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The Beginning Impulsive of Solar Burst Type IV Radio Emission Detection Associated with M Type Solar Flare

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ABSTRACT

First light detection of solar burst type IV in Malaysia in the region of 260 MHz till 380 MHz has been successfully detected on 5th March 2012. This significant solar burst variations is associated with solar flare type M level 2.0 occurred from 0412UT. Due to the effect, strong bursts that caused by extraordinary solar flares due to magnetic reconnection effect potentially induced in the near-Earth magneto tail. One possible reason behind the formation of this very complex long duration of this loop is the magnetic reconnection and disruption of the loops which is observed during flare maximum. Sunspot 1429 active region was a site of several intense in several days. In Malaysia, monitoring solar burst in radio region is just in beginning by involved the project under International Space Weather Initiative (ISWI) since 2011. We also analyzed multi wavelength observation from different sites as continuity of the phenomenon. Observations presented in this paper confirmed that Malaysia can be one of the potential countries to focus on solar monitoring solar radio emission at low-broadband frequency (45-870) MHz using ground-based telescope due to 12 hours per day throughout a year.

Key words: Solar burst type IV, Solar flare, Sunspot, CALLISTO
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INTRODUCTION

Solar burst type IV always related with the development of sunspot groups. It has been considered to obligate high probability of being followed by geomagnetic disturbances. Initial study by Antalová (1970) has identified seven (7) different spot-groups that can produce type IV bursts. Type IV solar radio bursts has been identified by Boischot (1957) (Van Eenoo et al., 1994) and comprehensively listed by Pick-Gutmann (1961).

The duration of burst lasting from hours to a few days in the region of 20 MHz till 2 GHz. According to (Kundu & Firor, 1961), type IV exhibits two (2) distinct phases in its occurrence. At first stage, the frequency is higher than 250 Mc/s and associated with centimeter-wave burst. In the second phase, this burst will associate with type II burst; however, the frequency is lower than 250 Mc/s.

Castelli, Aarons, and Michael (1967) have shown that the typeIV radio bursts sometimes associated with solar proton flares show the U-shaped peak flux spectra with the minimum flux at decimetric frequencies.

In Malaysia, the study of solar burst is just in beginning phase. We make an effort by joining e-CALLISTO research network. The main objective of this research is to observe the solar radio spectrum for 24h per day through all the year. CALLISTO (Compact Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory) spectrometer is a programmable heterodyne receiver build by ETH Zürich, Radio and Plasma Physics Group in 2002. A regular practice to distinguish decimetric solar radio bursts signals is to record the digital dynamical spectra, extract sequences of single frequency events with limited discrete length and to determine quantitative characteristics on the basis of these observations. In Malaysia, monitoring solar burst in radio region is just in begining phase.

We have just started this research by collaborate the project under International Space Weather Initiative (ISWI) since 2011. Some basic experimental such the investigations of Radio Frequency Interference (RFI) and the construction of Log Periodic Antenna have been done in order to setup the research. Solar monitoring system installation has been succesfully done on 20th February 2012 at National Space Centre, Banting Selangor. The purpose ofthe present paper is to highlight the begining situation before solar burst type IV succesfully detected at our site and comparing the result with X-ray observation at the same phase and time.

SYSTEM CONFIGURATION AND OBSERVATIONS

CALLISTO spectrometer is a programmable heterodyne receiver has been setup at National Space Centre, Selangor located (3.0833°N 101.5333°E) on 22nd February 2012 is a valuable new tool for monitoring solar activity and for space weather research. The main observation system consists of a log periodic dipole antenna, CALLISTO spectrometer and a PC connected to the internet. With minimum Radio Frequency Interference noise level, average – (85-100) dBm, this site is one of the radio quiet zone candidate sites in Malaysia. Experimental setup designed to observe solar flares in 24hours monitoring which have been distributed to 19 sites so far.

In principle, e-Callisto receiver uses a microprocessor controlled television tuner, logarithmic detector and other integrated circuit components. This receiver has provisions for controlling focal plane unit located at the antenna that can include a low noise amplifier (LNA), antenna polarization switching, noise calibration source and associated coaxial switches. It observes automatically and their data is collected every day via internet and stored in a central data base. All data are stored with a scale factor and an offset applied so that the measured ADC digits range fits into the byte data range (0-255).

Schematic diagram of CALLISTO system is illustrated in Figure 1. The data obtained from CALLISTO are FIT-files with up to 400 frequencies per sweep.

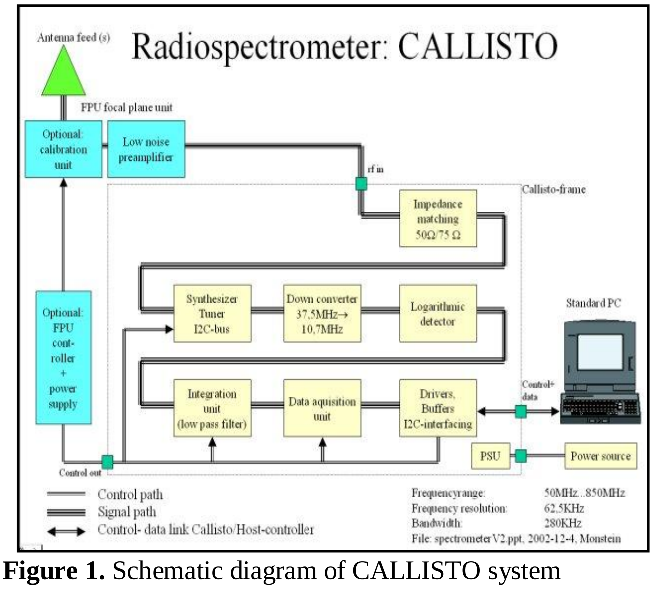

Figure 1. Schematic diagram of CALLISTO system

Practically, we used a Log Periodic Dipole Antenna (LPDA) could cover the range of frequency from 45 MHz till 870 MHz. However, in order to minimize the noise level, we focus only in the region of 260 MHz till 380 MHz specifically.

