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Astronomy

Correlation between the Solar Radio Noise Storm and the Photosphere Optical Formations

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(Presented by Academy Member J. Lominadze)

ABSTRACT. Long-term observations of the solar radio noise storms carried out at E. Kharadze Georgian National Astrophysical Observatory on 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 and their areas. © *2008 Bull. Georg. Natl. Acad. Sci.*

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

It is known that discovery and study of the solar radio emission have played an important role in investigation of the processes occurring on the Sun. The fact that the solar radio emission presents 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 atmosphere 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 wavelengths are changed, the investigation of the solar atmosphere in its full depth will be possible.

Solar radio observations in the metric bands (λ=1.43, f=210MHz) have been performed at the Astrophysical Observatory since 1957. Observations lasted 4-6 hours per day. Within 1957-2008 highly abundant observational data, comprising the 5 solar cycles (maxima in 1957-1958, 1969-1970, 1980-1981, 1990-1991, 2000-2001), are available. The fifth cycle is in its ascending period.

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.

The abundant data, accumulated over these years, demonstrate well that the noise storm is closely connected with solar spot or a group of spots. Very often the group of spots accompanied by solar radio storm is of E and F type (according to the accepted classification). The fact that spots or a group of spots of opposite polarity could be the source of the noise storm, is established as well. Certain characteristics of a 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 of whether the noise storm is connected with other solar features, i.e. to flares, is answered by various authors in different ways. Some believe that any chromosphere flare precedes or coincides with a noise storm in time [2]. Others think that a noise storm is only observed when there are strong chromosphere flares of 2 or 3 force power, on the Sun [3].

It is known that a noise storm lasts several hours or days. Therefore, the noise storm might coincide with a

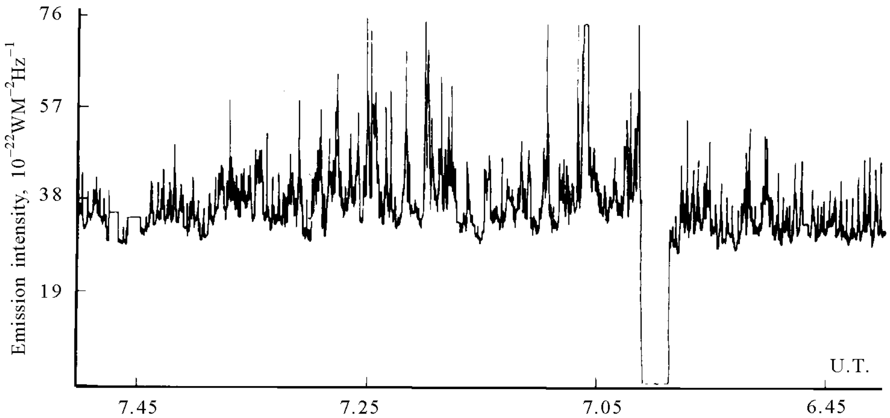

Fig. 1. Diagram of solar radioemission, 24.04.81

chromosphere flare, especially when its lifetime is more that 30 min.

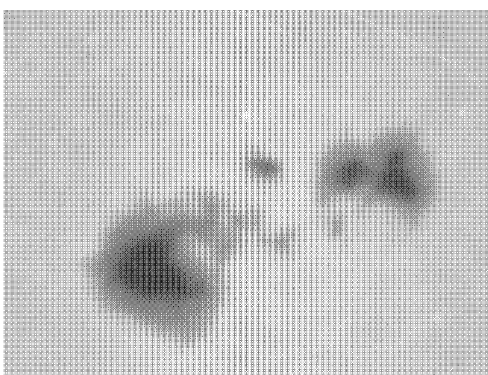

Fig. 2. Sunspots in the photosphere, 24.04.81

Although at present there are many investigations devoted to the origin of the noise storm and its relation to the solar activity cycle, from our huge number of data, covering about 50 years, we have singled out about 200 such cases when the relation effect is more obvious. Therefore we would like to consider three distinguished cases. They are, for instance: optical observations performed at our observatory according to the "Solar Service" program during almost 5 solar cycles, their comparison with radio observations recorded by us in the same time period and an appropriate analysis.

