EPSC Abstracts
Vol. 8, EPSC2013-738, 2013
European Planetary Science Congress 2013

Decameter type III bursts with positive and negative frequency drift rates

V.N. Melnik (1), A.I. Brazhenko (2), **A.A. Konovalenko** (1), C. Briand (3), V.V. Dorovskyy (1), P. Zarka (3), A. V. Frantzusenko (2), H.O. Rucker (4), B.P. Rutkevych (1), M. Panchenko (4), T. Zaqarashvili (4), B. Shergelashvili (5)
(1) Institute of Radio Astronomy, National Academy of Sciences of Ukraine, Kharkov, Ukraine (melnik@rian.kharkov.ua / Fax:+38-057-7061415), (2) Gravimetrical Observatory, Poltava, Ukraine, (3) Paris Observatory, Meudon, France, (4) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (5) Centre for Plasma-Astrophysics, University of Leuven, Leuven, Belgium

Abstract

We report about observations of decameter type III bursts whose frequency drift rates vary their signs from negative to positive. Moreover drift rates of some bursts vary the sign some times. Positive drift rates for some bursts are changed from 0.44 MHz/s to 12 MHz/s. At the same time the negative drift rates of these bursts are standard values for decameter type III bursts. A possible interpretation of such phenomenon on the base of plasma mechanism of type III burst generation is discussed. The sense of this interpretation is that group velocity of type III electromagnetic waves generated by fast electrons at some conditions can be smaller than velocity of these electrons.

1. Introduction

Type III bursts have been studying during more than 60 years. Their properties have been analyzed quite well. One of them is a drift of bursts from high frequencies to low frequencies [1]. It means in the plasma mechanism of radio emission that a source of radio emission moves in the solar corona from the regions with large densities to the regions with small densities. As a rule radio emission at lower frequency arrives to the Earth later than the radio emission radiated by the same source at larger frequency. As a consequence the frequency drift rates of type III bursts are negative. In this paper we report about observations of decametre type III bursts with changing sign of drift rates. These bursts have negative drift rate in some frequency band and positive one in another frequency band. The possible explanation of such type III bursts is discussed.

2. Observations

In this paper we discuss three type III bursts with changing sign of frequency drift rates. They were observed simultaneously by radio telescopes UTR-2, URAN-2 (Ukraine) and NDA (France) in frequency band 8-32 MHz and 28-41 MHz on June 3 (Fig.1), August 25 and August 26, 2012.

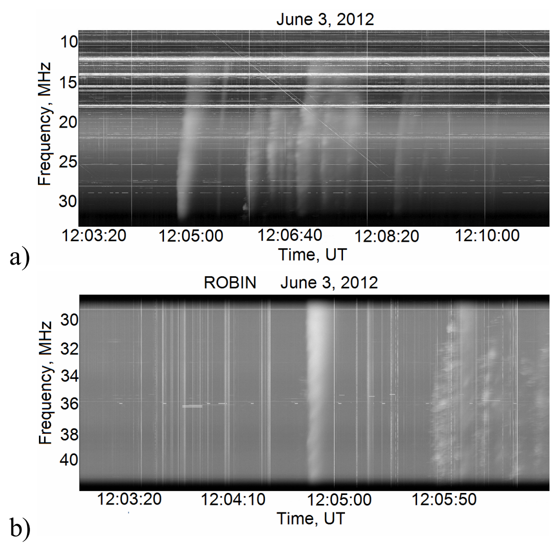
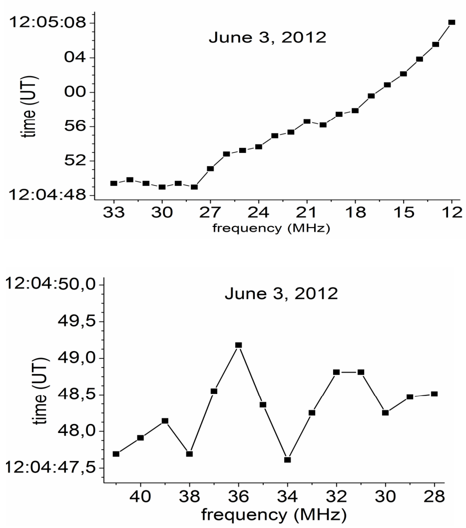


Figure 1: Type III burst (12:05:00) with changing sign of frequency drift rate observed by URAN-2 (a) and NDA (b).

