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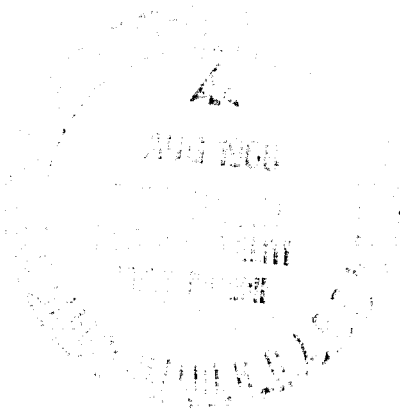
QUASIPERIODICAL LOW-FREQUENCY FLUCTUATIONS OF SUN'S RADIOEMISSION

by

O.I. Yudin

(USSR)



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QUASIPERIODICAL LOW-FREQUENCY FLUCTUATIONS OF SUN'S RADIOEMISSION

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SUMMARY

The quasiperiodical low-frequency fluctuations of Sun's radioemission are studied on the basis of influence of weak chromospheric parameter fluctuations on the variations of Sun's radioemission flux. To that effect the quasi-zero registration method was applied in the 3.3 cm wavelength. The results obtained by the author corroborate the findings that its quasiperiodical modulation is conditioned by processes in the upper chromosphere.

* * *

By its structure, the solar chromosphere is a complex and heterogenous medium, in which parameters determing its formation fluctuate around several mean values. Motions of chromospheric masses of various scales [1], of which the most intensive are observed in it alongside with spatial fluctuations, induce variations in the flux of Sun's radioemission in the centimeter wave range. Radioemission $\lambda \sim 3$ cm wave originates from the chromospheric layers, located at altitudes ranging from $5 \cdot 10^3$ to 10^4 km above the photosphere, and, consequently, its variations are conditioned by the processes in this region.

For the investigation of influence of weak chromospheric parameter fluctuations on flux variations of Sun's radioemission, a quasi-zero registration method was applied in the 3.3 wavelength [2,3]. Investigations of statistical characteristic fluctuations of signal level from the Sun, have been carried on the radioastronomical range of our Institue "Zimenki" since 1964. The signal at radiometer output was proportional to the difference of temperatures Δt at its input

$$\Delta t = T_{A\odot} - T_{ng}$$

where $T_{A\odot}$ is the temperature at the radiometer output when radiotelescope antenna is aimed at the Sun and T_{ng} is the temperature at the second input of modulation radiometer, produced by the noise generator. As a result of lengthy observations

it was determined that with the appearance on the Sun of active retions, signal level fluctuations at radiometer output increase from 0.05 to 1.0% from $\overline{T}_{A\odot}$. The recurring frequency of these events is 70-80%. Altogether 200 cases of signal fluctuation growth were observed during the 3 and a half years. Such penomena were also observed earlier [4-6] and explained only by the troposphere influence.

In view of this we specially carried out experiments for the separation of effects of solar origin from the fluctuations caused by other reasons, such as equipment instability, tropospheric propagation, etc.. Application of quasi-zero reception method of solar radioemission, allowed us to reduce by one order the random variations ΔT_α of signal level at radiometer output caused by the fluctuations of the amplification factor. Measurements showed, that $\Delta T_\alpha < 0.05\%$ of $\overline{T}_{A\odot}$. To eliminate the influence of other factors, the observations were conducted on two radiotelescopes installed in one place at the outset, and later spaced by a distance of 500 m from each other. Comparison of registrations of solar radioemission flux variations on both radiotelescopes, showed that the fluctuations observed at solar activity increase, remain correlated also in the dispersion reception. The average mutual correlation coefficient of registrations from two antennas is 0.5 for the active Sun and 0.1 for the quiet Sun. By this method the influence of effects, due to the equipment, were totally eliminated.

To decrease the influence of tropospheric inhomogeneities on signal fluctuations, the observations were conducted at the height of the Sun exceeding 15 to 20° above horizon. It is well known [7], that for small-scale inhomogeneites, the correlation radius of spatial field fluctuations of radioemission flux, having passed through an inhomogenous layer of thickness L, is equal to $\sqrt{\lambda L}$. In our case $\sqrt{\lambda L} << 500$ m, which allows us to by-pass the investigation of these field inhomogeneities as the source of the observed fluctuations. The large-scale inhomogeneities with dimensions $l > 500$ could, in principle, cause correlated fluctuations at radiotelescope output, spaced by a distance $d < l$. However, for such an explanation of vari tions in the observed solar radioemission flux it is necessary that the appearance in the atmosphere of large-scale inhomogeneities of refractive index, be linked with the appearance of active regions on the Sun. For such an assertion there are neither experimental nor theoretical foundations. Thus, according to our own judgement, there are enough reasons to consider that the correlated part of radioemission flux's fluctuations at the output of both spaced radiotelescopes, represents signal variations linked with processes in the solar chromosphere.

