

N E W S**OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN****PHYSICO-MATHEMATICAL SERIES**

ISSN 1991-346X

Volume 2, Number 318 (2018), 5 – 8

УДК 523.985

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**STATISTICAL ANALYSIS OF X-RAY SOLAR FLARE REGISTERED
ON SEPTEMBER 10, 2017**

Abstract. In this paper, we performed statistical studies of solar flares registered on September 10, 2017. We have identified several physical quantities of solar flares and estimated reconnection rate of solar flares. To determine the physical parameters we used images taken with the AIA instrument on board SDO satellite at wavelengths 131 Å, 174 Å, 193 Å, 211 Å, 335 Å, 1600 Å, 1700 Å, 4500 Å, SXT - pictures, HMI Magnetogram, SOLIS Chromospheric Magnetogram, GOES XRT-data.

Keywords: solar flares, Alfvén waves, reconnection rate.**Introduction**

Solar flares are powerful bursts of radiation, while coronal mass ejections are massive clouds of solar material and magnetic fields that erupt from the Sun at high speeds. Harmful radiation from a flare cannot pass through Earth's atmosphere to physically affect humans on the ground, however - when intense enough - they can disturb the atmosphere in the layer where GPS and communications signals travel [1-13].

Solar flares can be classified according to their brightness in the x-ray wavelengths. There are three categories: X-class flares are big; they are major events that can trigger radio blackouts around the whole world and long-lasting radiation storms in the upper atmosphere. M-class flares are medium-sized; they generally cause brief radio blackouts that affect Earth's polar regions. Minor radiation storms sometimes follow an M-class flare. Compared to X- and M-class events, C-class flares are small with few noticeable consequences here on Earth. Solar flares are different to 'coronal mass ejections' (CMEs), which were once thought to be initiated by solar flares. CMEs are huge bubbles of gas threaded with magnetic field lines that are ejected from the Sun over the course of several hours. If a CME collides with the Earth, it can excite a geomagnetic storm [14-17].

Large geomagnetic storms have, among other things, caused electrical power outages and damaged communications satellites. The energetic particles driven along by CMEs can be damaging to both electronic equipment and astronauts or passengers in high-flying aircraft.

Solar flares, on the other hand, directly affect the ionosphere and radio communications at the Earth, and also release energetic particles into space. Therefore, to understand and predict 'space weather' and the effect of solar activity on the Earth, an understanding of both CMEs and flares is required.

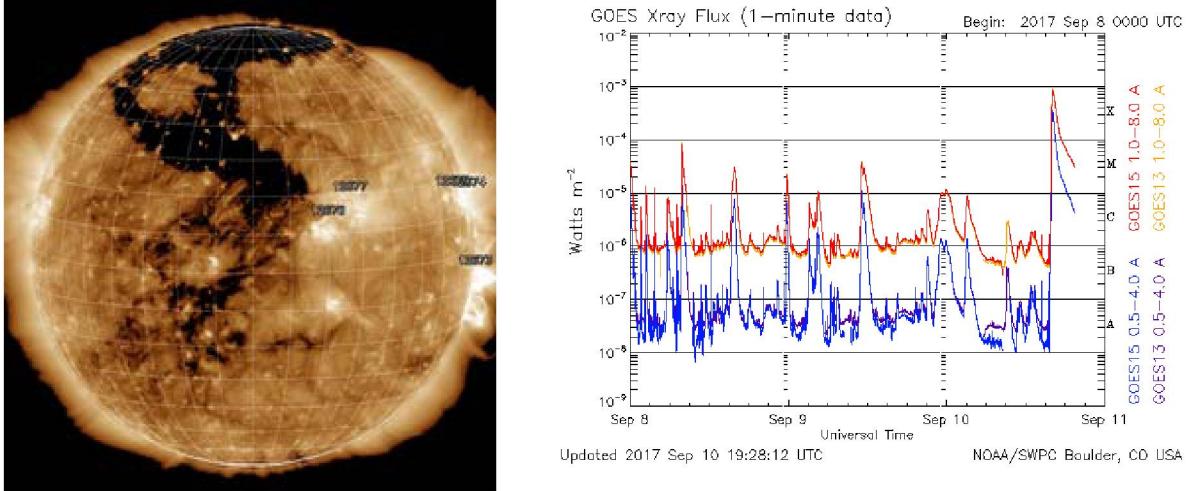


Figure 1 - Active area 12673 in AIA 193 Å and the total X-ray flux obtained in GOES 13 and GOES 15 [18]

