Impact of shock wave on weakly ionized gas: numerical evaluation

V.A. Pavlov[1], J.V. Triaskin[1]

[1] *Physics Department, St. Petersburg State University, 1, Ulyanovskaya str., Petrodvorets, 198504, St. Petersburg, Russia*

The basic principles of nonlinear ion-acoustic waves formation in weakly ionized gas subjected to the shock wave of neutral gas were investigated by the numerical and analytical methods. The ion-acoustic approximation were employed to describe the plasma component of charged gas [1]. Within a such approach the ion-acoustic waves arise via the collisions of charges with the neutral particles only. For numerical simulation the initial and approximate boundary conditions for non-stationary problem are determined in assumption that the solution of runaway wave type can be found [2]. The strong anomalous nonlinear effects appear in this case. The competitive action of nonlinearity, dispersion and dissipation at the formation of specific plasma "condensations" and "rarefactions" is shown [2]. In narrow range of the shock wave velocities the anomalous relaxation of plasma oscillations occurs behind the front. It appears in the total ambipolar entrainment by the shock wave of charged components. This effect possibly results from the strong nonlinear resonant (in respect to the shock wave velocity) perturbation in the region ahead of front.

Nonlinear perturbations of weakly ionized non-isothermal gas ($T_e \gg T_i \approx T_n$) under the action of a strong stationary shock wave of the neutral component have been studied based on computer-aided calculations. The detected patterns reflect the most essential features of the additional mechanism of reduction of the intensity of a strong shock wave of the neutral component without energy release for heating the region ahead of the front. The reciprocal action of the charged components upon the neutral particles result in change of the structure and reduction of the intensity of the shock wave. In such a case, a paradoxical situation arises: low-ionized plasma (the nonperturbed state is meant) exerts a strong effect upon the neutral component and the reduction of the shock wave intensity. Laboratory experiment data to corroborate such influence are available [3].

References

[1] V. A. Pavlov, Plasma Phys. Rep. 22, 167, (1996)

[2] V.A. Pavlov. Ya. V. Tryaskin. Journal of Applied Mechanics and Technical Physics, Vol. 56, No. 3, (2015)

[3] Yu. L. Serov, MODERN SCIENCE, No.2, Vol.10, 2012