ELECTROMAGNETIC PULSE GENERATION IN THE LOWER IONOSPHERE

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ABSTRACT

We consider the radiation of low-frequency electromagnetic waves from pulse of the axisymmetric electric current and the propagation of these waves in the homogeneous ionospheric plasma with Hall and Pedersen conductivities. Green\'s function of the electromagnetic radiation in the ionospheric plasma has been obtained. Convolution of the Green\'s function with the temporal dependence of radiating current has been calculated. The external geomagnetic field is perpendicular to the plane in which radiating current is located. It is shown that the electromagnetic perturbation propagates inside cone at angles up to about 20° to the magnetic-field direction and it has the form of an oscillation wave packet. The frequency of the wave packet decreases depends on time. Its characteristic group velocity, wave length, and frequency decrease depends on angle between the propagation direction and the external magnetic field. The characteristic frequency of oscillations varies from 0.1-10 Hz. The phase velocity decreases in the interval from 10 to 100 km/sec depends on distance from the source. As the angle increases, the oscillations disappear and the field propagates as a single-polarity pulse. Formation of the explosion shock wave electromagnetic field in the ionosphere is theoretically investigated. A shock wave arises in explosion-type active experiments and disasters of space engines at the ionospheric altitudes. A semi-empirical model of shock wave in the rarefied gas is constructed. This model enables to determine the spatial-temporal distribution of gas temperature, velocity, density and pressure between shock wave front and explosion product surface depend on the Mach number and the explosion altitude. In analyzing the electrodynamic processes accom-panying the explosive injection it was assumed that their source is the electric current generated in a propagating shock wave. Electric current occurs by the ionosphere plasma perturbation in external magnetic field behind of the shock wave front. Theoretical results have been compared with experimental data obtained by observations of electromagnetic phenomena during explosive injections of easily ionized elements in the ionospheric plasma. It is shown that the observed characteristics of electromagnetic pulse such as the propagation along the mag-netic field, the presence of oscillations, the spectral interval, and the characteristic values of the phase and group velocities can be interpreted using the presented model. High-amplitude electric field pulses have been recorded during experiments with such injection. Considerable electric field disturbances were observed in cases where the measurements were carried out near the same line of force of the geomagnetic field.