

Scenario of Solar Radio Burst Type III During Solar Eclipse on 14th November 2012

Z. S. Hamidi^{1,*}, N. N. M. Shariff², C. Monstein³

¹School of Physics and Material Sciences, Faculty of Sciences, MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia

²Academy of Contemporary Islamic Studies (ACIS), MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia

³Institute of Astronomy, Wolfgang-Pauli-Strasse 27, Building HIT, Floor J, CH-8093 Zurich, Switzerland

*E-mail address: zetysh@salam.uitm.edu.my

ABSTRACT

A compact solar flare was observed during a total solar eclipse event on 13-14 November 2012. This phenomenon is beginning in local time on November 14 west of the date line over northern Australia, and ended in local time on November 13 east of the date line near the west coast of South America. During the eclipse, the highest magnitude was 1.0500, occurring only 12 hours before perigee, with the maximum eclipse totality lasting just over four minutes. Considering the observational facts, the solar radio burst type III can be detected from the National Space Centre Malaysia by the Compound Low Cost Low Frequency Transportable Observatory (CALLISTO) system from 00:00 UT – 1:30 UT. The group and individual solar burst type III can be detected in the region of 150-400 MHz. However, the eclipse cannot be observed from our site. From the observation, it was found that the eruption in the active region is becoming more active with a tens of groups solar radio burst type III can be observed. It continuing bursting within the first one hour. The sunspot number exceeds to 108 and solar wind speed 454.9 km/sec. Still the Sun remains active and we need to consider other processes to explain in detailed the injection, energy loss and the mechanism of the acceleration of the particles.

Keywords: Sun; solar eclipse; solar radio; burst, type III; e-CALLISTO

1. INTRODUCTION

In principle the magnetic energy in the solar corona is explosively released and converted into a heating radiation, mass motion and particles acceleration during solar flare phenomena. During that time, a large number of electrons are accelerated with very high temperature (~ 10-20 MK). This explosion can be a combination of Bremsstrahlung which can be detected in the X-ray region and non-thermal electron which could be observed in radio region. The solar radio burst type III plays a fundamental role in solar activity [1]. Solar eclipse occurs when the Moon passes between Earth and the Sun, thereby totally or partly obscuring the image of the Sun to a viewer on Earth. It happens when the Moon's apparent diameter is larger than the Sun, blocking all direct sunlight, turning day into darkness.

Totality occurs in a narrow path across the surface of the Earth, while a partial solar eclipse will be visible over a region thousands of kilometers wide.

In principle, type III solar burst, a fast drift burst is the most common of the meter wavelength bursts. This burst was first characterized by Wild in 1963 [2] in the frequency range 500-10 MHz. The formation can be found during a pre-flare stage that could be a signature of electron acceleration [3]. It has a dynamism in terms of structure and can be divided into a few sub-types. This burst has a dynamical structure and very dominant in meter region [4]. It can also associated with Coronal Mass Ejections (CMEs) event [5].

The question of nonlinear wave-wave interaction which involving interaction of electrostatic electron plasma that called as Langmuir waves active region radio emissions also have been studied [6-10]. This wave is a rapid oscillation of the electron density in conducting media such as plasmas or metals. The oscillation is due to instability in the dielectric function of a free electron gas. The Langmuir waves initiate from the non-thermal electrons, and the intensity of the radio bursts depends on the nonthermal electron density and energy . It is believed that a beam-plasma system is unstable to the generation of Langmuir waves, which are high frequency plasma waves at the local plasma frequency.

2. EXPERIMENTAL SETUP AND OBSERVATION

The development of radio astronomy in Malaysia started since 2005 [11]. The Compound Astronomical Low-frequency, Low-cost Instrument for Spectroscopy Transportable Observatories (CALLIISTO) system is used in obtaining a dynamic spectrum of solar radio burst data. We used our own Log Periodic Dipole Antenna (LPDA) and this system was mounted on the top of the rooftop of National Space Centre (ANGKASA) building at Sg. Lang, Banting, Selangor located at (N 02° 49.488' E 101° 36.168') covered from 45-870 MHz [12]. The preliminary analysis of RFI has been done in the previous work [13]. The modification, calibration process and basic testing of the antenna has been done in order to improve the quality of the system [14-18]. In order to avoid the interference signal, we focused the range of 150 MHz till 350 MHz [19,20]. This region is the best region with minimum interference at our site that might affect the solar radio burst data [21]. We have selected the data from 150-400 MHz region seems this is the finest range with lowest of Radio Frequency Interference (RFI) [22]. Continuous solar observation of 12 hours solar monitoring is done routinely [23-39].

