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A Case Study of Explosion A Single Solar Burst Type III and IV Due to Active Region AR1890

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ABSTRACT

Using data from a BLEIN Callisto site, we aim to provide a comprehensive description of the synopsis formation and dynamics of a a single solar burst type III and IV event due to active region AR1890. This eruption has started since 14:15 UT with a formation of type III solar burst. To investigate the importance of the role of type III solar burst can potentially form a type IV solar burst, the literature review of both bursts is outlined in detailed. The orientation and position of AR1890 make the explosion of a class C-solar flare is not directly to the Earth. Nevertheless, it is clear that the interactions of others sunspots such as AR1893,AR1895,AR1896, AR1897 and AR1898 should be studied in detail to understand what makes the type III burst formed before the type IV solar burst.

***Keywords*:** Sun; solar burst; III; IV; radio region; X-ray region; solar flare; active region

1. INTRODUCTION

Under certain circumstances, type IV burst can be as a beginning of solar flare explosion [1-3]. During emission stripes the source drift over distances up to several × 10^4 km, with apparent velocities up to 10^5 km s^{-1}[4]. The direction of the source motion at a given frequency is on average found to be perpendicular between broadband radio pulsations (BBP) and zebra patterns (ZP) sources. [5]. BBP does show high frequency drift (≈–250 MHz s^{-1}). [6]. These solar type IV radio emissions is dominant a few days before solar flare and Coronal Mass Ejections explosion [7-9].

Type III bursts trace electron streams as they propagate along open field lines from flaring regions near the Sun into the interplanetary medium.In general, solar radio burst type III solar burst is the most the most common type [10] with range of frequency from 500-10 MHz [11-13].

This emission is probably from a part of the electron population that remains trapped in closed magnetic loops [14]. Usually, a fast drift (type III) solar radio bursts are synchronized in time with solar flares [15]. A previous study has shown that the type III are generated in a weak-field region comes from the absence or low degree of circular polarization of the bursts

[16]. Langmuir waves active region radio emissions is believed to be a main subject that relevant with a type III burst [17-21].

These forces drive the plasma to a state unstable to the growth the beam-plasma interactions, is believed to generating these waves [22,23]. This type is very synonymous at the meter and decimeter wavelengths [24,25]. Early stage of solar flares may indicate that open field lines are an essential part of models for energy release by magnetic fields [26,27]. Detailed analysis of the Sun in radio and x-ray region to understand the distribution of high and low energy [28-31]. We will highlight the solar flare and solar bursts in both electromagnetic radiation.

2. SOLAR FLARE OBSERVATION

During a major space weather event which includes a burst of solar [32-34]. Compact Astronomical Low cost, Low frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) from BLEIN with the 7 meter dish telescope at ETH, Zurich is being used to monitor the solar burst. [35,36].

We also have constructed a log-periodic antenna is a broadband, multi-element, unidirectional, narrow-beam antenna that has impedance and radiation characteristics that are regularly repetitive as a logarithmic function of the excitation frequency [34,37-40]. The Log Periodic Dipole Antenna has been constructed from 45 - 870 MHz [41,44].

The CALLISTO spectrometer is a low-cost radio spectrometer used to monitor metric and decametric radio bursts [45-49]. We select the range of 150 MHz till 900 MHz for this data [50-52].

This range has a very minimum interference at Blein, Switzerland site [53,54]. Selected the data from the 150 MHz till 900 MHz region seems this is the best range with a very minimum of Radio Frequency Interference (RFI) [54-63]. The next section will highlight the detailed analysis of solar flares in an X-ray and radio region to evaluate the distribution of high and low energy [41].

