Excitation Of Zonal Flow And Magnetic Field By ULF Planetary Waves In The Earth's Ionospheric E-layer

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Existence of the new type of coupled electromagnetic (EM) ULF waves in the Earth's ionospheric E-layer is revealed. It is shown that in the weakly ionized E-layer along with the prevalent effect of Hall conductivity the latitudinal inhomogeneity of both the Coriolis parameter and the geomagnetic field becomes essential for the ULF waves under the consideration. Action of these effects leads to the coupled propagation of EM Rossby and Khantadze modes on the one hand and coupled propagation of Rossby, Alfvén and Khantadze modes on the other hand. As a result the new type of dispersive Alfvén waves is revealed. Linear propagation properties of such coupled waves are given in detail. Possibility of existence of the other new coupled Internal-gravity and Alfvén EM planetary waves in the weakly ionized ionospheric E-layer is shown. Under such coupling new type of Alfvén waves is revealed.

Simplified set of nonlinear equations describing the dynamics of mentioned coupled EM modes in the conductive weakly ionized E-layer is obtained: 1) spatially 2D equations in case of coupled Rossby-Khantadze and coupled Internal-gravity-Alfvén, and 2) spatially 3D equations in case of coupled Rossby-Alfvén-Khantadze modes, respectively.

Nonlinear instability of short wavelength turbulence of mentioned coupled Rossby- Khantadze, Internal-Gravity-Alfvén, and Rossby-Alfvén-Khantadze EM planetary modes with respect to the excitation of low-frequency and large-scale perturbations of sheared zonal flow and magnetic field is revealed. The nonlinear mechanism of the instability is driven by the advection of vorticity and is based on the parametric excitation of zonal flow by three finite-amplitude coupled modes leading to the inverse energy cascade toward the longer wavelength. The corresponding driving forces along with the Reynolds stresses are stipulated by Maxwell's stresses also. The growth rates of the corresponding instability and the conditions for driving them are determined. The possibility of generation of the intense mean magnetic field (of the order of 10^2 - 10^3 nT) is shown.