OCT 11 1967

National Aeronautics and Space Administration
Goddard Space Flight Center
Contract No.NAS-5-12487

ST-SP-RA-10653

RELATIONSHIP BETWEEN THE RADIOEMISSION FLUX FROM LOCAL SOURCES IN THE SUN WITH THE STRUCTURE OF THE OPTICALLY OBSERVED ACTIVE REGIONS

by

A. R. Abbasov

(USSR)

9 OCTOBER 1967

RELATIONSHIP BETWEEN THE RADIOEMISSION FLUX FROM LOCAL SOURCES IN THE SUN WITH THE STRUCTURE OF THE OPTICALLY OBSERVED ACTIVE REGIONS*

Doklady A.N. SSSR,
Astronomiya
Tom 174, No.3, 538-40
Izd-vo "NAUKA", 1967

by A. R. Abbasov

SUMMARY

The relationship between the radioemission flux from local sources in the Sun's disk with the structure of the active regions observed optically is discussed by the results of statistical processing of daily radioastronomical data available at the Moscow International Center of Data Compilation. Some conclusion is offered in regard to possible proton burst forecasts.

*
* *

The characteristics of radioemission from local sources in the Sun, required for the investigations of solar activity, are insufficiently studied, whereupon a series of anomalous cases are known, which are difficult to explain. In order to obtain more complete data allowing us to broaden the possibilities of interpretation of results avaialble, we bring forth below the results of statistical treatment of daily radioastronomical observations filed at the Moscow international center of compilation of data.

The observations subject to such a processing correspond to those of 1961 and 1963, which were selected according to criteria referred to in [1, 2]. Moreover, the cases linked with the appearance of sources in the E-limb and their vanishing in the W-limb with a two-day reserve, were rejected. Then, equations of the following form were composed:

$$F_{\lambda_i} = \alpha_{1\lambda_i} \sum_{k=1}^{n} S_{\text{гл}_k} + \alpha_{2\lambda_i} \sum_{k=1}^{n} (S_{\text{p}_k} - S_{\text{гл}_k}) + \alpha_{3\lambda_i} \sum_{j=1}^{m} S_{\Phi_j} + F_{0\lambda_i},$$

where F_{λ_i} is the total flux of radioemission in the λ_i wavelength; $S_{\text{гл}_k}$ is the area of the main spot of the k-th group in ppm of the Earth's hemisphere;

---

* O SVYAZI POTOKA RADIOIZLUCHENIYA LOKAL NYKH ISTOCHNIKOV NA SOLNTSE SO STROYENIYEM AKTIVNYKH OBLASTEY NABLYUDAYEMYKH OPTICHESKI

$\alpha_{1\lambda_i}$ is the proportionality factor linked with the main spot; n, m are respectively the number of sunspots and floculli in the solar disk for the given day; S_{pk} is the total area of the k-th sunspot group in ppm of Sun's hemisphere; $\alpha_{2\lambda_i}$ is the proportionality factor linked with the remaining group spots; $S_{\phi j}$ is the area of the j-th flocculus in ppm of Sun's hemisphere; $\alpha_{3\lambda_i}$ is the proportionality factor linked with the area of flocculi; $F_{0\lambda_i}$ is the radioemission flux of the quiet Sun.

TABLE 1

λ, см	$\alpha_{1\lambda_i}\cdot 10^{6}$	$\alpha_{2\lambda_i}\cdot 10^{3}$	$\alpha_{3\lambda_i}\cdot 10^{5}$	$F_{0\lambda_i}\cdot 10^{22}$, м²
		1961		
3,2	24 ± 3	11 ± 2	35	244
8,0	23 ± 2	28 ± 3	63	89
		1963		
3,2	26 ± 3	13 ± 2	[illegible]	236
8,0	24 ± 2	27 ± 2	50	81

$\alpha_{1\lambda_i}$, $\alpha_{2\lambda_i}$, $\alpha_{3\lambda_i}$ and $F_{0\lambda_i}$ *. were found by the method of least squares. All calculations were conducted at the computing center of the Leningrad State University using the M-20 computer.

The results of computations are presented in Table 1. It follows from it that the ratio of radioemission intensity of two regions of the source, namely of the group of spots linked with the main spot and the remaining group spots, depends on : at λ = 8.0 cm these intensities coincide, within the limits of errors, and at λ = 3.2 cm their ratio is of the order of two. This leads to a notable difference in the contribution of the region of emission of the main spot and of remaining spots to the total emission.

The noted singularity may be caused by the different contribution of bremmstrahlung and magnetic bremmstrahlung mechanisms to the emission of the various regions of the source, for the intensities of the magnetic field H of the main and the peripheral points are different (H increases with the increase of spot area). The value of the intensity, sufficient for the effectiveness of the magnetic bremmstrahlung mechanism, depends on λ(it decreases as λ increases); this is why at λ = 8 cm this mechansim is effective for all spot groups, while at λ = 3.2 cm it is effective only for the main spot.

