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Radio signatures of shock accelerated electron beams in the corona

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1 Introduction

The Sun's activity appears not only in the well-knwon 11-year sunspot cycle but also in flares, eruptive events coronal mass ejections and radio bursts. Solar radio bursts are signatures of special plasma processes in the solar corona. For instance, electron acceleration in space plasmas is a hot topic in astrophysics, because energetic electrons are the source of non-thermal radio and X-ray radiation in space.

2 Extended Abstract

The Ukrainian radio telescope URAN-2 [1] observed special fine structures called ”tadpoles” in the solar radio radiation in the frequency range 8-32 MHz. In the dynamic radio spectrum they appear as a chain of ”tadpoles” slowly drifting from 26 to 23 MHz within 4 minutes. The individual tadpole consists of two components, the ”head” and the ”tail” rapidly drifting from the head to lower and sometimes higher frequencies over an extent of $\approx$ 10 MHz within 8 s. The ”head” shows a slow drift from high to low frequencies. These fine structures remind of ”herringbones” in solar type II radio bursts [2]. Type II radio bursts are considered as the radio signature of shock waves travelling outwards in the solar corona (see e.g. [3]). As the ”herringbones”, the tadpoles are interpreted as shock accelerated electron beams.

The electron beams are considered to be generated by shock drift acceleration (SDA) [4]. The beam electrons excite Langmuir waves which convert into radio waves by nonlinear wave-plasma processes, which are called plasma emission. Spectrometric data of the tadpoles data are linked to the theoretical results to get a better understanding of the generation of energetic electrons by shocks in the solar corona.

Adopting SDA for generating energetic electrons, the accelerated electrons establish a beam-like velocity distribution. Plasma emission requires the excitation of Langmuir waves, which is efficient if the velocity of the beam electrons exceeds few times of thermal electron speed. The Rankine-Hugoniot relationships describes the shock transition in the framework of magnetohydrodynamics. They are evaluated for the special case of nearly perpendicular shocks under coronal circumstances. The study leads to the conclusion: The electron beam, which generates the tadpole's radio radiation, is generated via SDA by a nearly-perpendicular shock, which is travelling nearly horizontal to the surface of the Sun.

References

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