3. RESULTS AND ANALYSIS

Based on the observation, we found that an individual type III solar burst with a fast drift pattern was formed at 14:17 UT with high intensity. This burst is an indicator of formation of solar flare. The burst is drifting from 200 – 600 MHz. Before the formation, it is clear that a complex of type III is also appearing. However, it did not take a long time of duration. The type IV solar burst with duration of 7 minutes can can be observed from 280 – 900 MHz. The class of C solar flare is evolving at this point. This type is the slow drift burst and could take a few hours. The Sun remains active during this time and solar flare C.9 class formed at 4:00 UT. This flare is the highest point during that day. After introducing our data, we will provide a description of certain parameter of solar burst based on calculation, energy for the burst, the energy of the burst is in the range of 1.524×10^{-25} J to 2.195×10^{-25} J.

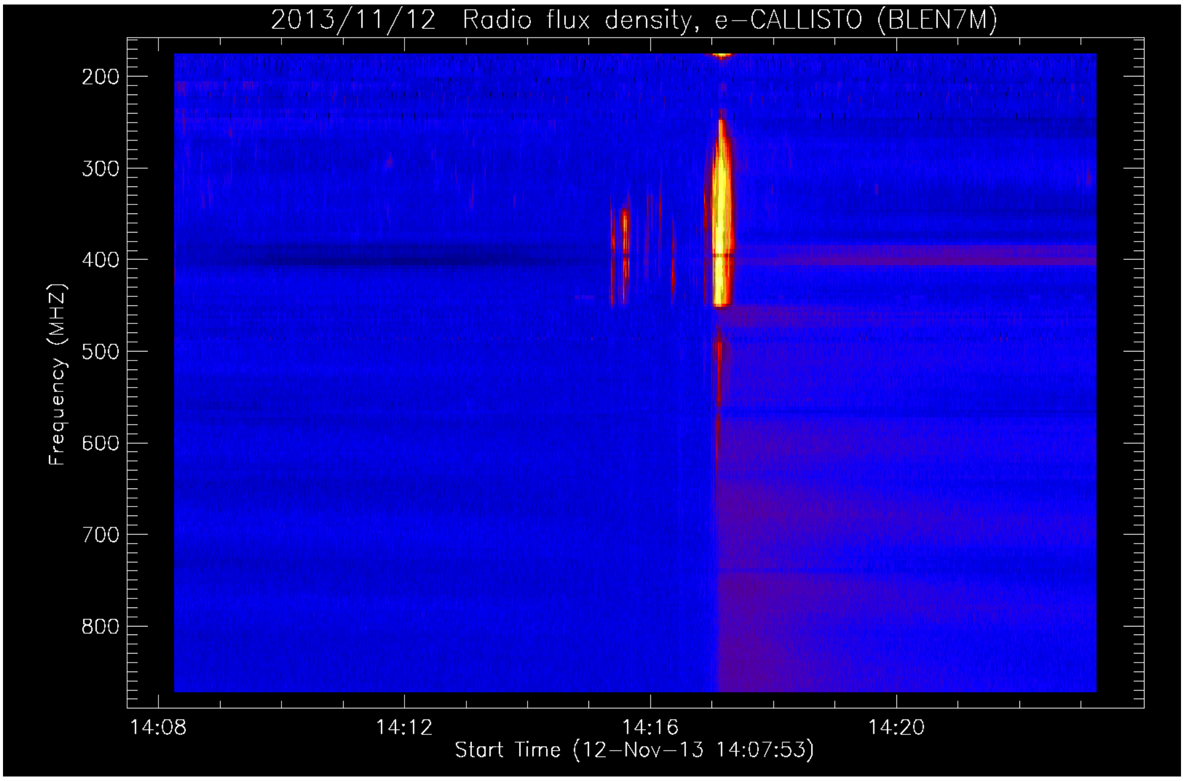

Figure 1. The continuous solar radio burst type III at 14:17 (Credited to: E-Callisto network (BLEIN7M)).