The above results agree well with the observations of single sources and allow us to diminish the data discrepancy in various publications. For example, spectra of 10 sources are brought out in [3], including two anomalous ones: the radioemission flux in them was found to be greater at 3.2 cm than at 8 cm. The calculation of the ratio $S_{г.п}/S_p$ gave for them the values 0.92 and 0.87, as was to be expected, and contrary to the same value for the remaining ones, which fluctuated from 0.65 to 0.14.

The results of observations of 60 single sources at λ = 3.2 cm and λ = 7.5 cm are brought out in [4]. The utilization of these data for the construction of the link between $F_{3,2}/F_{7,5}$ and $S_{г.п}/S_p$ gives the dependence plotted in Fig.1, which also agrees well with the above conclusions.

---

* Utilized here were the radioastronomical observations at the station Toyokawa and the optical data published in the "Solar Data" bulletin.

Several spectra of single sources with identical S_p but different $S_{r.л}$ could be constructed by the results of observations of stations Toyokawa and Ottawa. As follows from Fig.2, for all of them: 1) $S_{r.л}/S_p = 0{,}92$; 2) = 0.50; 3) = 0.30, the above dependences of the shape of the spectrum on the ratio $S_{r.л}/S_p$ are satisfied.

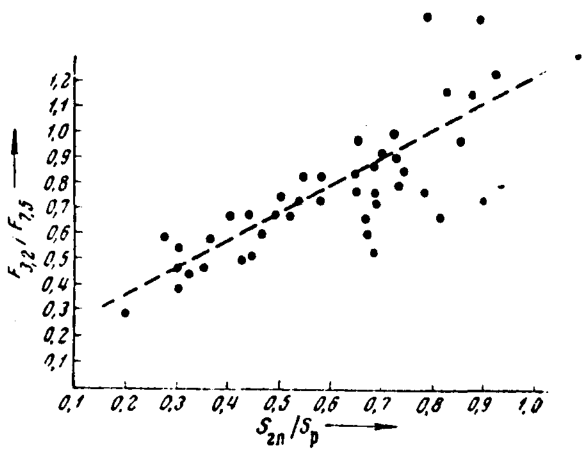

Fig.1

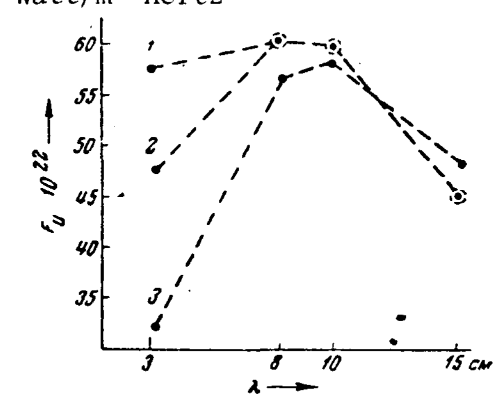

Fig.2

A stronger dependence of the flux on the magnetic field at λ = 3.2 cm than on λ = 8 cm must be reflected on the dimensions of the source, which is corroborated by observations during eclipses, according to which at λ = 3.2 cm the attraction of the source is lesser than at λ = 10 cm [5]. Besides, it follows from the above considerations that during observations with sufficient angular resolution, above complex spot group the source must consist of two p parts at least in certain wavelengths. Such cases are described in literature (see [5]).

The above referred-to strong dependence of $F_{3,2}/F_{7,5}$ on $S_{r.л}/S_p$ may be compared with the link of the ratio $F_{3,2}/F_{7,5}$ with the probability of proton burst occurrence indicated in [4], and it may be expected that such a burst may be forecast according to optical observations, determining the ratio $S_{r.л}/S_p$. The preliminary verification of 18 bursts provided a corroboration of such an assumption in 14 cases.

**** THE END ****

Leningrad State University

Manuscript received on
30 August 1966

CONTRACT no.NAS-5-12487
VOLT TECHNICAL CORPORATION
1145- 19th St.NW. D.C. 20036
Telephone: 223-6700

Translated by ANDRE L. BRICHANT
on 7 - 9 October 1967

REFERENCES

1. A. P. MOLCHANOV. Astronom. Zh., 38, 5, 849, 1961.

2. A. R. ABBASOV. Soln. dahhyye (Solar Data), 6, 69, 1963.

3. G. SWARUP, T. KAKINUMA ET AL. Astrophys. J. 137, 4, 1252, 1963.

4. H. TANAKA, T. KAKINUMA. Rep.Ionosphere and Space Res. Japan, 18, 1, 32, 1964.

5. A. P. MOLCHANOV. Izv. Glavn. Astronom. Observ.AN SSSR, 24, 177, 38, 1964.