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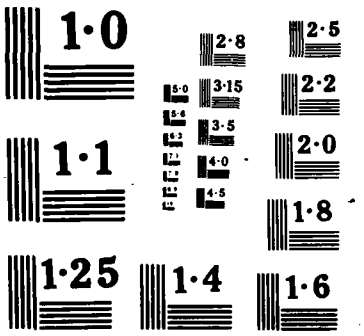
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RELATIONSHIP BETWEEN WEAK LOCAL RADIO SOURCES AT λ = 6.6 cm AND ACTIVE REGION CHARACTERISTICS, II

Translated by CM Bigger from an article by GB Gel'frejx, ZB Korobova, and NP Stasjuk
Edited by MP Bleiweiss

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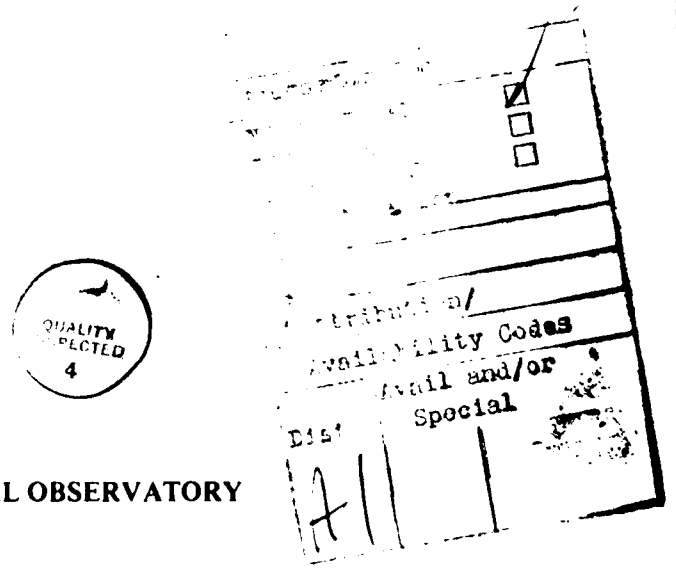

LA POSTA ASTROGEOPHYSICAL OBSERVATORY

At the present time there is no clear understanding of the physics of active region formation and decay. It is, therefore, of great interest to present the results of an investigation on the interrelationship of parameters characteristic of an active region during precisely these initial and final development stages.

The evolution of active regions can be traced most clearly by observing the appearance of weak local sources (l.s.) above flocculi during the appearance and disappearance of sunspots. In the first part of our work[1] we conducted a comparison of active region characteristics with processed solar strip chart data done during 1964 at $\lambda = 6.6$ cm. It was found that the weak radio emission flux of the S-component correlated well with the area of the sunspot groups but very poorly with the area of the floccular region. It is proposed[1] that the small correlation coefficient for l.s. flux and area of the separate floccular regions is a consequence of the overall area of the region occupied by the flocculus being utilized for the calculation rather than just the areas of the small intense knots. Therefore the processed observational material was obtained on the AFR-2 chromosphere telescope at the Institute of Astronomy of the Uzbek SSR Academy of Sciences. Now, when calculating the area of the floccular region only the intense small knots are considered while the background noise between them is omitted. But even in this case, the correlation coefficient for the l.s. emission flux and the floccular region area was not very high, $\Delta_r = 0.32 \pm 0.11$ ($m = 67$). Nevertheless, for a confidence level of 0.95, the resulting value $\Delta_r = 0.32$ is already comparatively larger than 0.241, which is the positive limit of the true correlation coefficient. This is assuming an absence of association for the $m = 67$ pairs of values [2]. For the given case, the actual correlation coefficient lies within the limits (0.09 - 0.51).

As a result of the small values obtained for the correlation coefficient of l.s. emission flux and floccular area, one may assume that a possible interrelationship of l.s. radio emission capability and floccular region enhancement in the optical wave range can be shown. For the clarification of this hypothesis the mean enhancements for the separate regions were determined on a Hα filtergram by a six-stage platinum attenuator imprinted in the depiction center of the solar disk.* The mean enhancement values found for the floccular regions are expressed in units of enhancements of the solar disk center. The correlation coefficient for the l.s. radio emission flux and the mean enhancement of the floccular region is equal to $\Delta_r = 0.67 \pm 0.06$ ($m = 67$). The correlation of the l.s. radio emission flux with the mean enhancement of the floccular region is higher than with the floccular area. Considering this mutual dependency during the calculation of the correlation coefficient, it is possible to assume that the l.s. radio emission flux is connected with area and enhancement of the floccular region through a complex correlational relationship.

It is known[1] that the mean sizes of the l.s. above floccular regions without sunspots are on the order of 2.0 - 3'.5, which exceeds by one and a half to two times the width of the direction diagram of the telescope. The sizes of sources above active regions containing sunspots average 1.0 - 2'.5. The flux from the radio source increases significantly during the appearance of sunspots in the active region. For the relationship of the source size and the direction diagram width described above, it is not possible through direct observation to separate emissions associated with flocculi from those associated with sunspots. In addition, it is known that, in the range of 21 cm, the large portion of the active region radio emissions is formed by a flocculus[3]. Analogous confirmation on the basis of observations at 10 cm can be found[4]. At wavelengths shorter than 10 cm, high resolution observations show that

* Translator's note: This is presumed to be a calibration technique.