Analysis of signal $T_{A\odot} - T_{ng}$ fluctuations was made by spectro-

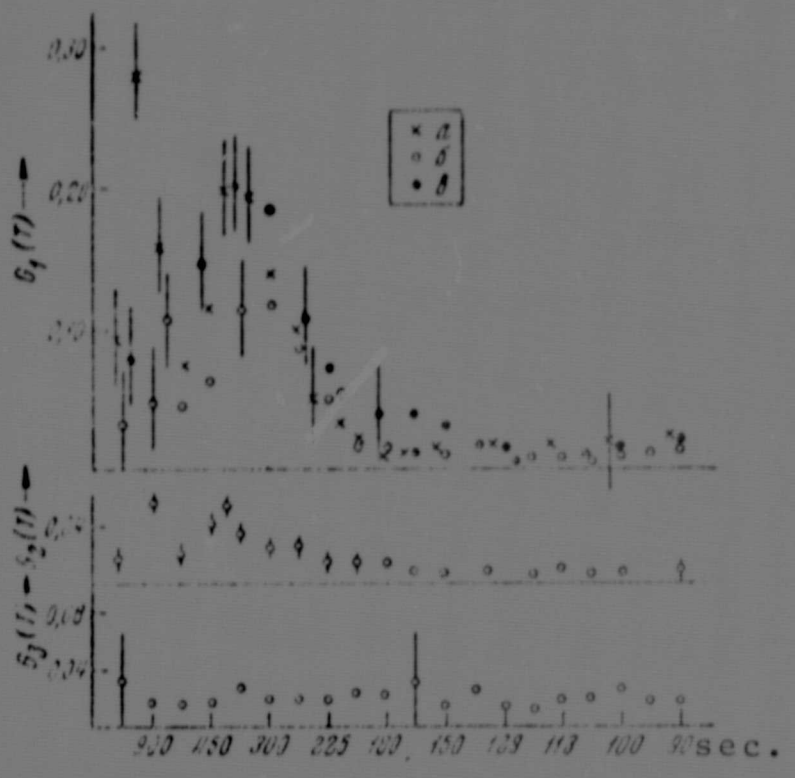

Fig. I. Spectra of Realisation:
G_1) Spectra of perturbed Sun;
G_2) Spectra of the quiet Sun;
G_3) Spectrum of noise generator:
a) 18 Oct.1966 at 0920-1100 hrs
b) 25 Oct.1967 at 0820-0930 hrs
c) 30 May 1967 at 1512-1610 hrs.

correlative method by using computer. The energy spectra were computed in the frequency range from 10^{-3} to 10^{-4} hertz by experimental auto- and intercorrelated functions. Actually we obtained the sum of fluctuation spectra of two signals $T_{A\odot}$ and T_{ng}. That is why the fluctuation of solar radioemission flux represents the difference between the spectra of the signal $T_{A\odot} - T_{ng}$, and the signal fluctuation spectrum from noise generator. The latter was determined experimentally from the registrations of difference in the emissions of both noise generators switched to radiometer input (T_{ng}-T_{ng}). Maxima were found in the spectra of signals $T_{A\odot}$-T_{ng}, the intensity of which correlated with the variation of Sun's activity. In the T_{ng} spectra such maxima are not observed, the spectrum in the analyzed frequency range is uniform with a precision to measurement errors.

Shown in Fig.I, are the instantaneous spectra of active Sun's noise registration (G_1), in which the intensity of quasiperiodical components is 2-4 times higher than that of the components in the spectra of quiet Sun (G_2). For comparison we brought up here the instantaneous fluctuation spectrum of noise generator (G_3). The vertical lines denote boundaries 95% of reliable interval ($\pm 2\sigma$). The quiet Sun's spectrum is obtained by averaging six reali ations, which reduced the random error. The relative values are plotted in the ordinate axis.

The obtained spectra are evidence of presence of quasiperiodical modulation of Sun's radioemission observed during quiet Sun, increasing with the emergence of active centers on the Sun. Such quasiperiodical components in the fluctuation spectra of solar radioemission flux were found for the first time. The frequency of modulation periods vary from one registration to another.

A histogram is shown in Fig.2, of quasiperiod modulation observed at different times between October 1966 and May 1967. Periods of the observed oscillations coincide with the vertical oscillations of photospheric layers and lower chromosphere detected by Leighton [8]. According to our opinion, the obtained results allow us to confirm that the quasiperiodical modulation of solar radioemission flux, is conditioned by the processes in upper chromosphere. This conclusion does not contradict the contemporary representation of the structure and the dynamics of solar chromosphere As a matter for discussion one may point to two possible mechanisms of this phenomenon; it is the quasiperiodical modulation of solar radioemission by vertical motions in chromosphere, and the modulation conditioned by chromospheric spicular structure [9].

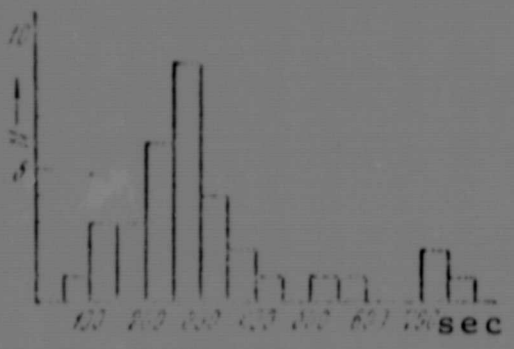

Fig.2

Histogram of Modulation Periods

In conclusion I consider it my duty to express my gratitude to M.M. Korbin for stating the problem to M.S. Durasova, G.A. Lavrinov and A.K. Chandaev for the great assistance in carrying out the experimental work and in the processing of observation materials, and to V.V. Zhelyeznyakov for the constructive discussion of the results.

* * * THE END * * *

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Volt Technical Corporation
1145 19th Street, N.W.
Washington, D.C. 20036
Telephone: [202] 223-6700 X-36,37.

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Dr. Andre L. Brichant
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