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Thin plasma cavities: the generation and escape of the Auroral Kilometric radiation

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Abstract

It has been demonstrated by experimental data obtained during the last two decades that the production of the terrestrial Auroral Kilometric Radiation (AKR) occurs in thin plasma cavities, filled by hot and tenuous plasma and separated from the denser and colder surrounding plasma by sharp density gradients. Usually the AKR sources are relatively long lived regions with a dimension along the background magnetic field of several thousand kilometers. They are extended in east-west direction along the auroral oval. The north-south extent is always small, often less than 100 km. In the light of these experimental data the waveguide model of the AKR generation describing the development of the electron cyclotron maser instability in sources of finite perpendicular extension was developed. It has been shown that one of the effects arising from the finite geometry of AKR sources is an existence of a preferential direction of wave generation: the instability growth rate increases with an enhancement of the wave vector component directed along the east-west direction. Calculations, made under the assumption of geometric optics and taking into account the global inhomogeneity of the Earth's magnetic field, have shown that the wave amplification factor may reach high values during the wave propagation inside the cavity. But in the frames of the plane waveguide model the produced electromagnetic energy is substantially confined in the source because the most part of waves cannot reach altitudes where their frequencies become equal to the local cutoff frequencies of the surrounding plasma. We show that the time-depending processes, such as the wave scattering inside the source and at the waveguide frontiers in the presence of low frequency fluctuations, may play a key role in the energy escape from the source in the formation of AKR radiating diagram. The comparison of obtained theoretical results with experimental data is discussed.