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Solar Coronal Radio Bursts at 1.5-3 Solar Radii Above Active Regions

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1. Extended Abstract

Observations of decametric radio emission provide a unique tool for remote sensing of the high solar corona at 1.5-3 solar radii above the solar active regions. The coronal plasma at these heights undergoes an additional energy input from the non-thermal motions (waves and/or turbulence), which leads to the solar wind acceleration. These regions are also channels for energetic particles and coronal mass ejections (CMEs) propagating from the flare sites. Altogether, solar wind, energetic particles, and CMEs, are key ingredients defining the plasma state and space weather also at larger distances, in the interplanetary space and near the Earth in particular. To understand drivers of space weather, it is therefore important to know properties of the plasma and waves at 1.5-3 solar radii and processes operating there.

We use the high-resolution radio spectra obtained recently by large radio telescopes UTR-2 and URAN-2 (Ukraine) to study solar radio bursts and their emission mechanisms. Our particular focus is on the AV bursts – narrow-band bursts with relatively low frequencies 15-30 MHz and drift rates around 100 kHz/s. Such drift rates correspond to source velocities close to the local Alfvén velocity (hence the abbreviation AV), which suggests that the Alfvén waves are involved in the generation scenario. On the other hand, AV-bursts are closely associated with much faster type III burst, and hence can share with them the common energy source – fast electron beams accelerated by solar flares. Combining two these facts, and accounting for kinetic properties of oblique Alfvén waves, we develop further the theory of AV bursts and their generation mechanism. Our estimations of the linear and nonlinear time scales show that kinetic Alfvén waves with elevated but still small amplitudes can accumulate Langmuir waves in density cavities. Energy of the trapped Langmuir waves is enough to generate observed AV bursts by the fundamental plasma emission mechanism.

However, some important properties of generated radio bursts, like their central frequencies and frequency drift rates, critically depend on the radial profiles of the magnetic field and plasma density. We analyzed several coronal models and did not find a universal one capable of explaining all observations. The plasma state above the active regions appears to be too dynamical and varies significantly from case to case, which may complicate future development of more precise models forecasting space weather near the Earth. Nevertheless, observed radio bursts remain a valuable source of new information about properties of plasmas and waves in the solar corona just above the active regions particularly influenced by the solar flares and CMEs.