3. RESULTS AND ANALYSIS

A fast drift Type III solar burst is formed intermittently within one and a half period of observation starting from 00:00 UT to 1:30 UT. The timeline of the event is very important to understand the formation of this burst. Figure 1-5 shows the chronology of the solar burst type III. At first stage, there is few singular and a group type III bursts that can be found within 15 minutes. This signal of the burst is not very strong and form intermittently. This can be prove in Figure 1.

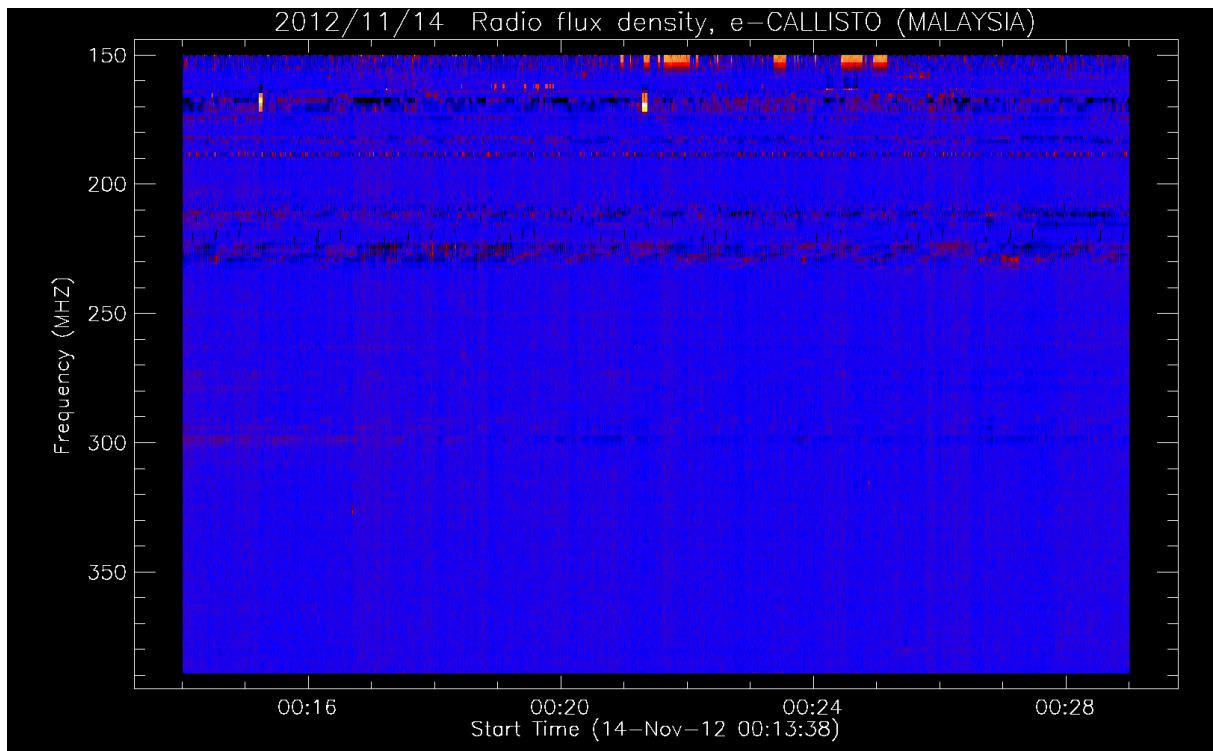


Figure 1. An intermittently and a group of type III burst from 00:00 – 00:30 UT.

