

## Interferometer for receiving and recording of radio emission of the Sun at the frequency of 220 MHz

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### ABSTRACT

The interference radiotelescope for receiving of the solar radio waves at frequency 220 MHz and continuous data obtained using the radiotelescope from 1 January 1985 to 30 November 2013 are presented.

### 1. INTRODUCTION

The interference radiotelescope for reception of the solar radio waves was constructed in the Institute of Physics in 1980 for didactic aims and popularization of radioastronomy. The immobile antennas are two so-called long Yaga-type comprising dipole and 10 director pieces, arranged horizontally in the East-West direction. The receiving frequency is 220 MHz. The two dipoles are connected with each other with a concentric cable, making one important common point by means of a T-connection of the BNC type. In this point during the apparent Sun movement, the interference of electrical vibrations takes place in the sky giving characteristic interference minima and maxima in succession. Farther only a single cable connects the antennas with a sensitive receiver, which is a selective transistor microvoltmeter of the WMS-4 type produced by the firm INCO (Wrocław). The

receiving frequency is 220 MHz, the band width of amplified frequencies is 120 kHz. At the output between the microvoltmeter and the recorder an additional circuit integration RC with the time constant of 2 sec was installed. The recorder or recording computer as usually works at the sensitivity of 50 mV on the whole scale, sometimes the system is manually switched over in the case of traditional recorder and automatically in the case of the computer working at present (at the period of active Sun) into a lower sensitivity, e.g. 100 mV or even 200 mV. The tape speed is 12 cm/h. The receiver works without switching off but the recorder is automatically switched on by a controller with a quartz clock at 7:00 UT and switched off at 14:30 UT. The computer switches on the recorder in the same time intervals, using an intrinsic computer clock which is daily synchronized by an internet time server.

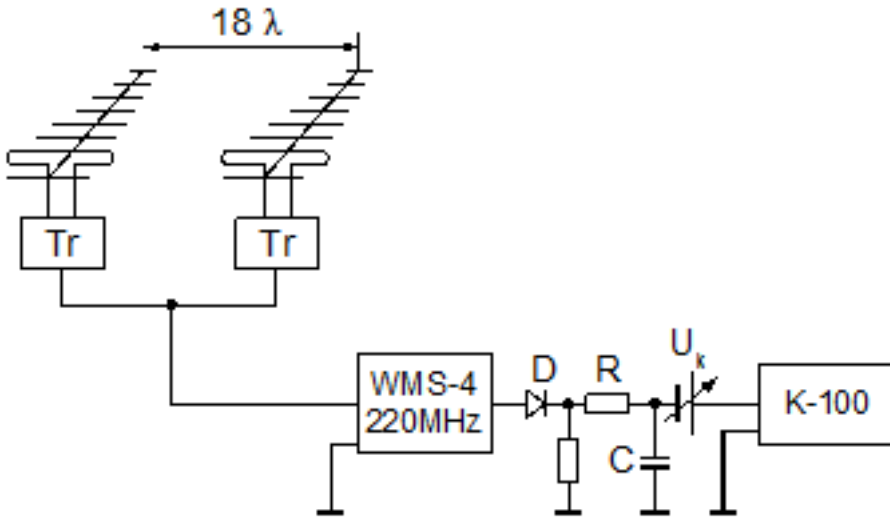


Fig. 1. Scheme of the interference radiotelescope. Tr are matching transformers, WMS-4 is a selective microvoltmeter working as a sensitive receiver, RC is an integrating circuit,  $U_k$  is the compensation system of constant voltage originated from the apparatus noise, K-100 is the recorder. The computer working based on the program written by Tomasz Pieńkos.

As it follows from the course of spectra of quiet and active sun radio emission, the most interesting effect in the form of so-called occasional radio phenomena should be expected on the meter waves; therefore the receiving frequency of 220 MHz was selected. The interference system parameter is the angular resolving power determined from the formula:  $\alpha = \lambda/l$ , where  $\lambda$  is the wave length of the received electromagnetic radia-

tion and  $l$  is the interference system base; in our case  $l = 18\lambda$ . This means that the angular diameter is about  $3^\circ$ . Thus the Sun is received as the whole (Sun angular diameter is  $0.5^\circ$ ), so the interference system resolving power does not allow to locate radio emission centers on the Sun's disk. These are the averaged measurements of total radio emission of the Sun on the wave 1.36 m in the spectrum of 120 kHz bandwidth. All natural radiosources in the outer space emit radio waves which induce electric charge fluctuation (noise) in the antennas.