Fig.2 shows motion of flux maximum of this burst on the dynamic spectrum. It is seen that burst maximum has negative drift rate equaled to -3.3 MHz/s at frequencies 36-41 MHz. In the frequency band 28-36 MHz maximum drift rate some times change the sign with average positive drift rate about 12MHz/s.

Observations by radio telescopes UTR-2 and URAN-2 give drift rate closed to this value, 11.6 MHz/s, in the frequency range 28-33MHz. At lower frequencies <28MHz drift rate is negative -0.84MHz/s. So we see that discussed type III burst changes the sign of its drift rate some times.



a) b)

Figure 2: Motion of type III burst maximum flux on the dynamic spectrum on data of URAN-2 (a) and NDA (b).

Approximately same situations are with other two type III bursts observed simultaneously only by UTR-2 and URAN-2. So there is a problem in what way such properties can be understood in plasma mechanism of radio emission.

3. Discussion

On our point of view the possible explanation of such phenomenon of type III bursts is in peculiarities of propagation of radio emission generated by fast electrons in the coronal plasma. Because the group velocity of electromagnetic waves v_{gr} generated at the frequency close to plasma frequency there is a possibility that it can be smaller than velocity of radio emission source v_b . Then generation of electromagnetic waves at large altitude happens earlier than electromagnetic waves generated at low altitude by the same source comes at this altitude. As a result type III bursts with positive drift rates appeared. If group velocity is close source velocity then the drift rate will be large. Such type III bursts with large drift rate were observed in the decametre range [2]. In the paper [2] the equation for frequency drift rate of type III burst

$$\frac{df}{dt} \approx \frac{df}{dn}\frac{dn}{dr}\frac{v_b v_{gr}}{v_{gr} - v_b \cos\alpha} \quad (1)$$

was derived. Here $n(r)$ is the plasma density at the distance r from the Sun, α is the angle between line of sight and the direction of source propagation. In the gas-dynamic theory of electron propagation through plasma [3] source velocity equals to $v_b = v_0 / 2$, where v_0 is the maximum velocity of electrons generating Langmuir waves with wave number $k_{l,0} \approx \omega_{pe} / v_0$. Then the group velocity of fundamental radio emission is $v_{gr} = \sqrt{3} v_{Te} c / v_0$, where v_{Te} is the thermal velocity. From Equation (1) we derive that frequency drift rate is negative when the group velocity is larger than source velocity $v_{gr} > v_b \cos\alpha$ or at the maximum electron velocity $v_0 > \sqrt{2\sqrt{3} v_{Te} c}$ (at $\alpha = 0$). In the opposite case the drift rate of type III burst is negative. Then type III bursts with changing sign of drift rate can be interpreted as radio emission from electrons, which propagate through plasma that consists from regions with different temperatures.

Acknowledgements

The work is fulfilled in the frames of FP7 project “SOLSPANET” and France-Ukraine joint project “PICS 2010”.

References

[1] Suzuki, S., Dulk, G.A.: In Solar Radio Physics: McLean, D. J. & Labrum, N. R. (ed.) Bursts of Type III and Type V, 1985.

[2] Melnik, V. N., Konovalenko, A. A., Rucker, H. O., Rutkevych, B. P., Dorovskyy, V. V., Abranin, E. P., Brazhenko, A. I., Stanislavskyy, A. A., Lecacheux, A.: Decameter Type III-Like Bursts, Solar Phys. Vol. 250, pp.133-145, 2008.

[3] Mel'Nik, V. N., Lapshin, V., Kontar, E.: Propagation of a Monoenergetic Electron Beam in the Solar Corona, Solar Phys., Vol. 184, pp. 353-362, 1999.