ANALYSIS OF THE FORBUSH EFFECT OF COSMIC RAY VARIATIONS BASED ON DATA FROM THE PERIOD MAY 30-JUNE 10 REGISTERED AT THE TBILISI COSMOPHYSICAL OBSERVATORY

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Abstract. *Cosmic rays, reaching from the depths of the galaxy and the Sun, bring information to Earth about the space where they are formed, accelerated, and propagated. The method of studying variations in cosmic rays allows us to use this information channel to study the processes that occur in interplanetary space, on the Sun, and in the Earth's atmosphere. The article discusses the analysis of data on the neutron component of cosmic rays observed at the Cosmophysical Observatory of the Institute of Geophysics for the period from May 30 to June 10, 2025 in relation to the parameters of the Earth's magnetic field.*

Key words: *cosmic rays, Forbush effects, magnetosphere, solar wind.*

Cosmic rays, which are high-energy charged particles, reaching the Earth from the depths of the galaxy and the Sun, carry information about the space where they are generated, accelerated, and propagated. The method of studying the variation of cosmic rays allows us to use this information channel to study the processes that take place in interplanetary space, on the Sun, around the Earth, and in the Earth's atmosphere. Observations of cosmic rays are being conducted in interplanetary space, in the Earth's atmosphere, on the Earth's surface, and underground in various energy ranges. These observations complement each other in terms of informativeness, among which the variations of cosmic rays observed on the Earth's surface are important. One such object is the Cosmophysical Observatory of the Institute of Geophysics, where the neutron components of cosmic rays and atmospheric pressure have been continuously recorded since 1972. [1]

The intensity of cosmic rays recorded on Earth reveals time-varying features called cosmic ray intensity variations. The study of cosmic ray variations is one of the methods that provides information for studying physical processes occurring in interplanetary and near-Earth spaces. Cosmic ray emission data are important for studies such as magnetic storms, auroras, geomagnetic and ionospheric phenomena, and others. [2]

Cosmic ray variations during strong geomagnetic storms are the result of magnetodynamic interactions with interplanetary shock waves during solar chromospheric flares and significant changes in the magnetospheric space. Cosmic ray variations caused by changes in the magnetosphere provide unique information about the processes taking place in the Earth's magnetosphere. The study of these effects and their physical interpretation is a very complex problem that is still not fully understood.

During strong magnetic storms, the magnetospheric structure changes significantly, since the magnetospheric state changes, namely, the "closed" magnetosphere turns into an "open" magnetosphere, the size of the magnetosphere decreases, and its induced current system increases. The state of the magnetospheric structure depends on the shock wave and magnetic clouds. The magnetohydrodynamic parameters of high-speed plasma clouds can change from case to case, which occurs during chromospheric flares on the Sun. Therefore, magnetospheric structures are subject to qualitatively different changes. The change in the magnetosphere has a qualitative effect on the trajectory of cosmic ray particles in the geomagnetic field and the location of the impact zone from which cosmic rays reach the Earth. [3]

The article discusses the analysis of data on the neutrino component of cosmic rays observed at the Cosmophysical Observatory of the Institute of Geophysics during the period from March 30 to June 10, 2025.