The distribution data radio flux density of burst versus frequency range of the spectral peak and intensity level has been collected daily within 12 hours starting from 7.30 am till 7.30 pm. This basic data for each burst consists of 15 minutes of dynamic spectrum with 0.25 second time resolution.

PRELIMINARY RESULTS AND DISCUSSION

Series of experimental data have been collected during the first observation on solar burst type IV. This first light curve associated with type M 2.0 solar flare on 5th March 2012 also successfully detected at National Space Centre, Banting. Here we consider the range that almost free from interference from 240 MHz till 380 MHz, see Figure 2. Significant solar burst variations happened starting from 4.12 UT. Unfortunately, the continuous detailed data could not been taken due to the limitation of the period of observations.

Due to the effect, strong bursts that caused by extraordinary solar flares due to magnetic reconnection effect potentially induced in the near-Earth magneto tail. The tenuous plasma in that region is then accelerated down magnetic field lines into the Polar Regions, striking Earth's atmosphere and exciting nitrogen and oxygen atoms as well as other atoms present in our atmosphere.

Time variations in the emission may due to the changes in the electron density. However, these variations mainly proceed slowly. It is due to the change in the local ionization temperatures. The bursts were selected by their appearance which was made simultaneously with digital recording. One possible reason behind the formation of this very complex long duration of this loop is the magnetic reconnection and disruption of the loops which is observed during flare maximum.

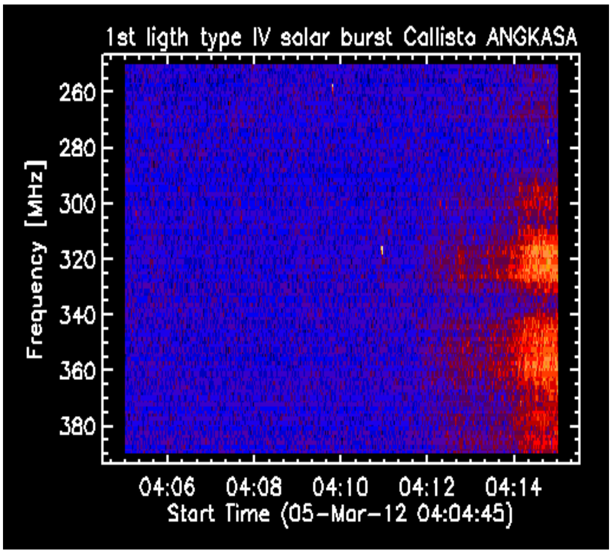

Figure 2. The beginning phase of solar burst type IV

As for the solar data, we compare our rough data to the real time data obtained from NOAA Space Weather Prediction Center. During each event, Sunspot 1429 active region was a site of several intense in several days. There are also others active region 1423, 1428, 1430 respectively as in Figure 3. Below is a result of solar parameter on that day.

This latest solar flare is the second X-class sun storm of 2012 that has successfully detected. The first event occurred on Jan. 27 and classified as an X1.7 on the space weather scale.

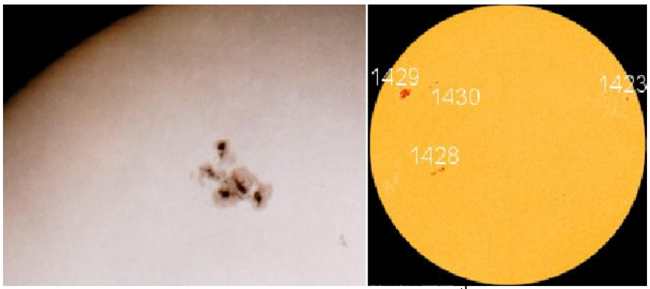

Figure 3. The sunspot that visible during 5th March 2012

Figure (Left) shows the large scale of active region 1429 that responsible solar flare phenomenon. The sun-spot group 1429 is seen on the surface of the sun on this photo taken from Salgotarjan, 109 km northeast of Budapest, Hungary. Although the main purpose of the instrument is to provide imaging data, in order to study a large number of bursts, we restrict ourselves to total power data without spatial resolution. Time variations in the emission may due to the changes in the electron density. One of the apparent disadvantages of the spectral expansion and limited averaging procedure is that this data can be only automatically saved in a daily basis only. Another difficulty in the interpretation is due to the fact that the observations suggest a few non-axisymmetric harmonics.

Observations presented in this paper confirmed that Malaysia can be one of the potential country to focus on solar monitoring solar radio emission at low- broadband frequency (45-870) MHz using ground-based telescope due to 12 hours per day throughout a year lies in the fact that they originate in the same layers of the solar atmosphere in which geo-effective disturbance probably originate.

CONCLUSIONS

Herein, the nature of low–frequency solar radio bursts type IV has been discussed. Thus, our first light detection result of solar burst type IV is approximately consistent with solar flare type M level 2.0. For all of these reasons, the study of solar radio burst has become an important practical task in addition to the intellectual understanding the physical processes involved. Observations in radio region in the low frequency are the most can potentially diagnose the space weather effect originates from the Sun’s atmosphere. It is also play an important role in monitoring the space weather sources.

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