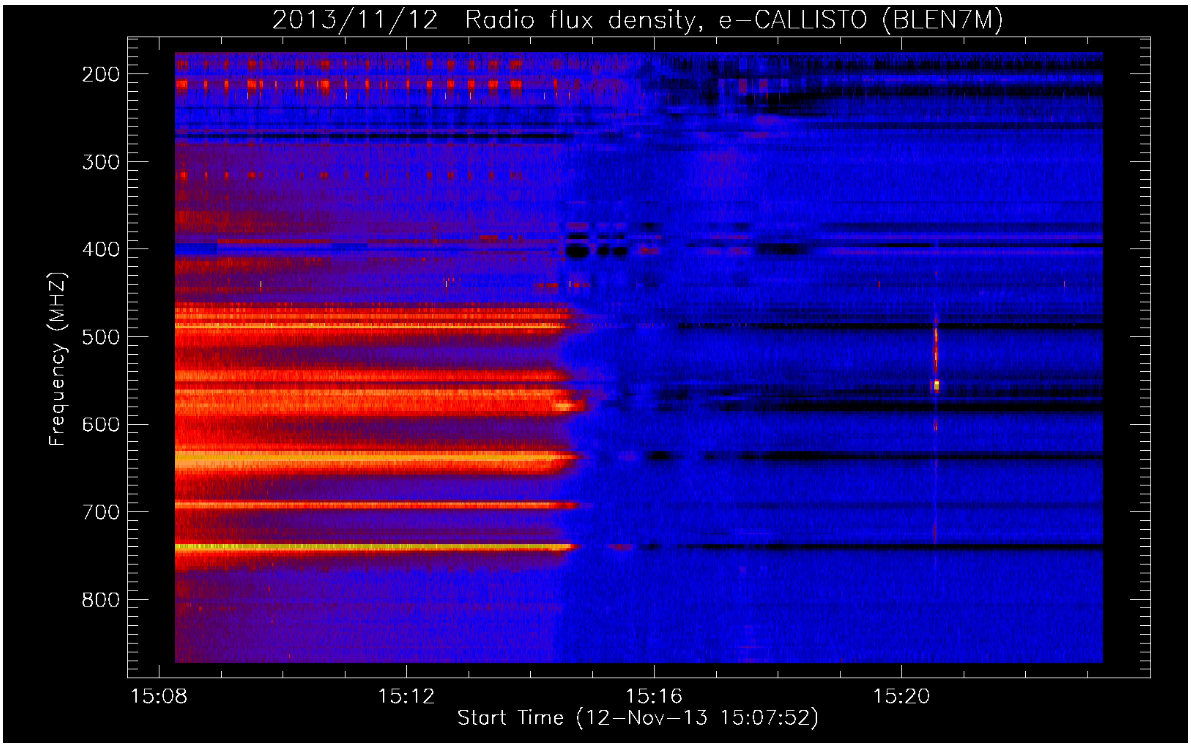

Figure 2. A type IV solar radio burst appears 7 minutes after solar radio burst type IV (Credited to: E-Callisto network (BLEIN7M)).

The energy released is higher than first case and the second case because the burst happen in the higher frequency. Based on the theoretical point of view, the drift velocity also calculated as shown below:

