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Quasi - periodic pulsations at decameter wavelengths in the November 24, 2000 solar flare

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Abstract. Spectral observations of the Sun in the frequency range of 54 to 78 MHz in the November 24, 2000 solar flare showed quasi - periodic pulsations with periods in the range of 11 - 19 seconds. YOHKOH images of this flare in the active region AR 9236 showed loop structures. Assuming an impulsively generated propagating MHD wave for the pulsations, the coronal magnetic field at 1.6 $R_\odot$ height is derived as $\sim$ 8 Gauss.

Keywords : Sun - Corona - Pulsations - MHD waves

1. Introduction

Study of pulsations at long wavelengths is important, since it provides information on the periodic acceleration processes and oscillatory structures in the outer corona. For over 4 decades, solar astronomers have been observing pulsating structures in the solar corona. Achong (1974) observed quasi - periodic emission with a period of 4 seconds in the 18 - 23 MHz band. Sastry et. al (1980) reported pulsations with a period of 2 - 5 seconds at 34.5 MHz. Most of these pulsations occured during some phase of the type IV events. Karliky et al. (2000) have reported that at the start of large solar flares quasi - periodic pulsations can occur. We present here observations of quasi - periodic pulsations in the frequency range of 54 - 78 MHz which occured after the X2 flare of November 24, 2000.

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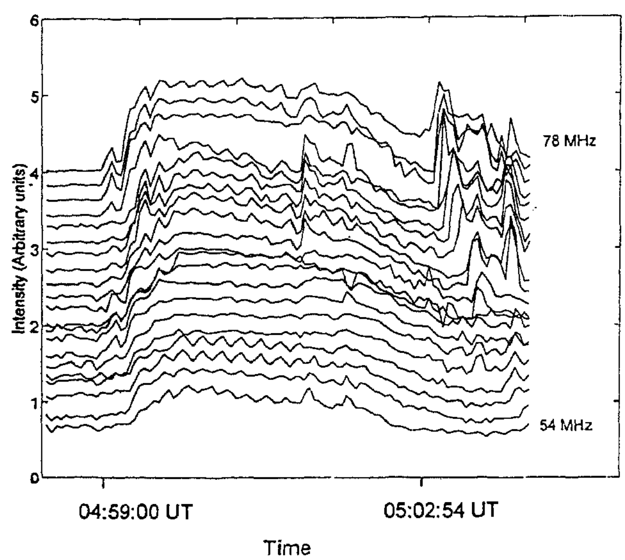

Figure 1. Time profiles of flare continuum emission in the frequency range of 54 - 78 MHz. Pulsations are seen during the maximum phase of the continuum. The intensity at each frequency is arbitrarly shifted in this figure.

2. Observations

The observations were made with the Gauribidanur Digital spectrograph (Ebenzer 2000). The frequency and time resolution respectively are 1 MHz and 3.32 seconds. A large flare continnum emission was recorded around 04:59 UT on November 24, 2000. Pulsations were seen during the maximum phase of the flare continuum emission. Figure 1 shows the time profiles of the pulsation event in the 54 - 78 MHz frequency range. The peak flux density of these pulsations vary from 0.08 SFU to 0.12 SFU. From the time profiles at several frequencies in the above band the pulse period was determined. The period ranges from 11 to 19 seconds with the pulse period around 13 seconds for 30 bursts out of 65.

3. Discussions

In a magnetically structured corona with density inhomogenities, the surface forms a natural boundary for standing and propagating waves. If a disturbance is impulsively generated in a coronal loop as in the case of a flare, fast sausage mode MHD waves are produced. The time period P in this case is given by P= 2.6× a / V_a (Roberts et al. 1984) where a is the radius of the coronal loop and V_a is the Alfven velocity.

The H_α flare corresponding to the above radio event started at 04:57 UT (SGD 2000) in the active region AR 9236. Existence of loop structures were seen in the YOHKOH images of this region during the flare time. The onset of the pulsations was at 04:59:34 UT i.e 2 minutes and 34 seconds after the solar flare. If we equal this time of 2 minutes and 34 seconds to h/V_a where h is the height at which the 60 MHz (the center frequency of our observing band) radiation occurs, we can estimate the velocity of the exciting agent. Assuming 2 times the Newkirk's electron density for the active region and fundamental radiation for the pulsations, we get h $\sim 4\times10^5$ km above the photosphere. The derived Alfven velocity is $\sim$ 2600 km/ s and hence the magnetic field strength is $\sim$ 8 Gauss. For the pulse period of 13 seconds, the derived radius of the loop is $\sim$ 13000 km. The radio emission may be due to synchrotron radiation from electrons trapped inside the coronal loops since the observed pulsation event is broad band without any frequency drift.

4. Conclusions

We described a pulsation event at decameter wavelengths associated with the onset of a solar flare. From the pulsation period of 13 seconds and assuming a model of propagating MHD waves, we derived the magnetic filed strength as $\sim$ 8 Gauss and radius of the loop as $\sim$ 13000 km. The significance of these observations lies in the estimation of the magnetic field of coronal loops at about 1.6 solar radii where optical observations are not possible. The estimated strength of the magnetic field lies in the range of values determined by coronal loop oscillations by TRACE (Nakariakov and Ofman 2001).

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