Bursts of kinetic Alfvén waves and coronal radio emission at 2-3 solar radii

Yuriy Voitenko* (1) , Valentin Melnik(2) , and Viviane Pierrard(1)
(1) Belgian Institute for Space Aeronomy, Brussels, Belgium
(2) Institute of Radio Astronomy of NASU, Kharkov, Ukraine

Solar radio observations at 10-30 MHz have been carried out recently using radio telescopes UTR-2 (world's largest radio telescope at decametric wavelengths near Kharkov, Ukraine) and URAN-2 (Poltava, Ukraine). High sensitivity and time resolution of these observations allowed revealing many new interesting features of the coronal radio emission (V. N. Melnik et al., *AIP Conf. Proc.*, **1206**, 2010, pp. 427-432). Results of these observations can be used for studying coronal processes and remote coronal diagnostics. Of our particular interest in the present paper are coronal radio bursts at 23-29 MHz with drift rates implying the emission sources propagating upward with velocities ~ 10^8 cm/s. We discuss such radio bursts and propose a feasible generation mechanism for them.

The deduced propagation speeds of the radio emission sources are close to the local Alfvén velocity, which suggests that the Alfvén waves are involved. We construct a new coupled Alfvén-Langmuir wave model explaining these radio bursts. First the bursts of highly oblique kinetic Alfvén waves (KAWs) are generated by magnetic reconnection events at the coronal base. These KAWs can be driven by the reconnection outflows (Y. Voitenko and M. Goossens, *Solar Phys.*, **206**, 2002, pp. 285-313), or directly by the magnetic reconnection (M. A. Shay et al., *Phys. Rev. Lett.*, **107**, 2011, id. 065001). The KAWs possess the electric field component parallel to the background magnetic field and accelerate a fraction of the background electrons along the magnetic field. The resulting electron beams propagate ahead of the KAW bursts and generate Langmuir waves by the bump-on-tail instability. Finally, the Langmuir eigenmodes, trapped in the density wells associated with the original KAWs, generate the fundamental and second harmonic radio emission via the antenna mechanism (D. M. Malaspina et al., *Astrophys. J.*, **755**, 2012, id. 45). The role of KAWs is here two-fold: they accelerate the electron beams and provide the density traps for Langmuir waves.

Using typical values of the coronal plasma parameters at 2-3 solar radii, we analyze the electron acceleration and beam formation by the upward-propagating KAW pulses. We found that electron beams with densities about 0.1 of the background electron density and velocities about two local Alfvén velocities can be formed by the KAW bursts with reasonable magnetic amplitudes about 0.1 of the background magnetic field. Such beams are capable of generating Langmuir waves with amplitudes sufficient to explain the brightness of observed radio bursts.