$$E = hf$$

$$= (6.626 \times 10^{-34}\ m^2\ kg / s)(230 \times 10^6\ Hz)$$

$$= 1.524 \times 10^{-25}\ J$$
$$= 2.44 \times 10^{-44}\ Ev$$

$$E = hf \qquad (1)$$

$$= (6.626 \times 10^{-34}\ m^2\ kg / s)(440 \times 10^6\ Hz)$$

$$= 2.915 \times 10^{-25}\ J$$

$$= 4.66 \times 10^{-44}\ eV$$

$$\frac{df}{dt} = \frac{f\ high - f\ low}{t\ high - t\ low} \qquad (2)$$

$$= 52.5\ MHz/second$$

The plasma frequency calculated,

$$Vp = \underline{\sqrt{e2Ne}}$$

$$4\pi\varepsilon_0 m_e \qquad (3)$$

$$= 1.06 \times 10^4\ Hz \qquad (4)$$

In addition, data from the Space Weather Web Site is used. Owing to the complex structure of Active Region 1890, the spatial distribution of the dynamical energy transport in the region is very complex. There are other five active regions, mostly at the West part of the Sun. Based on the analysis, the speed of the solar wind also exceeds 386.9 km/sec with 1.4 g/cm^3 density of proton in the solar corona. The radio flux also shows 104 SFU. During that day, there are six active regions or sunspot spotted. Moreover, there are a large coronal holes on the Earth- facing side of the sun. The Solar flare class C4 is continuously being observed in X-ray region for 24 hours since 1943 UT and a maximum class C4 is detected on 1943 UT. The active region 1890 is responsible to eject solar flares. As we know, the probability of solar Emissions is high when a large sunspot group is present, as for this event, the number of sunspots spotted during the day is 104 with 164 SFU. Based on the figure, it is shown that the formation of burst at 13.48 UT. From the figure, it is found the sunspot 1890 responsible to eject the Solar flare. Although, it is said that sunspot 1890 is decaying, but it still has a magnetic field that ejects X-class solar flares.

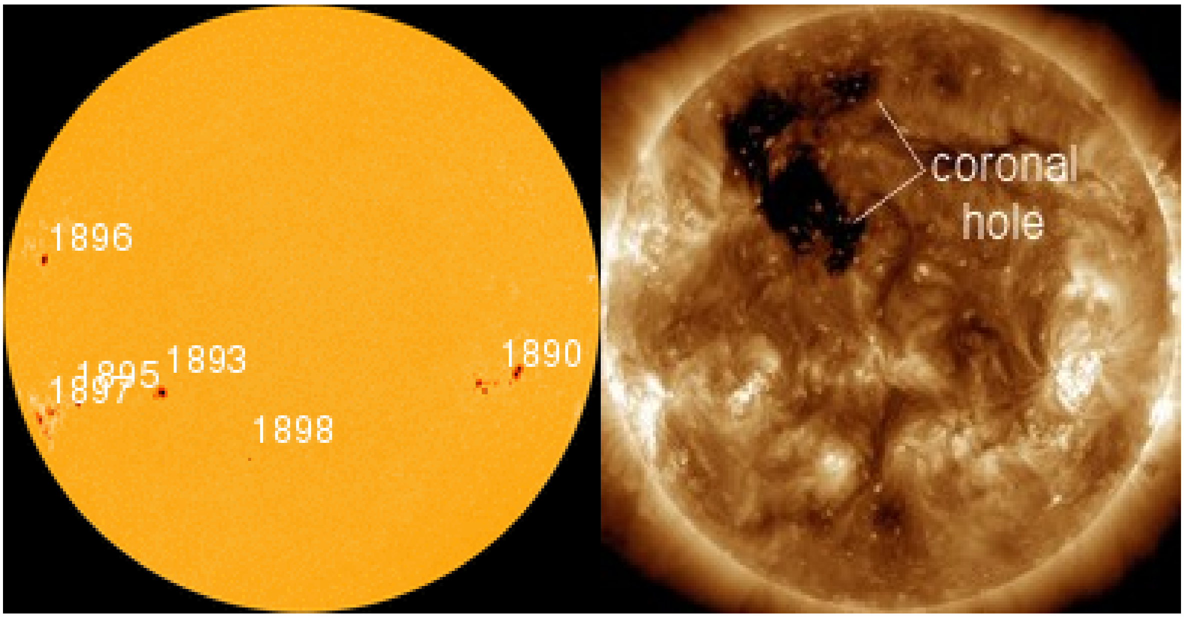

Figure 3. Active region (1890) in visible wavelength and the image of the Sun by X-ray from Space Weather Website (Credited to: NOAA/ SWPC).