In Fig. 1 the diagram of 24. 04. 81 Solar radio emission is presented. The observational moments in U.T. are in X-direction and the emission intensity in 10^{-22} $WM^{-2}Hz^{-1}$ units in Y- direction. The diagram corresponds to type I radio emission [4] (i.e. to the noise storm) resulting from the active areas observed in the optical band. Fig. 2 shows the photo of the sunspots on the same day, when Wolf's number attained 290 and the sunspot area was $1.832{\cdot}10^{-3}$ of the solar hemisphere. The chromosphere flare of force 1 is recorded by the observatory chromosphere telescope, apparently giving rise to the noise storm observed in the radio band. The Janu-

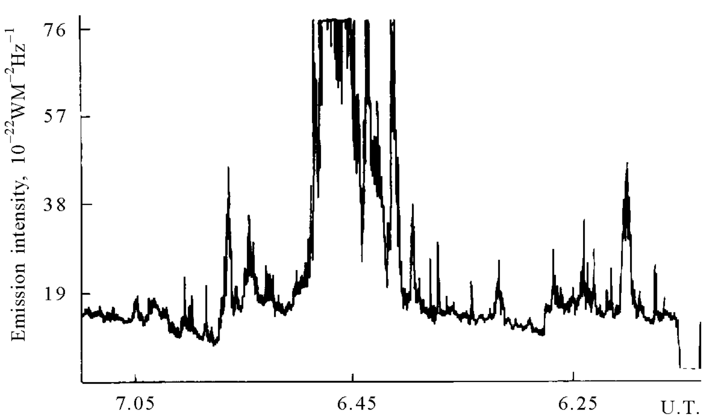

Fig. 3. Diagram of solar radioemission, 18.01.89

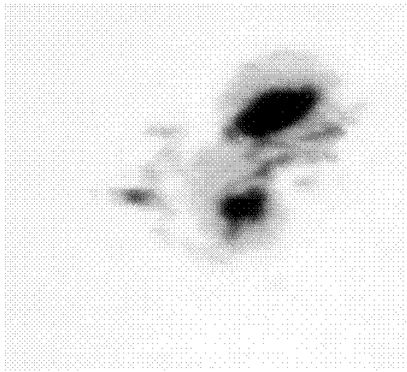

Fig. 4. Sunspots in the photosphere, 18.01.89

ary 18, 1989 radio emission in the above units is plotted in Fig. 3. Fig. 4 shows the sunspot photo of the same day. Here Wolf's number is 162 and the sunspots total area in the above units makes $3.47 \cdot 10^{-3}$.

erful magnetic fluxes of the sunspot groups, for their part, represent a precondition of strong chromosphere flares.

Various researchers [5,6] have obtained similar results at different frequency bands [5-7] at interferometric and polarimetric observations. Based on a few examples in [8], I have concluded 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 record both the magnetic field tension of large sunspots and variation of their area with the time interval of an hour. Besides, it might be as well to register the noise storm by means of broad band radiospectrographs of different frequencies, interferometers and polarimeters.

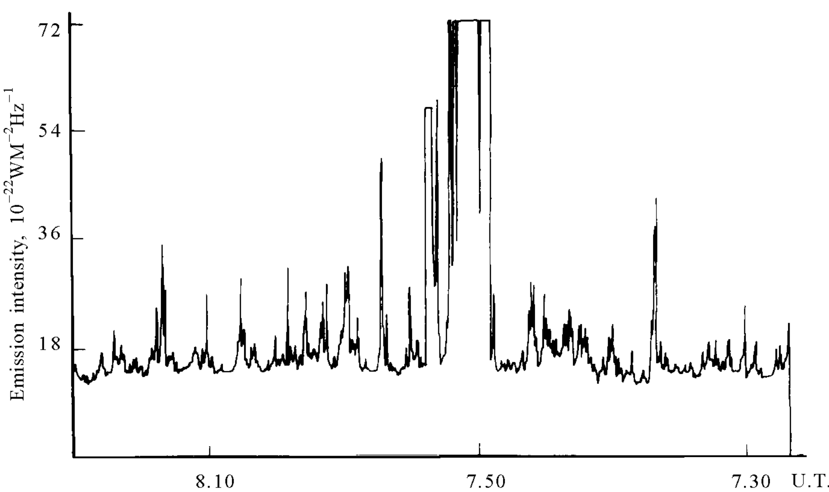

Fig. 5. Diagram of solar radioemission, 14.12.2006

According to observations of December 14, 2006 a rather large sunspots group, shown in Fig. 6, was noticed on the east solar limb near the North pole. At the same time a noise storm, displayed in Fig. 5, was observed in the radio frequency band. Clearly enough, it is rather an intensive one, varying within (30-100) $10^{-22} WM^{-2} Hz^{-1}$ units.