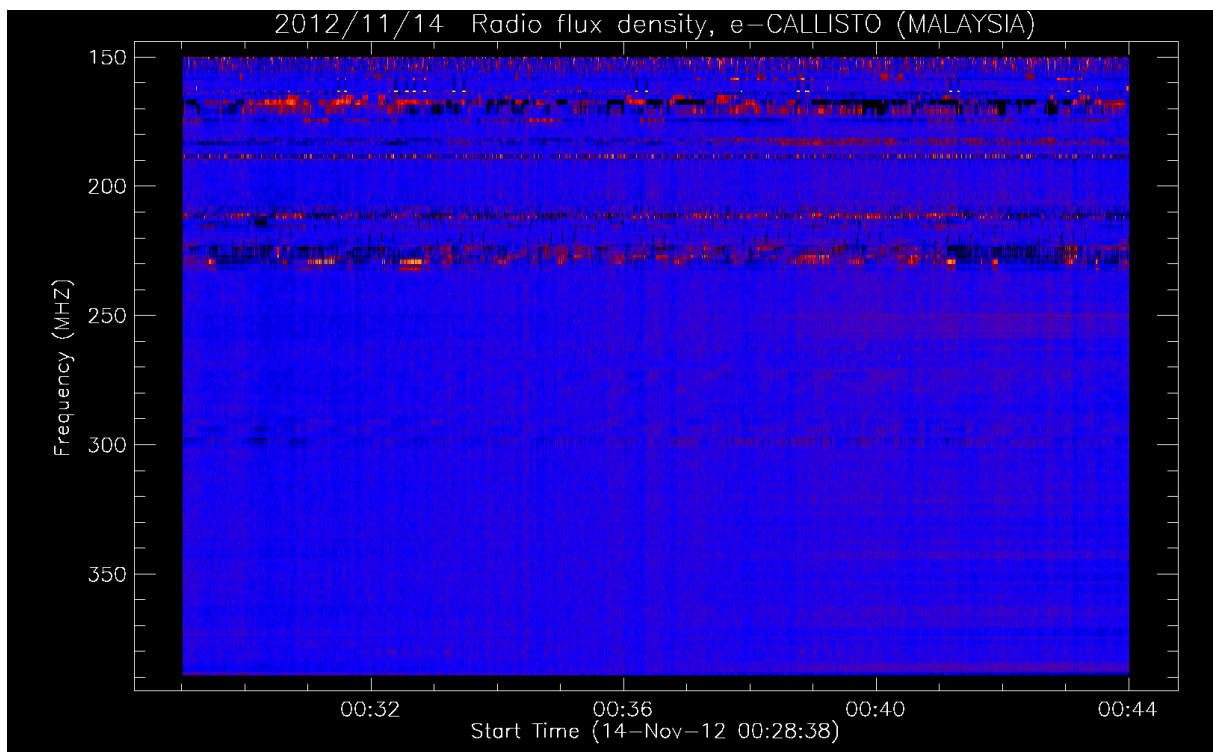


Figure 2. An intermittently and a group of type III burst from 00:30 – 00:45 UT.

