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Does the plasma radiate near a Double Layer?

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Earth is an intense radio source in the kilometer wavelength range. Being a direct consequence of the parallel acceleration processes taking place in the Earth's auroral region, the radiation contains fundamental information on the characteristic spatial and temporal scales of the turbulent accelerating layer.

It is now widely assumed that the cyclotron maser instability leads to Auroral Kilometric Radiation (AKR) generation. It has been suggested from the FAST measurements that the AKR results from a so-called horseshoe electron distribution. This distribution is generated when a localized parallel electric field – called Double Layer (DL) - accelerates earthward the electrons that propagate into an increasing magnetic field. The magnetic moment of the electrons is conserved so that their pitch angle is increased. This results in the creation of a horseshoe-like shape for the electron distribution exhibiting large positive velocity gradients in the direction perpendicular to B, thereby providing free energy for the AKR generation which takes place at the local electron gyrofrequency. In these circumstances, the radiation is generated far away (several thousand kilometers) from a DL, because the parallel accelerated electrons need to travel a long distance before forming a horseshoe distribution.

From an experimental point of view, it is not an easy task to highlight the presence of DLs, because they are moving transient structures so that high time resolution measurements are needed. A detailed analysis suggests that these large-amplitude parallel electric fields are located inside sharp density gradients at the interface separating the cold, dense ionospheric plasma from the hot, tenuous magnetospheric plasma. We present some FAST observations which illustrate the generation of elementary radiation events in the neighborhood of a DL. The events occur 10 to 20% above the local electron gyrofrequency in association with the presence of nonlinear coherent structures (such as electron holes) located on the high potential side of the DL. These observational results might encourage investigation of such radiating processes because they could be relevant to other astrophysical radio sources, such as the recently discovered aurora around a brown dwarf.