) component were initiated during the summer of 1969. A grid of twisted conductors was utilized to compensate for parasitic circular polarization (ref 4 and 5). The resolving power of the LPR in an E-W direction at $\lambda = 3.2$ cm consists of approximately 1'.1 at the half power level. Determinations were made for displacement of the feedhorn** towards the west relative to the grid center (the feedhorn is situated at the grid center at $\lambda = 4.4$ cm (ref 6) and is displaced to the east relative to the disk center at $\lambda = 9.0$ cm (ref 7)). Two Stokes parameters, I-intensity and V-circular polarization of solar radio emission, were registered simultaneously.

The present work undertakes an attempted evaluation of the coordinates of the l.s. of polarized and nonpolarized solar radio emission during the period 20-31 October 1969.

During the period in question, 25 different groups of sunspots were observed on the solar surface; the largest of these was group No 382*** ($\phi = +11°.5$, CMP - X - 26.6). Group No 382 had a complex structure with clearly expressed leading and trailing portions. During the first 3 days following its appearance from behind the edge of the solar disk (20-22 October), the leading portion consisted on one large umbra which then separated into two umbrae of approximately equal size. This structure survived through the remaining days until the setting of the group. The trailing portion consisted of a series of shallow spots and pores. In agreement with reference 8, magnetic fields of southern polarity were observed in the leading portion while mainly northern polarity was observed in the trailing, even though weak fields of southern polarity were fixed in the trailing portion during all these days. According to Zurich classification, this group is related to the F Class (ref 9).

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*Translator's note: It is supposed that this refers to a telescope having a primary reflector consisting of many different elements, all of which can be adjusted or varied to form different shapes, ie, parabolic or circular.

**Translator's note: An alternate translation for this term is irradiating unit or irradiator.

***The group enumeration is given according to the Bulletin Solnečnye Dannye.

[1] NA Esepkina i dr Radiotexnika i elektronika, 6, 1947, 1961
[2] GV Kuznecova, NS Soboleva, Izv GAO No 172, 1964
[3] NS Baxvalov i dr Astrofizičeskie issledovanija, 5, 1972
[4] NA Esepkina i dr Radiotexnika i elektronika, 14, 1870, 1969
[5] NA Esepkina i dr Ivz VUZ'ov, Radiofizika, 14, 1149, 1971
[6] NG Peterova, AV Temirova, Soln dannye, No 7, 1970
[7] SB Axmedov, AV Temirova, Soln dannye, No 6, 1972
[8] Magnitnye polja solnečnyx pjaten 16-31 oktjabrja 1969 g Priloženie k bjull "Soln dannye", No 10, 1969
[9] Maps of the Sun, Institut Fraunhofer, October 1969

The basic characteristics of group No 382 are presented in the table where S_{p_Σ} is the overall area in the group in m.s.h. $S_{p_{beg}}$ is the area of the largest sunspot in the group, n is the number of sunspots, r/R is the position of the center of gravity on the solar disk (according to the bulletin Solnečnye Dannye). Also included are the l.s. characteristics associated with the group in polarized and nonpolarized light.