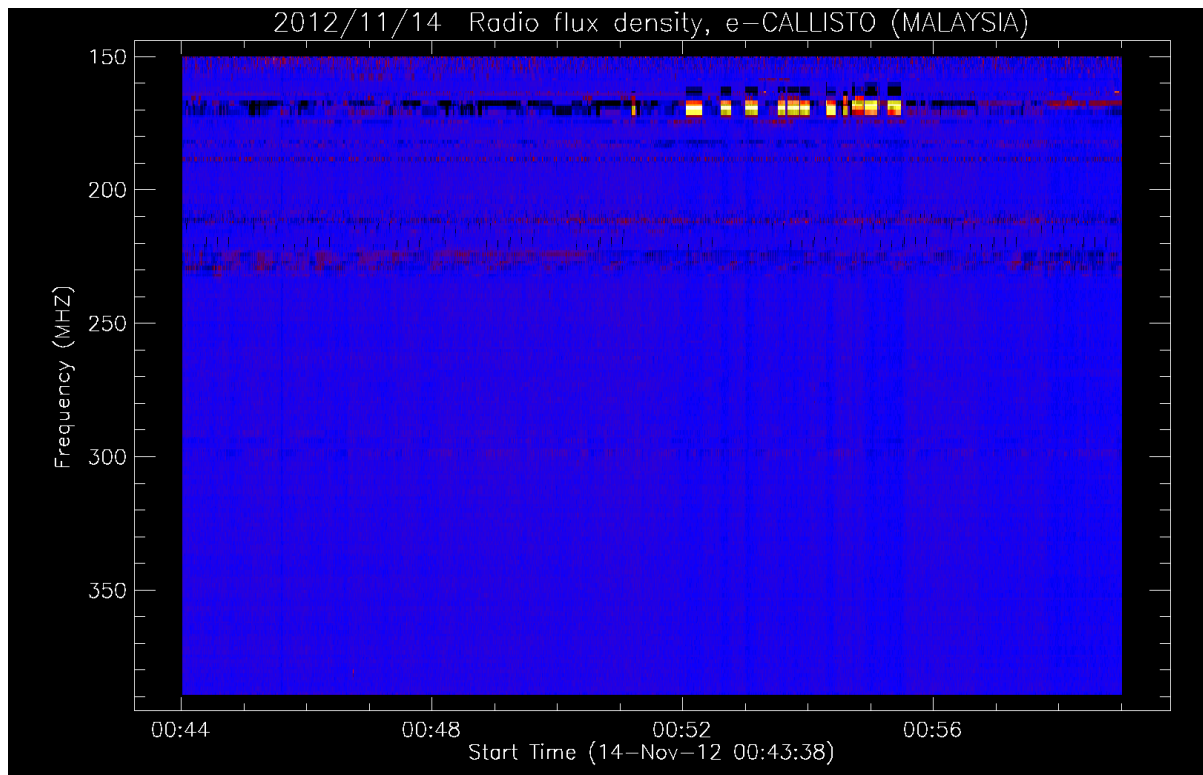


Figure 3. An intermittently and a group of type III burst from 00:45 – 01:00 UT.

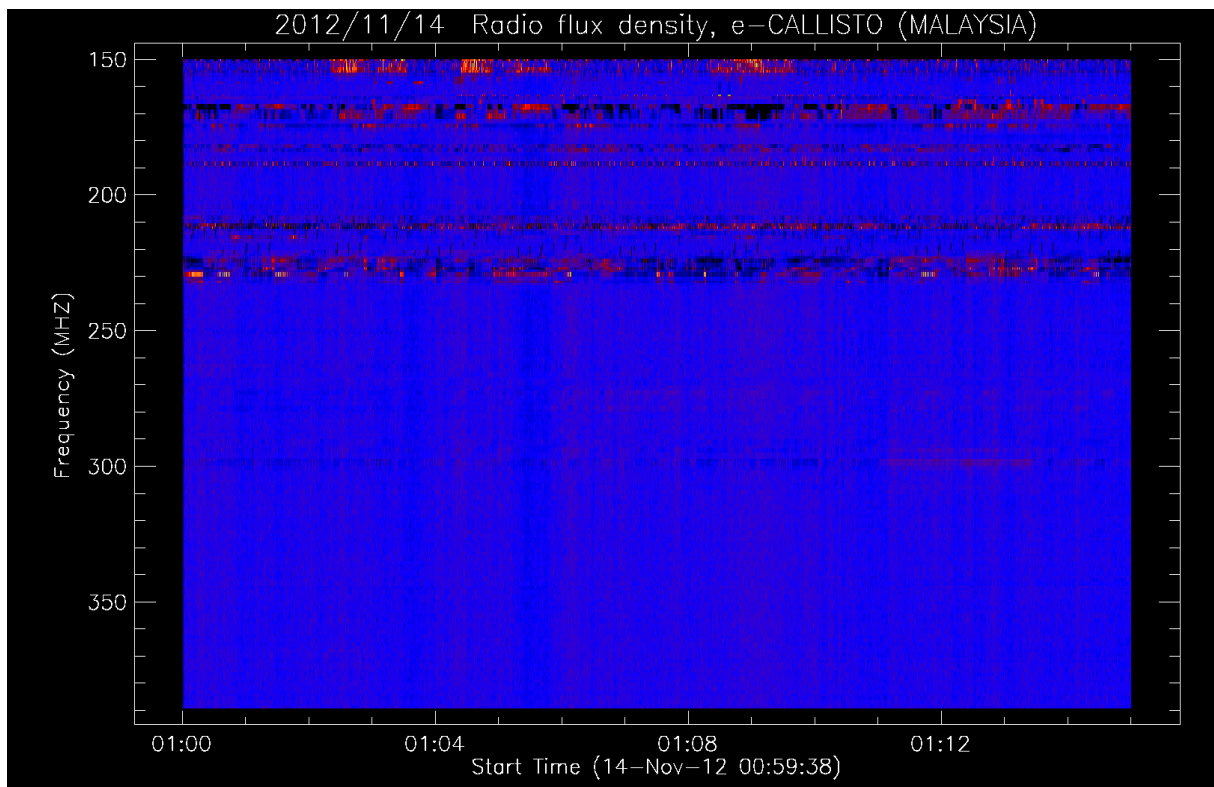


Figure 4. An intermittently and a group of type III burst from 01:00 – 01:15 UT.

