SCREENED ELECTROSTATIC AND VAN DER WAALS INTERACTION OF NANOPARTICLES IN DUSTY PLASMAS AND ELECTROLYTES

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This work is devoted to the consideration of screened electrostatic interaction and van der Waals interaction of nano- and micron-sized particles in dusty plasmas and electrolytes. Electrostatic interaction is considered on the basis of the linearized Poisson–Boltzmann equation for particles with both fixed charges uniformly distributed over their surfaces and fixed electrical potentials of the surface. The found solution to the problem allows us to study the interaction of both particles of comparable radius and particles of very different sizes. The interaction force takes into account the osmotic component, which in the case of constant charges leads to the restoration of equality of forces acting on the first and second particles. For the van der Waals interaction, the screening of static fluctuations and the retardation of electromagnetic fields for the dispersive part of the interaction are taken into account. Based on the analysis of various expressions for the geometric factor, taking into account the retardation of the electromagnetic field, a numerically stable method for calculating this factor is proposed. The total energy of interaction of two charged dust particles is calculated for plasma parameters which are representative for dusty plasmas: the electron and ion number densities are varied from 10^8 to 10^{12} cm^{-3}, the nanoparticle radius from 10 nm to 1 μm and the particle charges from 10 to 10^3 elementary charges per micrometer of particle radius.

The study showed that with particle charges representative for dusty plasmas on the order of 10^3 electron charges per micrometer of particle radius, the total interaction potential has a fairly high barrier, which strongly prevents the approach and coagulation of particles of comparable sizes in dusty plasmas. A decrease in the radius of one of the particles in the pair leads to a noticeable decrease the potential barrier. Also, the deviation from the linear dependence of the charge on the particle radius leads to a slight decrease the potential barrier, which must be taken into account when modeling the processes of coagulation of particles in dusty plasmas.

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