The outburst of solar flares in short and long wavelength of active region AR2650

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Abstract. We analyzed solar burst type III occurred on 15th of May 2017 and compare with optical and X-ray region using the high time resolution hard X-ray data from space weather and 10 MHz-120 MHz dynamic spectra from CALLISTO network. The eruption mechanism of solar flares and type III has been observed intermittently in the last a few hours since 10:00 UT. The burst consequences from the ejection of plasma oscillations localized disturbance due to excited in the plasma frequency incoherent radiations such as gyro synchrotron and free–free emissions. Significant results of the flaring becoming more intense at 10:05 UT. During this event, the electrons greater than 2 MeV at geosynchronous orbit reached a peak level of 73 sfu. Solar wind speed reached a peak of 375 km/s at 14/2246Z. Total IMF reached 6 nT at 14/2123Z. It was found that radiation from the flare created waves of ionization in the upper atmosphere over Asia and Australia and possibly HF radio blackouts at high latitudes. We believed these data represent the first direct evidence of high-speed flows will be exploded on 20th April 2017 due to this pattern of eruption.

Introduction

Each solar burst has their own characteristics [1] [2]. It shows a significant relationship between bursts and solar activities. There are two phases of particle acceleration that responsible for the phenomena. First, the first stage is refer to the short wavelength which can be detected by hard X-ray (HXR) emission, microwave (centimeter wavelengths) emission and the second stage mainly at radio wavelength which mostly at m-λ [3].

In this paper, we will highlight solar flares that has potential to be identified as precursor of eruption. The study of particles acceleration and high energy process is much relevant to the solar flare [4]. This too complex phenomenon is due to magnetic reconnection process [5]. The high energy charged particles have a variety of other observed effects [6]. This means that the foot points of the magnetic field lines, which penetrate into the corona where the energy release occurs in effect frozen
into the photosphere. One should realize that not all of the energy stored in the magnetic field loops can be released.

A successful project by e-CALLISTO with 24 hours monitoring of the Sun in radio region is hoping to meet the current knowledge about the Sun characteristics [7]. Solar flares observation in radio region is very important in order to recognize the active flares sources due to properties with plasma parameters and their nature mechanisms [8, 9].

A flare produces a negligible effect on the overall visual or bolometric luminosity of the Sun [10-12]. Observations of flares in all regions from visible to gamma rays provides a possible spatial properties and temporal properties of flare region. Still, the main question is why flares occur and where the energy comes from. Thus, the energy release in flare region might be of order $10^{22}$ J/m$^3$. The magnetic field might possess the energy required to power a flare [13]. It is required that the distribution of magnetic field in the solar atmosphere can change rapidly to one which has a significantly lower energy.

Active Region and Radio and X-Ray observation

Active region is identifies with the appearance of sunspots. This dark region, which disturbed the smooth brightness of the solar surface sometimes become visible and slowly disappeared. Sunspot consists an umbra, which is a dark region at the central and surrounding less dark region called penumbra. The observations of active region shows that the rotation of the Sun was not same at all latitudes.

The mechanism of burst can be divided into two categories, (i) nonlinear wave-wave coupling processes the coalescence of two and, (2) Langmuir waves, first proposed by the highly nonlinear process [14] and direct emission mode conversion due to density inhomogeneity [15]. Of course, the non-linear wave-wave coupling will lead the quantum solution and the process is very complex. Meanwhile the Langmuir wave is a relevant theory that responsible to Type III burst structure. One possible clue is that nonlinear wave processes limit the wave growth by removing wave energy from the linearly unstable region of phase space [16].

Methodology

E-CALLISTO network is one of the systems that possible to monitor the Sun within 24 hours in radio wavelength [17, 18]. The signal is measured in Watt/m$^2$ in frequency versus time axis. The basic radio system consists an antenna or telescope, the low noise amplifier and the spectrometer. In ideal case radio telescope is better than antenna because it can collect more signal. By measuring the signal of the Sun, we can predict how much radiation is possible can be detected at the ground even though we know the distance from the Sun and Earth is very extensive. This system is connected with a GPS time signal receiver and the frequency of the synchronization signal is 1 MHz [19]. By using these data, the comparison of selected sites also can be done [20]. There is also a Practical Extraction and Report Language (PERL) script running on our server connect each site in all the countries [21].