Fig. 2. Photo of one of two antennas.

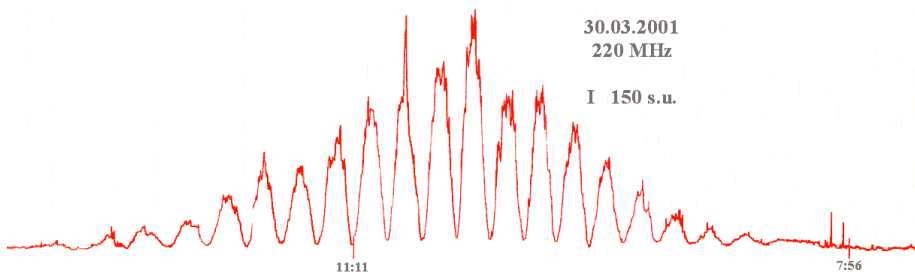


Fig. 3. Typical record of radio emission of the active Sun. There can be seen sequential interference maxima and minima when vibrations from both antennas amplify or attenuate each other in succession due to shift of the Sun position in the sky. The effect of immobile antennas is also visible, the maxima are lower in the morning and in the afternoon. Corrected, full day's courses of interference record are obtained by multiplication of the node heights by the correction coefficients calculated during multiple recordings of the Sun on different days.

## 2. RESULTS

The first recordings of the radio emission of the Sun were made in the Institute of Physics in 1976 at the frequency 105 MHz, then free from the radio station. The website [www.zfo.umcs.lublin.pl](http://www.zfo.umcs.lublin.pl) includes some interesting archival records made by means of the radiotelescope 105 MHz [1, 2]. Regular recordings at the frequency 220 MHz began in 1980 [3] but the data have been elaborated since the beginning of 1985 [4]. All data about rare phenomena, given on [www](http://www) and published in scientific papers and Master theses, were compared with those obtained in the Department of Radioastronomy, Nicholas Copernicus University in Toruń ([www.astro.uni.torun.pl](http://www.astro.uni.torun.pl)). The present authors are grateful to M.Sc. Grażyna Gawrońska for her comments and detailed monthly reports [5], [6], [7], [8]. Occasional industrial disturbances which appear sometimes (looking like solar ones which are a sudden increase in the radio wave intensity), were eliminated with caution. Everyday typical data and statistical descriptions from 1 January 1985 to 30 November 2013 can be found on our website. There we also place interesting recordings of rare phenomena, using the nomenclature introduced into the radioastronomical literature by H. Tanaka [9] and adjusted for the Polish readers needs by K. Borkowski [10].

Detailed data about the radiotelescope and the obtained measurements results can be found on the earlier mentioned website and in the bibliography. Everyday current data are given on the website of the Department of General Physics and Physics Education, the Institute of Physics, M. Curie-Skłodowska University in Lublin.

Almost a 30-year period of time and good correlation of our results with those obtained by Radioastronomers from Toruń made it possible to carry out statistical analysis of the course of daily data about intensity of solar radio waves.

This paper presents such an analysis. The diagram in Fig. 4 presents the daily average radio emission, whilst in Fig. 5 the yearly average values are plotted. The probability distribution of occurrence of individual values (this can be called the distribution of amplitudes of the data obtained in the studied period of time) are shown in Fig. 6.