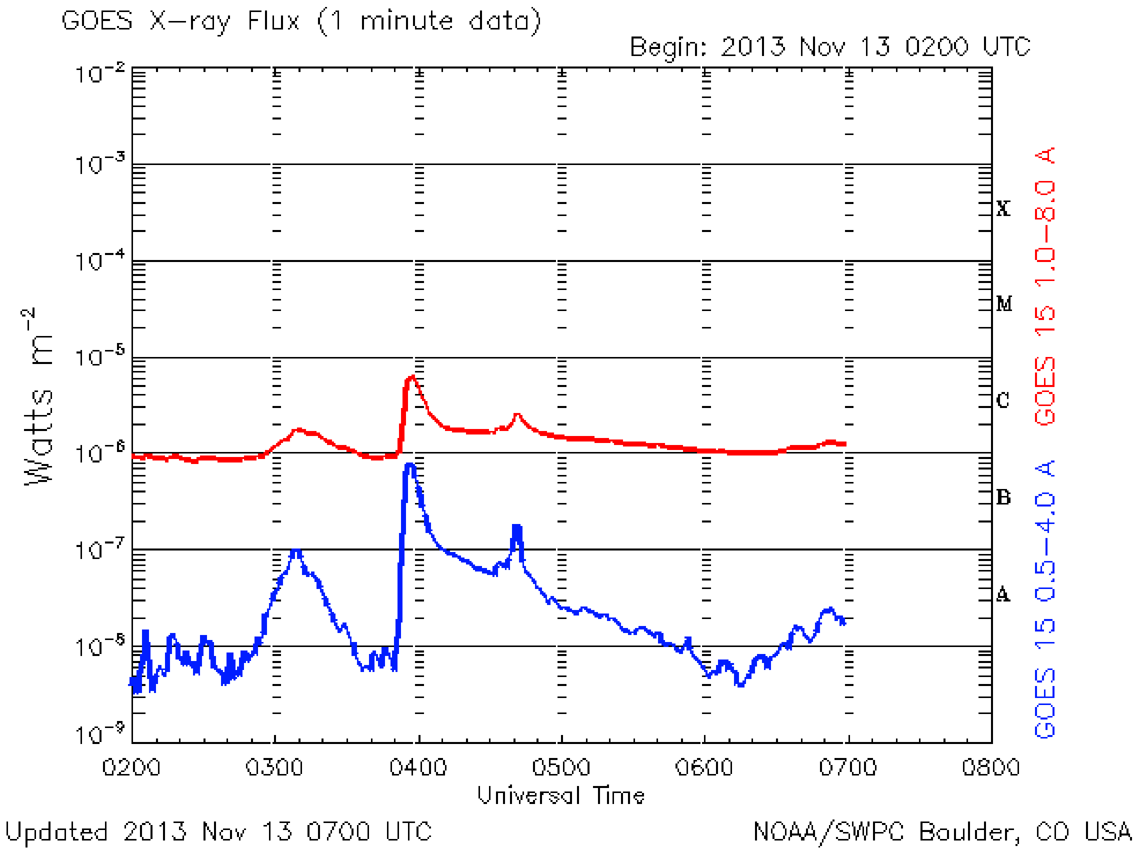

Figure 4. The variability of solar flare during 13th November 2013 (Credited to NOAA Space Environment Centre).

From the calculation the drift rate and plasma frequency is 52.5 MHz/second and 1.06×10^4 respectively. In this event, the burst occurred as low frequency compared to the previous events, but this event occurred longer compared to the previous event. It has been observed that the solar wind and density is low as the plasma frequency also low. It is found when the number of electron and proton ejected in the solar wind is low, so the plasma frequency low, hence the drift velocity and total energy also low. This is because the particular particles as electron or proton each bring respective energies. As the energy is carried low, the energy produced also low.

4. CONCLUDING REMARKS

The orientation and position of AR1890 make the explosion of a class C-solar flare is not directly to the Earth. Nevertheless, it is clear that the interactions of others sunpots such as AR1893, AR1895, AR1896, AR1897 and AR1898 should be studied in detail to understand what makes the type III burst formed before the type IV solar burst.

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Biography

Dr Zety Sharizat Hamidi is currently a senior lecturer and focused in Solar Astrophysics research specifically in radio astrophysics at the School of Physics and Material Sciences, Faculty of Sciences, MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia. Involve a project under the International Space Weather Initiative (ISWI) since 2010.

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