Based on a statistical analysis of the observational data in most cases the radio emission was found to be connected with the 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 radio emission and large sunspot groups coincide with the accuracy of a day. Pow-

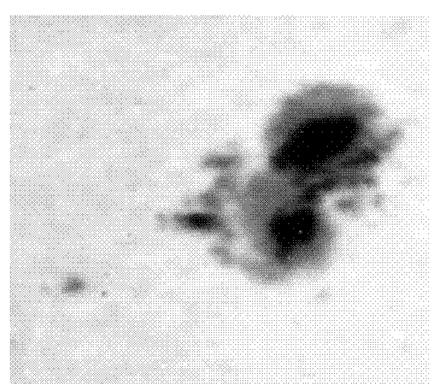

Fig. 6. Sunspots in the photosphere, 14.12.2006

ასტრონომია

მზის რადიოხმაურთა ქარიშხლის კავშირი ფოტოსფეროს ოპტიკურ წარმონაქმნებთან

შ. მაქანდარაშვილი

ე. ხარაძის საქართველოს ეროვნული ასტროფიზიკური ობსერვატორია, აბასთუმანი
ი. ჭავჭავაძის სახელმწიფო უნივერსიტეტი, თბილისი

(წარმოდგენილია აკადემიკოს ჯ. ლომინაძის მიერ)

ე.ხარაძის ეროვნულ ასტროფიზიკურ ობსერვატორიაში სამზეო რადიოდაკვირვებები, ოპტიკურ დაკვირვებებთან ერთად, მიმდინარეობს 1957 წლიდან მეტრიან დიაპაზონში (λ =1.43 მ, f = 210 მგჰც). დაკვირვებათა ხანგრძლივობა ყოველდღიურად 4-6 საათია, 1957-2008 წლებისათვის მოპოვებულია მეტად მდიდარი დაკვირვებითი მასალა, რომელიც მოიცავს მზის აქტივობის 5 ციკლს (მაქსიმუმები 1957-58, 1969-70, 1980-81, 1990-91, 2000-01).

უკვე დაწყებულია ახალი ციკლის აღმავლობის პერიოდი.

იმ დიდ მასალაში, რომელიც წლების განმავლობაში დაგვიგროვდა, კარგად გამოხატულია, რომ ხმაურის ქარიშხალი მჭიდრო კავშირშია მზის ლაქებთან ან ლაქათა ჯგუფთან. ხშირ შემთხვევაში ლაქათა ჯგუფი, რომელსაც თან ახლავს მზის რადიოგამოსხივების ქარიშხალი, მიეკუთვნება E და F კლასს (ლაქათა მიღებული კლასიფიკაციის თანახმად).

ნაშრომში განხილულია აქტიური არეების რადიოგამოსხივების ჩანაწერების დამუშავება 200 სხვადასხვა ჩანაწერიდან. მოყვანილია 3 მაგალითი, როგორც ოპტიკური, ასევე რადიოდაკვირვებებისა. გამოთვლილია სხვადასხვა მახასიათებლები. დაკვირვებითი მასალის ანალიზის საფუძველზე დადგენილია, რომ უმრავლეს შემთხვევაში რადიოგამოსხივება დაკავშირებულია ლაქათა ჯგუფთან. კერძოდ, ხმაურის ქარიშხალი წარმოიქმნება რთული კონფიგურაციის მქონე ლაქათა ჯგუფებში, დიდი ლაქების ზრდის პროცესში. ამასთანავე, რადიოგამოსხივებისა და დიდი ლაქათა ჯგუფების მაგნიტური ნაკადების მაქსიმუმი ემთხვევა ერთმანეთს ერთი დღე-ღამის სიზუსტით. ლაქათა ჯგუფების მძლავრი მაგნიტური ნაკადები კი, თავის მხრივ, მძლავრი ქრომოსფერული ამოფრქვევების წინაპირობაა.

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