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INFLUENCE OF POLARIZATION EFFECTS ON CHARGING OF DUST PARTICLES IN A PLASMA

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In a dusty plasma one of the most important characteristics of micron-sized particles, called grains, is their electrical charge that can range from dozens to thousands of the elementary. This usually results in that the dust component of the plasma turns a strongly non-ideal system in which the average interaction potential energy is of the order of or even exceeds the thermal kinetic energy. In this case it is rather clear that physically meaningful properties of the dust component are completely governed by the intergrain interaction energy, which depends on their charge to a large extent.

Under ordinary experimental conditions, the dust particles, immersed into an ambient plasma, readily acquire a high negative electric charge. This obviously happens because at the initial time moment the plasma electron flux on the gain surface is significantly greater than the flux of ions, since the corresponding mobilities differ by orders of magnitude. Gradually charging the dust particles start to repel the electrons and attract the ions that eventually makes the total electric charge flux on the grain surface vanish. This condition fully determines an equilibrium charge of the dust particles which can be calculated, for example, within the so-called orbit motion limited (OML) approximation [1].

It is presumed in the standard version of OML that the interaction of the electrons and ions of the ambient plasma with the dust particle is purely Coulomb. It is proposed herewith to also take into account the polarization effects which can particularly be implemented by invoking the charge image method [2]. This implicitly implies that the dust particles are made of a perfect conductor, however, the polarization effects will come to play regardless of the material the grains are made of.

Numerical evaluations show that the electrostatic induction plays an essential role, especially when the charge of dust particles is not too high. In addition the obtained results asymptotically approach those data of the OML with the pure Coulomb interaction potential when the grain charge grows.

The present investigation, together with the results of [3], opens up the possibility of constructing a self-consistent theory of the static properties of the dust component that correctly treats the finite size of the dust particles and the polarization effects in their mutual interaction.

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