The Physical Basis for Predicting Flares in Active Regions of the Sun Based on Microwave Data

E. A. Kurochkin[1], N. G. Peterova[1] N. A. Topchilo[2], and A. V. Shendrik[1]

[1] St.Petersburg Branch of SAO RAS, St.Petersburg, Russia,
79046155404@yandex.ru
[2] Saint Petersburg State University, Saint Petersburg, Russia

Abstract. Investigation of the dynamics of active regions (AR) in the microwaves is important in predicting flare events. In this work, the dynamics is investigated using the example of a flare-productive AR NOAA 12371 near the maximum of the 24th solar activity cycle, which produced several flares of class M2.0 or higher. The data from the Nobeyama radio heliograph (NoRH) and the RATAN-600 radio telescope were used. Since the AR was sufficiently well isolated, a more detailed study of its dynamics on the RATAN-600 became possible.

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Flares prediction in solar active regions (AR) is an important problem of solar physics and solar-Earth connections. There are several assumptions about the mechanism of solar flares. One of them is associated with the emergence of a new magnetic flux (and further reconnection of the magnetic field lines) - it is well indicated by the method called the Tanaka-Enome Criterion (TEC), which is based on spectral-polarization observations at microwaves with high angular resolution. In the original work of its authors Tanaka & Enome (1975), TEC was applied for powerful flare events (proton-hazardous), later Bogod et al. (2018) was modernized and used to predict weaker events. The advantage of observations in the microwave range for predicting flares is that it is very sensitive to changes in the magnetic field and is especially effective in the transition region (chromosphere-corona) at altitudes less than 10 thousand km above the photosphere, which allows early detection of the emergence of a new magnetic flux. In

this paper, we investigate the correlation between flares in the X-ray range and their manifestations in the microwave range.

In the study of solar flares, one of the most important questions is the mechanism of their formation, in the study of which the pre-burst period of the life of the AR generating the flare plays a significant role. The past 24th cycle of solar activity was characterized by a very low level, which, however, provides additional opportunities for studying powerful events, especially at the pre-burst stage, ensuring the isolation of the AR on the solar disk under study. Here we present the results of the study of AR NOAA 12371 observed during the maximum of the 24th solar activity cycle (2013-2015) according to the microwave data of the RATAN-600 radio telescope and Nobeyama radio heliograph (NoRH), as well as some other instruments. This AR developed rather quickly (within several days), emerging outside active longitude, and had a large-scale bipolar structure and a fine structure in the tail. In individual spots, a magnetic field of up to 3 KG was observed, and the maximum brightness temperature, according to NoRH data, was more than 1 MK. As a result, this AR gave approximately 30 flares, of which 5 were of a class not lower than M2.0.

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