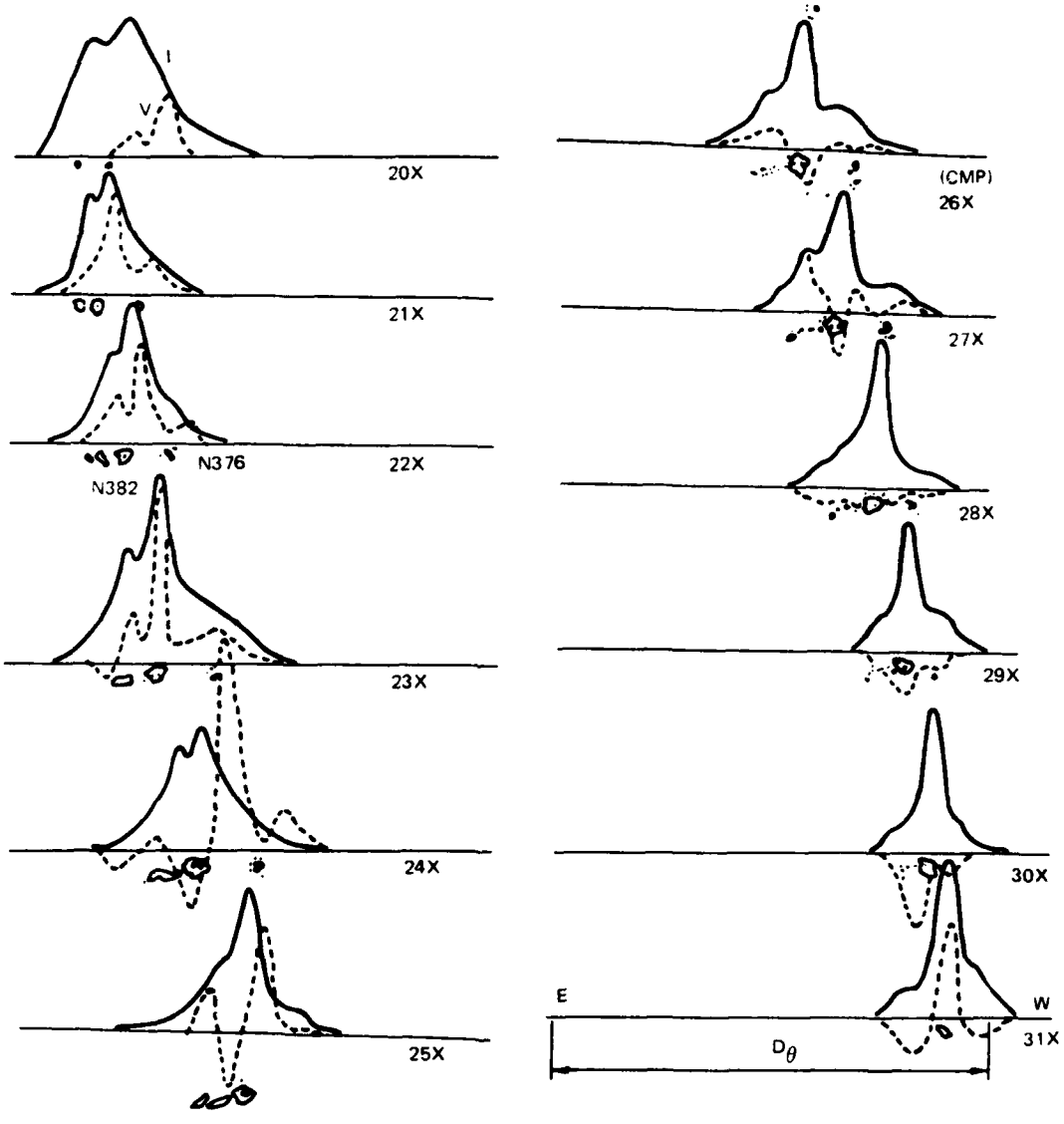
Date (X 1969)	S_{p_Σ}	$S_{p_{beg}}$	n	r/R	F_Σ	F_{beg}	All Groups		Leading Spot	
							P_Σ (%)	Sign	P_{beg}	Sign
20	920	458	10	0.94	–	–			–	
21	1930	1175	53	0.90	37	25	4.5±1.0	L	6.8±1.5	L
22	2040	1040	49	0.79	51	31	4.5±0.8	L	5.0±0.9	L
23	1919	1082	68	0.66	49	29	2.6±1.0	L	3.4±1.1	L
24	2002	1240	48	0.44	24	24	2.9±1.0	L		
25	1690	1280	73	0.30	32	25	2.8±1.0	L		
26	1800	1285	72	0.14	29	20	1.1±0.5	L		
27	1640	1085	53	0.23	38	24	1.4±1.4	L		
28	1490	1230	60	0.45	23	18	3.8±0.3	R		
29	1613	1295	38	0.62	21	17	2.6±0.4	R		
30	1332	1275	20	0.77	30	26	3.1±0.6	R		
31	1450	1380	7	0.95	16					

Ill 1 describes the curved passages of the nonpolarized (S component) and the circularly polarized (dashed line) l.s. radio emission of group No 382 and its neighbor, group No 376, during the period 20–31 October 1969. In this illustration the schematic sketches of these sunspot groups (No 382 and No 376) were depicted according to the photographs of the sun obtained from the Gornyi Astronomical Station of the Main Astronomical Observatory of the USSR Academy of Sciences. The coordinates of the sunspots matched their projections on the diurnal parallel* at the moment of solar radio observation on the LPR. As is evident from Ill 1, the l.s. connected with group No 382 (parameters I and V) consists of two parts, the largest of which is identified with the leading portion of the group and the smaller with the trailing portion. The table, therefore, consists of reductions made for values of the spectral density of the fluxes**, the integral degrees of polarization, and also for the polarization sign for the entire group No 382 ($F_\Sigma P_\Sigma$) as well as for that portion which matches the leading sunspot (F_{beg}, P_{beg}). It is necessary to note the relatively narrow

*Translator's note: This is thought to be a technique whereby the profile of the radio emission from only the active region is plotted in order to show its position during disk transit.

**The spectral density of the "quiet" sun flux in absolute units was set equal to 238×10^{-22} watt m^{-2} Hz (ref 10).

[10] L. Mollwo et al Intern Report presented at the III IQSY Assembly Madrid, 1965


I
V
20X
21X
N376
22X
N382
23X
24X
25X
(CMP)
26X
27X
28X
29X
30X
E
W
31X
D_θ

III 1

degree of l.s. polarization (P = 1–7%), which is evidently characteristic for large Class F groups having a complex magnetic field structure located in the photosphere. An analogous observation was noted in reference 11. The smallest degree of l.s. polarization was also observed close to the group's passage across the central meridian. Polarization sign reversal occurred during the period 27–28 October: this is in agreement with reference 6.

