Drift and diffusion ion and electron in He-Ar gas mixture

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Possible influence of the mix composition on the properties of the dusty structures was first discussed in [1, 2], where it was shown that a strong influence of gas composition on the plasma-dust structures in discharges. This influence is based on the fact that the properties of the dusty structures in dc discharge plasma are mainly determined by the characteristics of ion flux.

In this paper, we present the calculation of ion and electron velocity distributions as a function of gas pressure, field strength, and concentration of the heavy gas for the mixture of helium and argon (see experimental work [3]).

Analysis of the distribution functions obtained by the application of Monte Carlo simulations showed that the drift of heavy ions in a light gas results in the suppression of the ion heating by the electric field and in the formation of the supersonic ionic jet at high electric field strength. In spite of high anisotropy and large difference in the temperatures $T_{\|}$ and $T_{\perp}$ (temperatures along and across the electric field), the velocity distribution is described well by the shifted Maxwell distribution function.

This result predicts a considerable influence of the gas composition on the characteristics of the plasma-dusty structures in dc and rf discharges. It should be possible to evaluate the peculiarities stipulated by the supersonic nature of the jet such as Mach cone, dust particle interaction anisotropy and others.

Based on that, one could suppose that the dusty structures in some light gases (such as helium or hydrogen) with minor amount of the heavy and more easily ionizing gas (such as argon, krypton, xenon or heavy metal vapors – mercury, cesium and others) would exhibit a range of remarkable features due to the high Mach numbers. One should note that a minor admixture to the working gas in amounts of about 1% or less can also result in a strong and uncontrolled change in discharge characteristics.

The work was supported by Russian Foundation for Basic Research (Grants 06-08-01554-a, 08-02-00791-a, 08-02-01172-a), and the Netherlands Organization for Scientific Research (NWO) (grant no. 047.017.2006.007).

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