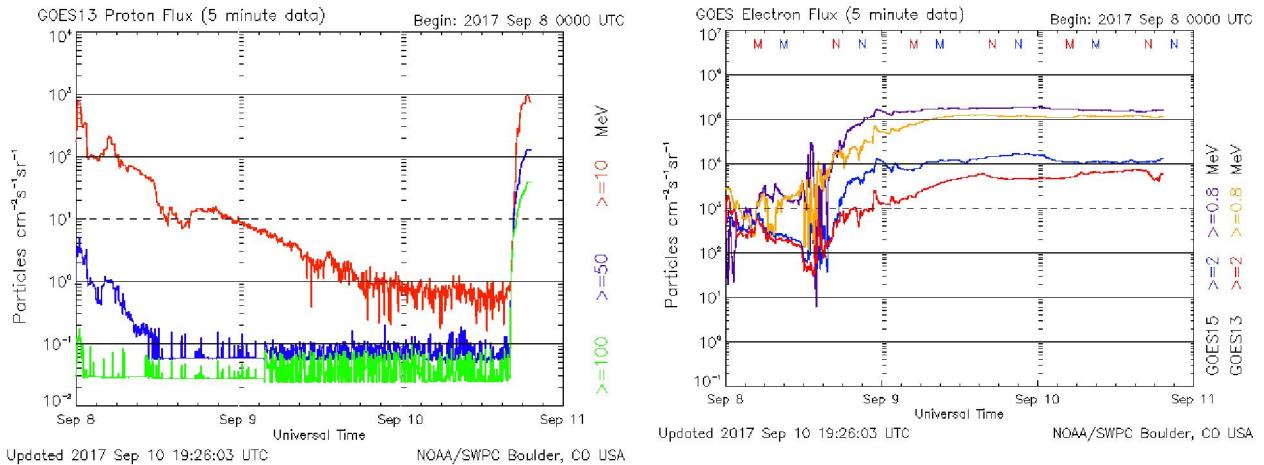


Figure 2 - Total proton and electron flux obtained in GOES 13 and GOES 15 [18]

DATA ANALYSIS

In the energy release process in solar flares, magnetic reconnection is generally considered to play a key role. The reconnection rate is an important quantity, because it puts critical restrictions on the reconnection model. To evaluate the reconnection rate in nondimensional form, $M_A \equiv \frac{V_{in}}{V_A}$, we must

estimate the Alfvén velocity in the inflow region: $V_A = \frac{B_{cor}}{(4\pi\rho)^{1/2}}$. Hence, if we measure the coronal density ρ , the spatial scale of the flare L , the magnetic flux density in the corona B_{cor} , and the timescale of flares τ_{flare} , we can calculate inflow velocity V_{in} , Alfvén velocity V_A , and reconnection rate M_A [19].

Monitoring of solar flares in real time is performed by the Geostationary Operational Surveillance Satellite GOES. Electron, proton and X-ray fluxes are tracked by the satellites GOES 11, GOES 13 and GOES 15.

The sun emitted a significant solar flare, peaking at 12:06 p.m. EDT on Sept. 10, 2017. This flare is classified as an X8.2-class flare. X-class denotes the most intense flares, while the number provides more information about its strength. An X2 is twice as intense as an X1, an X3 is three times as intense, etc.

In Fig. 1 shown the images obtained on the board of GHN satellite in XRT. To determine the length of the loops, we used SXT images. From the SXT data, we get values for the length of the loops.

In Fig. 2 shows the total flux of X-rays and an electron, which was registered on September 10, 2017.

RESULTS

Using the method described in [20], we analyzed solar flare that have been registered on September 10, 2017. Examined the dependence of the reconnection rate from GOES class of solar flares. Figure 3 shows the dependence of the reconnection rate from GOES class.