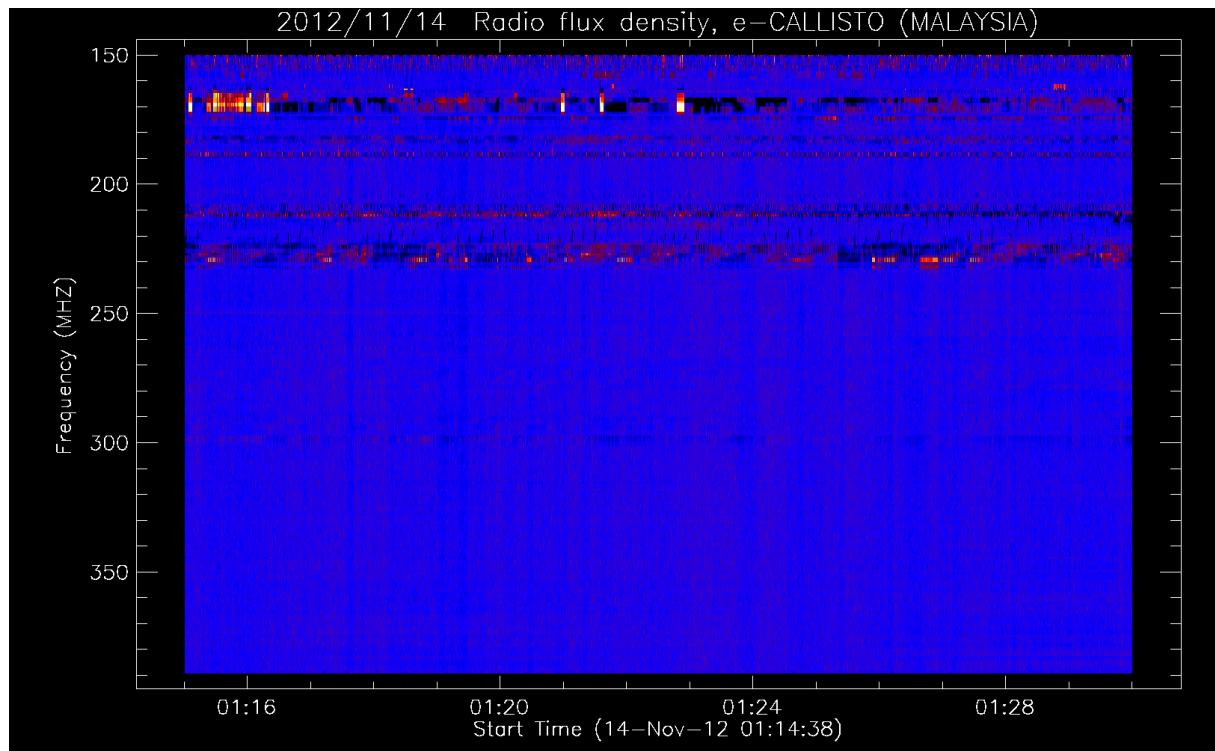


Figure 5. An intermittently and a group of type III burst from 01:1 – 01:30 UT.

However, the eruption in the active region is becoming more active with a tens of groups solar radio burst type III can be observed. It continuing bursting within the first one hour. Table 1 displays the detailed parameter of each active region that can be observed directly from ground and space observation during 14th November 2012.

Table 1. The current condition of the Sun (Credited to Space Weather).

Parameter	Value
Solar wind speed	454.9 km/sec
Density	1.4 protons/cm ³
Sunspot number	108
10.7 cm flux	146 sfu
24-hr max	M1
6-hr	B9



Figure 6. Solar Eclipse on 14th November 2012.

The first contact of eclipse begin at 9:33:00 UT at longitude W 41° 06.2 and longitude S 25° 04.8. We could observe a penumbra at 10:28.4 UT. A few minutes later, the central eclipse began at 11:57.8 UT. This phenomenon is ending at 14:34.3 UT at longitude E 45° 12.2' and longitude S 14 ° 57.5'. The active regions during that event is presented in Table 2.

Table 2. Parameter of each active region during 13th November 2012.

