Astronomy

Relation of Noise Storms to Optical Phenomena on the Sun

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ABSTRACT. Long-term observations of the solar radio noise storms carried out at Abastumani Astrophysical Observatory with the solar radio telescope at 210 MHz are presented. It is shown that there is a strong correlation between the amplitude of the noise storm and sunspot number. © 2011 Bull. Georg. Natl. Acad. Sci.

Key words: radio storm, radio noise, radio burst.

As is known the discovery and study of the solar radio emission have played an important role in the investigation of the processes occurring on the Sun. The fact that the solar radio emission manifests itself in two ways, as the “quiescent” and “disturbed” i.e. “sporadic” Sun, attracts one’s attention. Their distinguishing features are known as well.

The solar radio emission of the “quiescent” Sun is explained by the atmospheric thermal emission, the power of which is estimated by the solar corona temperature.

The radio emission of the “disturbed” Sun is related to the features on the solar surface (flares, spots etc).

The emission of different wavelengths arrives from various depths of the solar atmosphere. Accordingly, if the wavelength, on which the solar radio emission is obtained, is changed, the investigation of the solar atmosphere in its full depth will be possible.


The radio telescope used at the observatory is described in [1]. Its receiving part is tuned at 210 MHz frequency and operates by the modulation method. Accurate and rough channels are provided in this piece.

On the abundant data, accumulated over many years, it is well expressed that the noise storm is closely connected with the solar spot or a group of spots. In many cases the spots group accompanied by the solar radio storm is of E and F types (according to the accepted classification). The fact that the spots or a group of spots of opposite polarity could be the source of the noise storm is established as well. Certain characteristics of the noise storm, such as its duration and intensity, are closely connected with the 11-year solar activity cycle. All the parameters vary with that of the solar activity cycle.

The question, whether the noise storm is connected with other solar features, i.e. flares, is answered by various authors in different ways. Some believe that any chromosphere flare precedes or coincides with the noise storm in time [2]. Others think that the noise storm is only observed when there are strong chromosphere flares with power of 2 or 3 points on the Sun [3].

It is known that the noise storm lasts several hours or days. Therefore the noise storm might coincide with the chromosphere flare, especially when its lifetime is more that 30 min.
Although at present there exist a lot of investigations devoted to the origin of the noise storm and its relation to the solar activity cycle, out of our tremendous data, comprising more than 40 years, we have singled out about 400 such cases when the relation effect is more obvious. Therefore I should like to consider three distinguished events, e.g. optical observations performed at the Abastumani observatory according to the “Solar Service” program during almost 5 solar cycles, their comparison with radio observations recorded by me in the same time period and an appropriate analysis.

Fig. 1 is the diagram of 13.09.88 solar radio emission. The observational moments in U.T. are in Z-direction and the emission intensity in $10^{-22}$ WM$^{-2}$ Hz$^{-1}$ units in Y-direction. The diagram corresponds to type I radio emission, i.e. to the noise storm [6] resulting from the active areas observed in the optical band. Fig. 2 shows the photos of the sunspots on the same day, when Wolf’s number attained 270 and the sunspot area was $1.714 \times 10^{-3}$ millionth of the solar hemisphere. The chromosphere flare of 1 point is recorded with the observatory chromosphere telescope, apparently, giving rise to the noise storm observed in the radio band. May 7, 1992 radio emission in the above units is plotted in Fig. 3 and Fig. 4 shows the sunspot photos of the same day. Here Wolf’s number is 150 and the sunspots total area in the above units makes up $3.545 \times 10^{-3}$.

According to October 11, 2002 observations a rather large sunspots group, shown in Fig. 5, was noticed on the east solar limb near the North Pole. At the same time a noise storm, displayed in Fig. 6, was observed in the radio frequency band. It is clearly seen that it is rather an intensive one and fluctuates in $(40-100) \times 10^{-22}$ WM$^{-2}$ Hz$^{-1}$ units.

Statistical analysis of observational data has shown that as a rule, in most cases the radio emission, is connected with sunspot groups. In particular, the noise storm is formed in the sunspot groups of a complex pattern, in the process of large spots growth. At the same time magnetic flux maxima of the radio emission and large sunspot groups coincide with the accuracy of a day. Powerful magnetic fluxes of the sunspot groups, for their part, represent a precondition of strong chromosphere flares.

Various researchers [7,8] have obtained similar results at different frequency bands [6-8] in terms of interferometric and polarimetric observations. Based on a few examples in [8] a conclusion is drawn that variation of a continuous constant of the noise storm is closely connected with that of the sunspot groups area and type I radio bursts are, likewise, closely related to variation of the sunspots magnetic field tension.
Further refinement and improvement of the mechanism of the noise storm require optical observations of the chromosphere flares and sunspots with magnetographs as well. Such observations will make it possible to fix both the magnetic field tension of large sunspots and variation of their area with the time interval of an hour, besides it might be used to register the noise storm by means of radiospectrographs, interpherometers and polarimeters in different frequency bands.

As a result of the analysis of observational data obtained by the author at the wave 1.43m it is shown that maximum duration of the radio noise is 7-10 days, bursts originate earlier and disappear later than the increased background radiation.

The intensity of the radio emission is as well connected with the value of the magnetic field flux. This suggests the idea that the intensity of the noise storm essentially depends on the gradient of the magnetic fields.

![Fig. 5. Sunspots in the photosphere on October 11, 2002.](image)

![Fig. 6. Diagram of solar radioemission on October 11, 2002.](image)

აშენებულია ისიც, რომ შემდეგი შალთის უკან განითვლის მაქსიმალური სხვაობა ახალმაპყრობელში. პატარა ზეილი შემდგომ გადახვეულ შლელთაგან შემოტოვებით ეხევი. შემდგომ უკან შალთა რადიოავალიები შიგნის, როგორც შემდგომ გამოქვეყნებით, საქართველოში შალთა ახალმაპყრობელი გამოქვეყნება იქნა გამოყენება.

იმის გამო, რომ შალთა შთაბჭობის უკან მაქსიმალური სხვაობა ქვემოთ, მაქსიმალური დამექვავების დაკავშირებით შალთის შიგნის, ლაპარაკში შეიძლება იქნა გამოყენებით, ლამაზი შემდგომი პროცესის შემავალი შალთის შიგნის, თანამედროვე ახალმაპყრობელი. შესაბამისად, რადიოავალიების შემდგომ გამოქვეყნობა შეიძლება ადრეულ ხარჯს გამოყენებით. მაქსიმალური მდგომარეობით შეიძლება შალთის შიგნის, ლაპარაკში, შალთის შალთაში მცირე შეტყობინებით, ლაპარაკში შეიძლება შალთის შიგნის, თანამედროვე ახალმაპყრობელი. ამგვარად შალთა შთაბჭობის უკან შალთის შიგნის ახალმაპყრობელი გადახვევის საფარი შეიძლება გამოიყენოს.