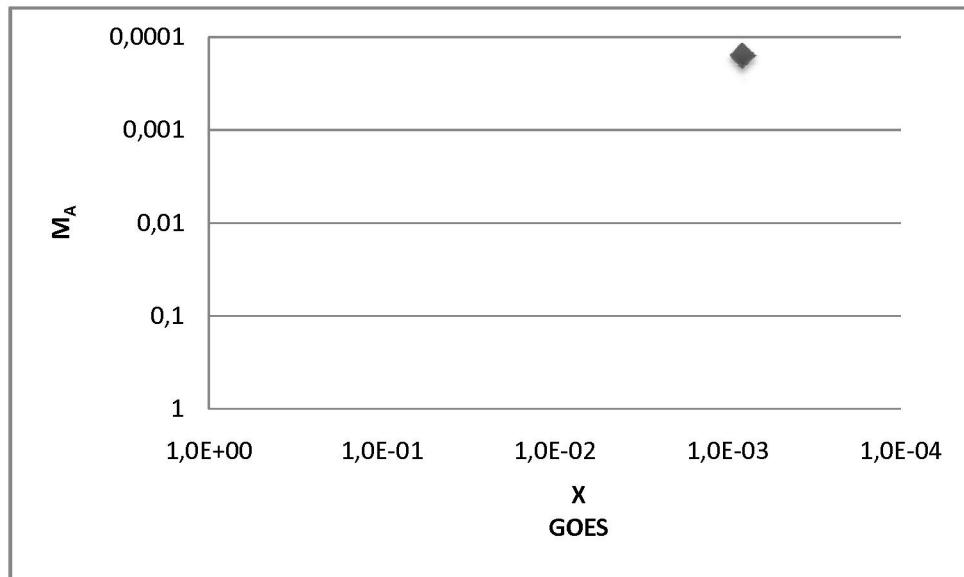


Figure 3 - Reconnection rate M_A plotted against the GOES class of the X flare

CONCLUSION

The values of reconnection rate are distributed in the range from $10^{-4} - 10^{-3}$. Here, the value of the reconnection rate decreases as the GOES class increases. The value of the reconnection rate obtained in this study is within 1 order of magnitude from the predicted maximum value of the Petschek model.

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2017 ЖЫЛЫ 10 ҚЫРКУЙЕКТЕ ТІРКЕЛГЕН КҮН ЖАРҚЫЛЫН СТАТИСТИКАЛЫҚ ТАЛДАУ

Аннотация. Осы мақалада 2017 жылдың 10 қыркүйегінде тіркелген күн жарқылдарының статистикалық зерттеулері жүргізілді. Біз күн жарқылдарының физикалық мәндері мен қайта ұштасу жылдамдығын бағаладық. Физикалық параметрді анықтау үшін SDO спутникінің бортында AIA инструментінің 131 Å, 174 Å, 193 Å, 211 Å, 335 Å, 1600 Å, 1700 Å, 4500 Å толқын ұзындығында алынған және SXT суреті, HMI Magnetogram, SOLIS Chromospheric Magnetogram, GOES XRT- деректері пайдаланылды.

Түйін сөздер: күн жарқылы, альфвен жылдамдығы, қайта ұштасу жылдамдығы.

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СТАТИСТИЧЕСКИЙ АНАЛИЗ СОЛНЕЧНЫХ ВСПЫШЕК, ЗАРЕГИСТРИРОВАННЫХ 10 СЕНТЯБРЯ 2017 ГОДА

Аннотация. В этой статье нами проведены статистические исследования вспышек, зарегистрированных 10 сентября 2017 г. Мы определили несколько физических величин вспышек и оценили скорость пересоединения солнечных вспышек. Для определения физических параметров мы использовали снимки, полученные с инструмента AIA на борту спутника SDO на длинах волн 131 \AA , 174 \AA , 193 \AA , 211 \AA , 335 \AA , 1600 \AA , 1700 \AA , 4500 \AA , SXT - снимки, HMI Magnetogram, SOLIS Chromospheric Magnetogram, GOES XRT-данные.

Ключевые слова: солнечные вспышки, альфеновская скорость, скорость пересоединения.