Solar Burst Type II Structures from CALLISTO Database Affected by Coronal Mass Ejections Events Detected using LASCO/SOHO Satellite

Z S Hamidi¹,², NNM Shariff³

¹Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
²Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia
³Academy of Contemporary Islamic Studies, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Abstract. This paper explains the CME phenomena that connect with type II solar burst, focused on the velocity and structure parameters. The data collected were from CALLISTO and LASCO/SOHO satellite for a solar type II radio burst. Radio data presented was from different stations over the world which similarly occurred within 8 minutes to reach the Earth. The drift rate of this solar burst type II is linear to its CME velocity. The majority of type II burst has a drift rate of range 0.05-0.4 MHz/s which is considered as a slow drift rate. Both harmonic and Herringbone structure of type II has a slow drift rate which drifted from high frequency to lower frequency as time duration increases. Slow drift rate was a complement to the solar radio burst type II. Using LASCO data, there was a CME present during the time burst observed. The energy produced during CME phenomena was high enough to associate with burst type II. Herringbone structure of type II burst has variation in its CME velocity and is unpredictable which may have the extreme velocity or much slower velocity. The structure forms a single band which propagates from high frequency to lower frequency in time duration. However, for the harmonic structure of burst type II, the velocity of its associated CME has average speed of 300 to 600 km/s which normally. Thus, the behavior of type II burst needs to be well understood as it associated with the interaction of particles in CME phenomena.

1. Introduction

It is well known that the solar radio burst type II closely related to a synergy of coronal mass ejection (CME) energy with close opaque coronal structures. It is a fact that higher coronal density of plasma and inferior bulk stream speed are the characteristic of these coronal structures than the surrounding solar wind plasmas which contribute to halo or partial halo CME. The varying magnetic field transforms to the magnetic potential energy and kinetic energy by accelerating plasmas in the solar corona [1]. Previous results show that the halos CMEs speed is at ~957 km/s [2].Thus, at the point where a CME attaches through a close-by streamer or coronal beam, related energy disruption may spread into an area with considerably lesser characteristic speed and originated from solar corona [3]. This supports the development or improvement of coronal shock, and additionally the ensuing electron acceleration and solar burst type II excitation which potentially increase the geomagnetic disturbances [4, 5]. This activity which is due to the magnetic fields disturb from low radio flux and solar wind variation [2].
Past reviews along this line of thinking were to a great extent in light of associated investigation of coronagraph data and radio spectrograph images. The type II burst initiated from condensed area of the corona, with greater energy at the bow of coronal shock. They concluded that the type II burst was generated at the interface of the CME flank and the streamer with higher energy density of proton [6]. Nonetheless, the data records which offer the strong indication on the radio source site. The main reason is that the shortage of synchronous imaging in short and long wavebands. Still, current studies have confirmed the significance of merging these data on top of the spectral data in enlightening the source of metric type II bursts and their association with CME-driven shocks in terms of dynamism relations. Beside this line of observational endeavors, we demonstrate a type II event with imaging figures from the Compound Astronomical Low cost Low frequency Instrument for Spectroscopy and Transportable Observatory (CALLISTO) data in Ooty India along with in ROSWELL-NM and Solar and Heliospheric Observatory (SOHO) spacecraft for CME image data [6] which use CACTus software in its application. This allows us to determine the characteristics and the behavior of both associated type II and CME events in terms of structure, time, frequency and other parameter. Thus, it is believed that the climate change has a strong relation with CMEs [7].

2. Solar burst type II structures and Coronal Mass Ejection (CME) events

Presently, over 80 system can be used from 43 locations, with consumers from more than 113 countries in the e-CALLISTO partner around the world [8, 9]. The database record radio signal for each day and stored in a central data and it is a international linkage [10]. The record is used for continuous data collection of solar activities every day through the internet connection and stored in the central database in the workstation [9]. The type II burst was imaged by CALLISTO in 8th January 2014 at 100 to 270 MHz in Ooty station and ROSWELL-NM station in 12th April 2015 with frequency of 34 MHz to 44 MHz. The spectral resolutions vary irregularly with frequencies. A grouping of these data is shown in Figure 1. The contours in the CALLISTO pictures represent colour code which eliminates the background to show clear structure of burst using Rapp viewer software. The type II burst in Ooty station shows harmonic structure with duration of occurrence is within 7 to 8 minutes. This burst displays band-splitting feature on both the fundamental (F) and harmonic (H) subdivisions. In addition, SRBT II shown by ROSWELL-NM station has duration of occurrence which is within 3 - 4 minutes. This kind of structure has single drift band which drifted to the lower frequency respective to time duration.

The drift rate of harmonic structure and Herringbone structure is ~0.393 MHz s^{-1} and ~0.117 MHz s^{-1} which is reflected as a slow drift rate. Slow drift rate was complement to the type II burst. It has been showed that $\varepsilon = 1.8$ for frequencies from 0.1 to 250 MHz. This association is referred to as the universal drift-rate spectrum, which suggests that there must be something common for the type II bursts at the CME driven shock. The exponent $\varepsilon$ can be devotedly derived assuming that the emission happens at the local plasma frequency ($f_p$).
3. Results and Discussion

Using the SOHO satellite using instrument Large Angle Spectroscopy Coronal Mass Ejection Observatory (LASCO)/SOHO mission in application of Computer Aided CME Tracking software (CACTus), CME image and its characteristics can be obtained more precisely as it consistent with CME rate for past 30 years. Using LASCO/SOHO satellite data, there was CME present for both type of type II burst observed. In 8th January 2015, the average velocity of CME during that time was 534 km/s with minimum speed of 504 km/s and maximum speed of 607 km/s while during 12th April 2014 the average velocity of CME is 359 km/s as its minimum velocity is 106 km/s while maximum velocity is 1736 km/s.

Figure 1. CALLISTO radio observation of SRBT II (left) by OOTY India station (harmonic structure) and ROSWELL-NM station with Herringbone structure and image obtained using Rapp viewer software (right)
The best way to be sure that CME is Earth-directed is with the help of pictures taken by the LASCO C2 and C3 coronagraph instruments which are positioned on the SOHO spacecraft. SOHO watches the Sun from Earth's perspective so potential Earth-directed coronal mass ejections can easily be identified. CMEs that are Earth-directed will show up as partial or full halo coronal mass ejections as they propagate away from the Sun. Using the all of the imagery available from the SOHO and STEREO missions. The maximum speed of CME can be categorized as Moreton wave speed which is above 500 km/s. Thus, energy produced during CME phenomena was high enough to produce burst
type II. Energy carried by ion, electron and proton inside CMEs was energetic enough to deliver the effect of Aurora phenomena.

4. Conclusion
Herringbone structure of type II burst has variation in its CME velocity and is unpredictable which may have extreme velocity or much slower velocity. The structure forms single band which propagate from high frequency to lower frequency in time duration. However, for harmonic structure of burst type II, the velocity of its associated CME has average speed of 300 to 600 km/s which normally. This kind of type II structure has double bands which split and both band form multiple band. Thus, energy interaction between the particles in the streamer of CME needs to be well understood.

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