1. GB Gel'frejx, ZB Korobova, NP Stasjuk, Soln dannye, No 11, 1974
2. SA Ajvazjan, Statističeskoe issledovanie zavisimostej Izd "Metallurgija," M, 1968
3. WN Christianson i, DS Mathewson, Radioastronomija. Parižskij simpozium 1958g IL, M 1961, str 109
4. EE Covington, J Roy Astr Soc Canada, 63, 125, 1967

strong l.s. are associated with sunspots and not with flocculi[5-9]. Therefore, utilizing homogeneous observational material, it is interesting to examine to what extent radio emissions of active regions containing only floccular areas differ from those of similar areas of approximately the same enhancement having an additional small sunspot group. For clarification of the overall picture, the active regions and the l.s. identified with them were divided into groups according to the enhancement interval of the flocculi. The mean characteristics of the components of these active region enhancement intervals were then calculated and are presented in the table.

Mean Values and Root Mean Square Errors

Interval of the mean floccular enhancement for the Hα line	Floccular region area according to intense knots in Hα line m.s.h.	l.s. emission flux $\left(\frac{F_{l.s.}}{F_{\theta QF}}\right)\cdot 100\%$	Size of l.s. in arc min	l.s. temp enhancement 10^3K	Area of sopt groups m.s.h.	Number of cases
		a) active areas not containing sunspots				
1.1-1.2	298 ±213	0.806 ±0.577	3.47 ±1.88	61.4 ±65.6	–	40
1.3-1.4	291 ±171	0.880 ±0.417	3.82 ±2.23	42.1 ±18.6	–	18
1.5-1.6	338 ±144	0.686 ±0.225	6.31 ±1.72	26.2 ±3.2	–	3
		b) active areas with small sunspot groups				
1.1-1.2	537 ±271	1.128 ±0.373	3.28 ±1.72	62.5 ±34.3	55 ±195	10
1.3-1.4	549 ±109	0.976 ±0.409	2.63 ±1.25	69.5 ±40.1	44.9 ±110	27
1.5-1.6	473 ±376	1.359 ±0.612	2.88 ±2.02	108.5 ±83.1	67.6 ±106	13
1.7-1.8	484 ±324	2.257 ±1.345	2.53 ±0.96	122.2 ±104.1	92.6 ±102	10
1.9-2.1	410 ±158	2.717 ±1.655	1.96 ±0.57	245.0 ±262.2	146.4 ±139	7

5. VN Ixsanova, Izv GAO AN SSSR, 21, vyp. 5, 62, 1960; 24, vyp 4, 51, 1966; 24, vyp 6, 229, 1967
6. SB Axmedov i, dr, Soln dannye, No 1, 1966; No 2, 1968
7. VN Borovik, Soln dannye, No 1, 1968
8. AN Koržavin, NG Peterova, AŽ, 45, 36, 1968
9. GB Gel'frejx i, dr, Izv GAO AN SSSR, No 185, 167, 1970

It must be noted that the calculation of the l.s. temperature enhancement was in the form of a circle with the diameter equal to the angular size as measured along one coordinate (cross diagram of the direction). Since the real area of the radio source (taking into consideration its fine structure) is possibly many times smaller than that assumed by us, the values of the enhancements shown in the table are at their lowest limits. The values calculated in line three may differ significantly from the actual values because the statistical data for this case were inadequate.

A comparison of the reductions of the mean values in the table shows that the presence of even small sunspot groups leads to a change in the basic parameters of the radio source. The radio emission flux from the l.s. for the same mean value of floccular enhancement increased a few tens of percent as did the upper limits of the mean enhancements and the radio flux.

The value of the correlation coefficient between the flux and the enhancement of the floccular regions located above sunspot groups equals $\Lambda_r = 0.61 \pm 0.07$ (m = 76). It is, therefore, possible that in the presence of sunspots the association becomes somewhat weaker. For the given case the true correlation coefficient lies in the interval (0.44 - 0.77). The correlation coefficient between l.s. flux and the enhancement of flocculi in regions without sunspots equals $\Lambda_r = 0.67 \pm 0.06$. The true correlation coefficient falls in the interval (0.51 - 0.80), ie, the intervals overlap significantly, the actual correlation coefficients may coincide with great confidence, and the degree of association does not change. On the other hand, let us also recall that the enhancement of the floccular region reaches a maximum when the sunspots are not large. This was reliably established in reference 10. The correlation coefficient for the l.s. flux and the floccular region area (the small intense knots) in the presence of sunspots has the value $\Lambda_r = 0.22 \pm 0.11$ (m = 76). The correlation is still weaker than for the case of flocculi without sunspots ($\Lambda_r = 0.32$). This is obviously a case of the influence of the sunspot's magnetic field, the presence of which leads to the growth of the radio flux.

It is apparent from the table that in the weak active region approximately 1/3 - 1/4 of the radio emission flux was connected with the sunspots and 2/3 - 3/4 with the floccular area. Let us emphasize that the numbers cited match up weak l.s. (flux is 1% of the total solar emission) with the strong sources by suppressing the apparent emissions associated with the sunspots and their large magnetic fields.

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10. ZB Korobova, Soln dannye, No 8, 1964

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