# ON MAGNETODYNAMIC EFFECTS INITIATED BY A HIGH-SPEED IMPACT OF A LARGE COSMIC BODY UPON THE EARTH'S SURFACE

I. V. Nemchinov, P. E. Alexandrov, V. I. Artemiev,
V. I. Bergelson, and V. A. Rybakov

Institute for Dynamics of Geospheres, Russian Academy of Sciences, Moscow,
Leninsky prospect, 38, build. 6

The impact of a large cosmic body with typical size R ~ 1 km (mass M ~ 4-10 Gt for a stony or icy body) moving with velocity V ~ 50-70 km/s (kinetic energy of the order of $10^{21}$ J or $10^6$ Mt of TMT) on the Earths surface leads to a full vaporization of a body and of a significant part of substance of the upper layers of the Earth and even to the ionization of this vapour cloud. As a result a hypersonic jet of air and erosion plasma is formed. The kinetic energy $E_j$ of the jet can reach 10-20% of the kinetic energy of a cosmic body or even more. The magnitude of $E_j$ is far above the total energy of the geomagnetic field of the Earth (approximately equivalent to the energy of 100 Mt) and the total mass of a fast-moving part of the jet $M_j \sim 10^{12}$ kg is far above the mass of atmosphere in the jet expansion cone. Thus the jet will propagate practically inertially with the constant mean velocity U ~ 10-20 km/s and even higher. The interaction of this plasma jet with the Earth's magnetic field causes magnetodynamic effects similar to those which are produced by cosmic nuclear explosions but of a larger scale.

The electric field of polarization and electric current through the ionosphere form a giant MHD-generator transforming the kinetic energy of the jet $E_j$ into the thermal energy of ionosphere Q. A coefficient of conversion $\zeta = Q/E_j$ is approximately equal to $U^2B^2t^3/(V_AM_j)$, where B is the inductivity of the geomagnetic field near the Earth's surface and $V_A$ is the effective Alfven velocity in the ionosphere connected with the charecteristic integral surface Pedersen conductivity of ionosphere $\Sigma_P = c^2/(4\pi V_A) \sim 1\text{-}10\ \mathrm{Ohm}^{-1}$, c is light velocity. Let us take for the characteristic time of interaction of the plasma jet with the magnetosphere $t = R_E/U \sim 600$ s, where $R_E$ is the Earth's radius (for this time the interaction is already global and the reduction of the geomagnetic field at the shock wave front takes place). Hence $\zeta \sim 10^{-3}$- $10^{-2}$ and the total thermal energy release in ionosphere $Q \sim 10^{17}$- $10^{-18}$J or $10^2$-$10^3$ Mt of TNT. This energy release is tens times greater then the thermal energy of the undisturbed ionosphere and energy of the geomagnetic field at the heights more than 100 km.

The substantial ionospheres heating and the deformation of the magnetosphere can lead to different immediate consequences (the destruction of the ozone layer, disruption of the radiation belts, and precipitation of the trapped energetic particles from them, to the large amplitude oscillations of the ionospheric and magnetospheric plasma, to the interruption in the transmission of the electromagnetic signals of different wavelengths which is an important factor in our information age especially in the case of the catastrophic impact etc) and to long term consequences which should be evaluated.

The preliminary results of experimental and numerical modelling of the plasma jet - magnetosphere interaction are presented.