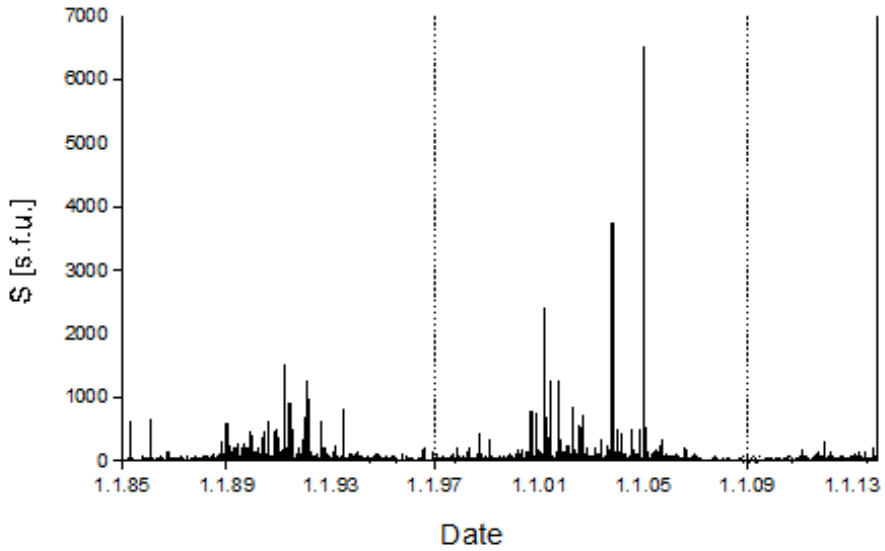


Fig. 4. Daily average radio emission of the Sun at frequency 220 MHz.

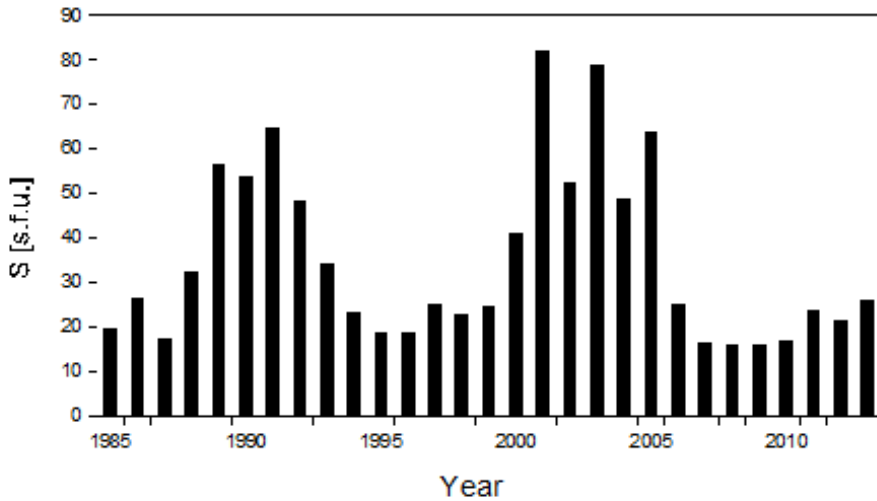


Fig. 5. Yearly average values of the solar radio emission.

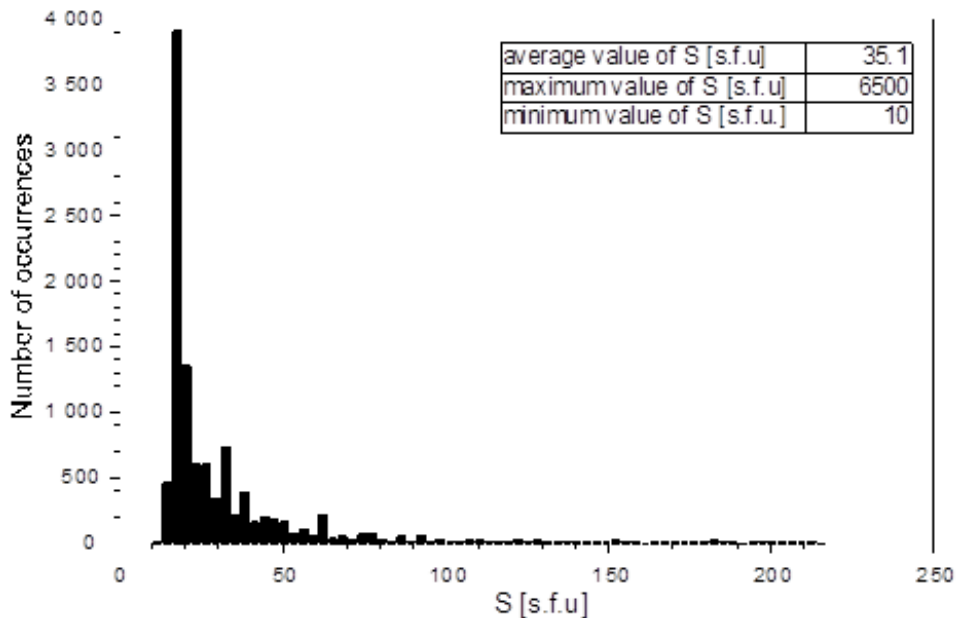


Fig. 6. Probability distribution of occurrence of individual values of the solar radio emission.

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