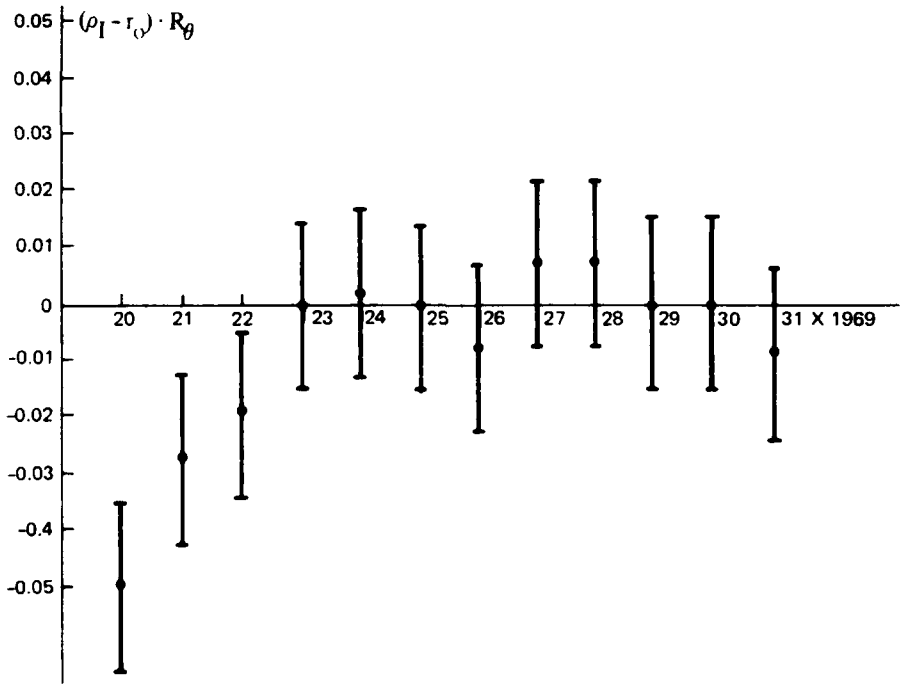
Let us evaluate the heights of the l.s. emitting regions connected with group No 382. Assuming a radial distribution of the sunspot and the emitting layers, the heights (h) of the sources above the photosphere are determined by this well known formula (ref 12):

$$h_{I,V} = \frac{\rho_{I,V} - r_o}{r_o} \qquad (1)$$

where $\rho_{I,V}$ represents the coordinates of the l.s. nonpolarized and polarized emission maxima relative to the disk center, and r_o the coordinates of the projected center of gravity for the sunspot on a diurnal parallel, also relative to the disk center.

Analogously, it is also possible to determine even the height differences for the polarized and nonpolarized l.s. emissions.

The results of the coordinate measurements ($\rho_I - r_o$) of the l.s. connected with group No 382 are presented in Ill 2. During the first 3 days (20–22 October), displacement of the coordinate for the nonpolarized l.s. emission maximum was observed relative to the umbra along the direction of solar disk center. During these days the height of the



Ill 2

[11]GB Gel'frejx, NG Peterova, AŽ, 47, 689, 1970
[12]VN Ixsanova, Izv GAO, No 164, 1960

nonpolarized l.s. emission above the photosphere appeared negative, which would evidently indicate an inaccuracy in the assumption of a radial distribution of the sunspot and emitting regions. It is possible that one of the reasons for such a displacement stems from the rearrangement of the umbra in the leading portion of the group which took place during these days. For the remaining days the difference in the coordinates ($\rho_I - r_0$) was close to zero, which is probably indicative of a small l.s. height above the photosphere. The height above the photosphere of the nonpolarized l.s. emission region (determined according to formula (1)) does not exceed 10 000 km to 15 000 km. During the period from 23 to 29 October, the l.s. under investigation was located above the first umbra of the leading portion of the group.

The difference in the coordinates of the polarized and nonpolarized l.s. radio emission maxima ($\rho_I - \rho_V$) was evaluated for the period 21–23 October when the observed group was unipolar. It appears that the sources of the polarized l.s. radio emission are displaced toward the solar disk center, relative to those which were nonpolarized. If we utilize formula (1) the polarized emission source appears below the nonpolarized source which, as determined above, was located in the photosphere. Obviously such a result is meaningless and it is possible to surmise that the regions of polarized and nonpolarized emission generation were also displaced relative to one another.

Subsequently, beginning with the 24th of October, when the polarization sign change was observed and until the end of the group's existence on the disk, it was difficult to tie the position of the polarized sources to the position of the nonpolarized sources and sunspots in the photosphere.

Obviously the absence of this link and the relatively small degree of polarization are a consequence of polarization washout for groups in the Class F phase having complex magnetic structure located in the photosphere.

The authors thank GB Gel'frejx for his valuable remarks during the course of the work and NF Šaxov for his help with the processing of the observational material.

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