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Ponderomotive interaction between the ULF waves and heavy ions in the magnetosphere

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There are two types of problems in the physics of ponderomotive interaction between the ULF waves and heavy ions in the magnetosphere. They arise at the conditions of nonresonant and resonant interaction, and they can be conditionally named constructive and conceptual problems respectively. The first type of problems may be solved in principle by using the standard theory of the ponderomotive forces, whereas an essential modification of standard theory is needed for the solution of the second one. The modification is required due to the nonintegrable singularity of ponderomotive potential at the resonant point. In this report we discuss the relevant tasks, disputable issues, and unsettled problems related to the both types of problems. The ponderomotive acceleration of polar wind, redistribution of ions with deep plasma cavities formation, and separation of the ion species under the action of Alfvèn waves are considered. The modification of the ULF wave fields due to ponderomotive redistribution of ions is demonstrated. In particular it is shown that the anharmonicity of the Alfven oscillations in combination with nonlocal boundary condition over the Earth's surface leads to the parasitic nonlinearity of the surface impedance of the Earth calculated by using the magneto-telluric method in the Pc5 frequency range. In addition the observational evidences of the technogenic and seismogenic ponderomotive impacts on the magnetospheric wave activity in the Pc1 frequency range are displayed. The idea of permanent ponderomotive resonance (PPR) is formulated. The special attention is given to an assessment of the upward acceleration of O+ ions under the condition of PPR. This rather complex and intricate mechanism delivers high-energy ions O+ of ionospheric origin to the periphery of the magnetosphere. According to our estimates an interesting pattern of PPR arises whose essential feature is in continuous acceleration of ions O+. Asymptotically the acceleration is determined by the longitudinal gradient of geomagnetic field, the transverse correlation radius of electric field oscillations, and supposedly weakly depends on their intensity. It is especially important in view of the satellite observations of high altitude O+ energization and outflows [Nilsson, Joko, Lundin et al., 2004]. The overall conclusion is that the formalism of ponderomotive forces is useful when solving some problems of the wave-particle interaction in the magnetosphere. The work was supported partly by grant RFBR 09-05-00048.