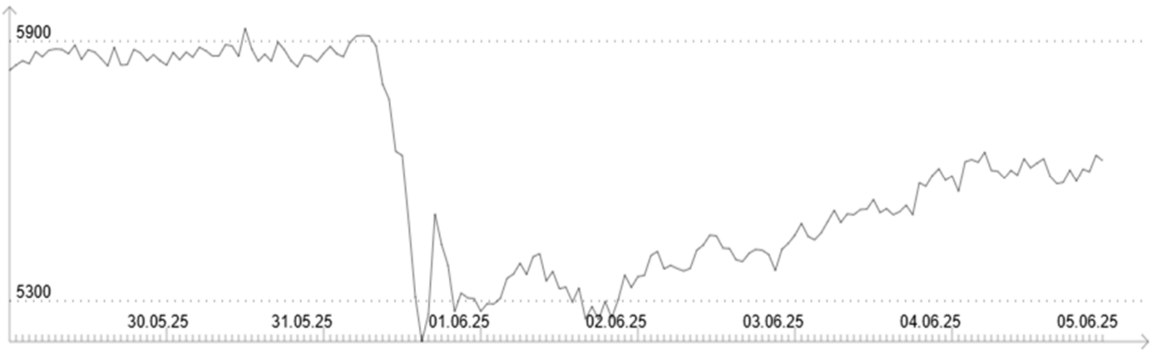

Fig.1

Fig. 1 shows the Forbush effect of cosmic ray variations observed at the Cosmophysical Observatory, with its three main phases: 1) the decay phase, 2) the main phase, and 3) the recovery phase. The graphical representations of the data clearly show pronounced anomalous fluctuations. A rather strong Forbush decay effect is observed for this period. Fig. 2 shows a diagram of the geomagnetic data from the Tbilisi station. As is known and generally accepted, geomagnetic storms and Forbush effects of cosmic rays have common causes. These are high-speed flows of solar plasma clouds resembling flares or flares. When discussing these two effects, one should always keep in mind which parameters of the solar wind are responsible for the formation of geomagnetic storms and which effects cause Forbush effects in cosmic rays. [4]

Solar flares are associated with a geophysical phenomenon – the fall of galactic cosmic rays. They are called solar Forbush effects (falls). This phenomenon is explained by the fact that the stream emitted during solar chromospheric flares brings with it a fairly significant magnetic field and cosmic rays, which are partially scattered and partially reflected from the Earth back into space. Such a stream for a certain time (several days) acts as a screen protecting the Earth from galactic cosmic rays, which leads to the fall of galactic cosmic rays (Forbush effect). About a day after the explosions on the Sun, magnetic storms begin on Earth. At first, a short-term increase in the Earth's magnetic field from its normal state by about 0.1% is observed, then a decrease in the magnetic field strength by several percent occurs and lasts for several hours (the main phase). Finally, after a few days, the magnetic field gradually recovers and returns to its original state [5].

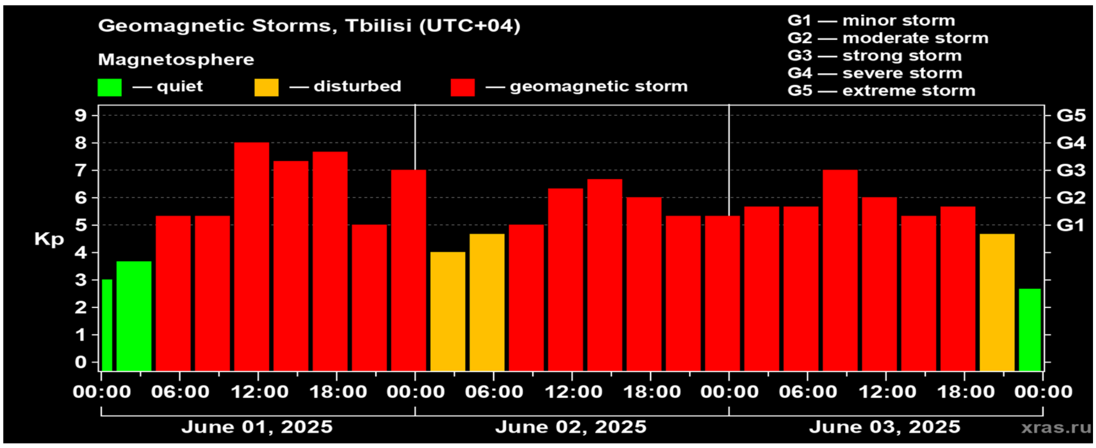

Fig. 2

Fig. 2 shows a diagram depicting a very strong G4 type magnetic storm that occurred in Tbilisi from May 31 to July 10, 2025. Fig. 1 shows the intensity data of the neutron component of cosmic rays, where the Forbush effect with an 8% decrease is observed [6].

Our conclusion is that both of these effects are caused by chromospheric flares on the Sun. The flares on the Sun occur mainly in the solar corona. A significant part of the energy is released as additional kinetic energy from the relatively dense plasma. As a result, a plasma cloud is ejected from the solar corona into interplanetary space. This cloud creates a downdraft wave because it interferes with the interplanetary plasma (solar wind), which also comes from the Sun, but at a lower speed. By penetrating the Earth's magnetic field, it causes the field lines to compress, which temporarily increases the Earth's magnetic field. The main phase begins when the plasma caused by the shock wave enters the magnetosphere, where the wave causes the energy of the plasma particles that already existed in the magnetosphere to increase. In either case, the magnetic lines of force are released and the magnetic field strength decreases.

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