Active Region Number	Location	Lo	Area	Z	LL	NN	Magnitude
1605	N16W82	340	0010	Bxo	07	04	Beta
1609	S14W10	263	0010	Hrx	04	03	Alpha
1610	S22W10	263	0550	Eki	11	51	Beta-Gamma
1611	N15E13	240	0250	Eho	12	12	Beta-Gamma
1612	N09E25	228	0100	Hsx	05	01	Alpha
1613	S22E43	210	0170	Dso	10	10	Beta

1614	N16E58	195	0350	Fho	17	19	Beta
1615	N10E48	205	0160	Cao	10	08	Beta

4. CONCLUDING REMARKS

Although we could not see the solar eclipse at our site, this is a part of our initiative to see the behaviour of the Sun during that event. Still the Sun remains active and we need to consider other processes to explain in detailed the injection, energy loss and the mechanism of the acceleration of the particles. The continuity of flares could be observed within a few hours. It is believed that the large solar flares with a few numbers of solar storms contribute the distribution of flux energy or the burst. However, how far the effect of the solar eclipse event of the Sun activity remains indefinite.

ACKNOWLEDGEMENT

We are grateful to CALLISTO network, STEREO, LASCO,SDO/AIA, NOAA and SWPC make their data available online. This work was partially supported by the FRGS (600 RMI/FRGS 5/3 2012) UiTM grants. Special thanks to the National Space Agency and the National Space Centre for giving us a site to set up this project and support this project. Solar burst monitoring is a project of cooperation between the Institute of Astronomy, ETH Zurich, and FHNW Windisch, Switzerland, MARA University of Technology and University of Malaya. This paper also used NOAA Space Weather Prediction Centre (SWPC) for the sunspot, radio flux and solar flare data for comparison purpose. The research has made use of the National Space Centre Facility and a part of an initiative of the International Space Weather Initiative (ISWI) program.

BIOGRAPHY

Dr Zety Sharizat Hamidi is currently a 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) and also a lecturer in School of Physics and Material Science, at MARA University of Technology, Shah Alam Selangor.

C. Monstein is a senior Engineer at Institute of Astronomy, Wolfgang-Pauli-Strasse 27, Building HIT, Floor J, CH-8093 Zurich, Switzerland and one of the researchers who initiated the CALLISTO system around the world.

Dr Nur Nafhatun Md Shariff is a senior lecturer in Academy of Contemporary Islamic Studies (ACIS), MARA University of Technology, 40450, Shah Alam, Selangor, Malaysia. Her current research is more on sustainability; environmental aspect. She is looking forward for cross-field research, i.e. solar astrophysics, light pollution measurement (mapping) and religious studies.

References

- [1] M. R. Kundu, *Solar Radio Astronomy*, John Wiley, 1965.
- [2] J. P. Wild, Smerd S. F., Weiss, A. A., *Ann. Rev. Astron. Astrophysics* 1 (1963) 291-366.
- [3] G.A. Dulk, *Type III solar radio bursts at long wavelengths*, in: R. Stone, E. Weiler, M. Goldstein (Eds.), *Geophys. Monogr.*, 2000.