Results and Discussions

The eruption mechanism of solar flares and Type III are currently an extremely active area of research, especially during the solar cycle is towards maximum. However, we are now facing the minimum phase, where there is not much great events impact to the space weather. Nevertheless, the X-class flare still possible to occur unexpectedly. Some of the cases are still under investigation because there is not much sign that the large explosion could occur. In this case, the total energy of solar burst Type III is of the order of $10^{15}$ ergs. It occurs in the impulsive phase, which is more intense at meter wavelengths and may have a continuum attached to it.

Sun will continuously loss its mass into space by solar wind. The existence of intermittent mass outflows from the Sun is in an attempt to understand magnetic storms on the Earth. The properties of
the Earth’s ionosphere are observed and radio communication seriously disrupted after the observation of some violent activity in the sun such as solar activity.

Table 1. Parameter during the event.

| Parameter                      | Value          |
|--------------------------------|----------------|
| Time (UT)                      | 10:05 UT to 10:09 UT |
| Active Region (AR)             | none           |
| Radio flux (SFU)               | 71             |
| Sunspot number                 | 0              |
| Solar wind (km/s²)             | 579.3          |
| Proton density protons/cm³     | 12.2           |
| Interplanetary Mag. Field (nT) | 7.3            |

Table 1 shows the results obtained at 15th May 2017. From the results, it is observed that the radio flux and sunspot number, which is zero are considered low situation. However, the solar wind values give the significant number and the possibilities of the Sun to have an eruption is positive. In Figure 1, there are a single and group of SRBT III that formed intermittently with a wide range frequency from 10 MHz until 120 MHz. This solar burst consequence from the ejection of plasma oscillations localized disturbance due to excited in the plasma frequency incoherent radiations such as gyro synchrotron and free–free emissions appear in the radio wavelengths plays a dominant role at the meter and decimeter wavelengths, which may be associated with the flare primary energy-releasing sites. In conjunction with constraints on the spectrum. A large flare might release in half an hour. This eruption ejectionof mass maybe comparable in total with the steady solar wind and they appear to be associated with events occurring lower down in the atmosphere. It is believed that the burst is fast drifting intermittently. The groups of SRBT III until 10:15 UT can still be observed. This proved that a meter solar radio burst will take a long period to decay and potentially active for a few days’ comparison, the dynamic spectra in an X-ray region.
There are currently zero numbered sunspot regions on the disk. Sunspot could be fixed on the surface and be carried out around by the rotating sun. The surface of the sunspot is depressed below the surface of the surrounding bright Sun. A characteristic of umbra temperature of about 4000K can account for the difference between the umbra and normal photospheric brightness. This is can be categorized as a very low to produce a C-class flares. It is not enough to say that the magnetic field might possesses the energy required to power a flare. However, due to the number of proton density, the potential of flares to be occurred is possible. It was observed that the highest peak of the solar flare could be observed during that time. The bursts show wide varieties of dynamic spectra, probably because of the solar plasma inhomogeneity through which parts of the shock wave travel. However, the energy of the optical emission of solar flares is provided by ionization losses of accelerated particles in the flares. There is also an extreme ultraviolet flash observed by the Solar Dynamics Observatory. The radiation from the flare created waves of ionization in the upper atmosphere over Asia and Australia and possibly HF radio blackouts at high latitudes.
Conclusions

A major concern of astronomers is to understand the observed properties of the Sun and how these properties have changed in the past and will change in the future. Based on the data, although the average properties of the Sun are essentially time independent, they are believed to be varied on a timescale in both time and space. The energy transport just below the solar surface is principally by convection and this produces a pattern of rising and falling elements. In addition, there are all of the phenomena associated with the surface magnetic activity. Thus to understand and predict the behaviour of the Sun is not an easy way. Therefore, the dynamisms of the Sun itself should not be neglected.

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