-
- [4] Z.S. Hamidi, N. Anim, N.N.M. Shariff, Z.Z. Abidin, Z.A. Ibrahim, C. Monstein, *Dynamical structure of solar radio burst type III as evidence of energy of solar flares*, in: R.Shukor (Ed.), PERFIK 2012, American Institute of Physics, Malaysia, 2013, pp. 11-15.
- [5] Z. Hamidia, Z. Abidina, Z. Ibrahima, N. Shariffa, C. Monsteinc, *AIP Conf. Proc* 1528 (2013) 55-60.
- [6] G.B.a.L. Gelfreikh, *Soviet Astron.* 23 (1979).
- [7] P. Lantos, *Sol. Phys.* 22 (1972).
- [8] A. Vourlidas, Bastian, T. S., Nitta, N., Aschwanden M. J., *Sol. Phys.* 163 (1996).
- [9] E.Y. Zlotnik, *Soviet Astron.* 12 (1968).
- [10] V.V. Zheleznyakov, *Radio Emission of the Sun and Planets* (1970).
- [11] N. Hashim, Z. Abidin, U. Ibrahim, R. Umar, M. Hassan, Z. Rosli, Z. Hamidi, Z. Ibrahim, *Radio Astronomy in Malaysia: Current Status and Outreach Activities*, Astronomical Society of the Pacific Conference Series, 2011, pp. 355.
- [12] Z.S. Hamidi, Z. Ibrahim, Z. Abidin, M. Maulud, N. Radzin, N. Hamzan, N. Anim, N. Shariff, *International Journal of Applied Physics and Mathematics* 2 (2011) 3.
- [13] Z.S. Hamidi, Z.Z. Abidin, Z.A. Ibrahim, N.N.M. Shariff, U.F.S.U. Ibrahim, R. Umar, *Preliminary analysis of investigation Radio Frequency Interference (RFI) profile analysis at Universiti Teknologi MARA*, IEEE, 2011, pp. 311-313.
- [14] Z.S. Hamidi, S. Chumiran, A. Mohamad, N. Shariff, Z. Ibrahim, N. Radzin, N. Hamzan, N. Anim, A. Alias, *American Journal of Modern Physics* 2 (2013) 4.
- [15] Z.S.Hamidi, Z. Abidin, Z. Ibrahim, N. Shariff, C. Monstein, *International Journal of Engineering Research and Development* 3 (2012) 36-39.
- [16] Z.S. Hamidi, Z. Abidin, Z. Ibrahim, C. Monstein, N. Shariff, *International Journal of Fundamental Physical Sciences* 2 (2012) 32-34.
- [17] Z.S. Hamidi, et al., *International Journal of Fundamental Physical Sciences* 2 (2012) 4.
- [18] Z.S. Hamidi, N.N.M. Shariff, *International Journal of Science and Mathematics* 2 (2014) 3.
- [19] Z.S. Hamidi, Z. Abidin, Z. Ibrahim, N. Shariff, *Indication of radio frequency interference (RFI) sources for solar burst monitoring in Malaysia*, ICPAP 2011, AIP Publisher, Indonesia, 2012, pp. 6.
- [20] Z.S. Hamidi, N.N.M. Shariff, C. Monstein, *The International Journal of Engineering* 1 (2012) 3.
- [21] N. Anim, Z. Hamidi, Z. Abidin, C. Monstein, N. Rohizat, *Radio frequency interference affecting type III solar burst observations*, 2012 National Physics Conference: (PERFIK 2012), American Institute of Physics, 2013, pp. 82-86.
- [22] Z.S. Hamidi, N.N.M. Shariff, R. Umar, *Malaysia Thailand Journal of Physics* 3 (2012) 6.
- [23] Z.S. Hamidi, N. Shariff, Z. Abidin, Z. Ibrahim, C. Monstein, *Middle-East Journal of Scientific Research* 12 (2012) 6.

-
- [24] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 13(1) (2014) 77-87.
- [25] Z. S. Hamidi, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 4 (2014) 29-36.
- [26] Z. S. Hamidi, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 5 (2014) 32-42.
- [27] Z. S. Hamidi, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 5 (2014) 43-49.
- [28] Z. S. Hamidi, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 7 (2014) 21-29.
- [29] Z. S. Hamidi, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 7 (2014) 30-36.
- [30] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, Z. A. Ibrahim, *International Letters of Chemistry, Physics and Astronomy* 7 (2014) 37-44.
- [31] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, W. N. A. Wan Zulkifli, M. B. Ibrahim, N. S. Arifin, N. A. Amran, *International Letters of Chemistry, Physics and Astronomy* 8 (2014) 13-19.
- [32] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, W. N. A. Wan Zulkifli, M. B. Ibrahim, N. S. Arifin, N. A. Amran, *International Letters of Chemistry, Physics and Astronomy* 9 (2014) 8-15.
- [33] Z. S. Hamidi, N. N. M. Shariff, M. F. Ali, C. Monstein, W. N. A. Wan Zulkifli, M. B. Ibrahim, N. S. Arifin, N. A. Amran, *International Letters of Chemistry, Physics and Astronomy* 9 (2014) 84-92.
- [34] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 11(1) (2014) 51-58.
- [35] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 11(2) (2014) 135-145.
- [36] Z. S. Hamidi, N. N. M. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 11(2) (2014) 167-176.
- [37] Z. S. Hamidi, C. Monstein, N. N. M. Shariff, *International Letters of Chemistry, Physics and Astronomy* 11(3) (2014) 243-256.
- [38] Z. Hamidi, N. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 10 (2014) 81-90.
- [39] Z. Hamidi, N. Shariff, C. Monstein, *International Letters of Chemistry, Physics and Astronomy* 12 (2014) 84-102.