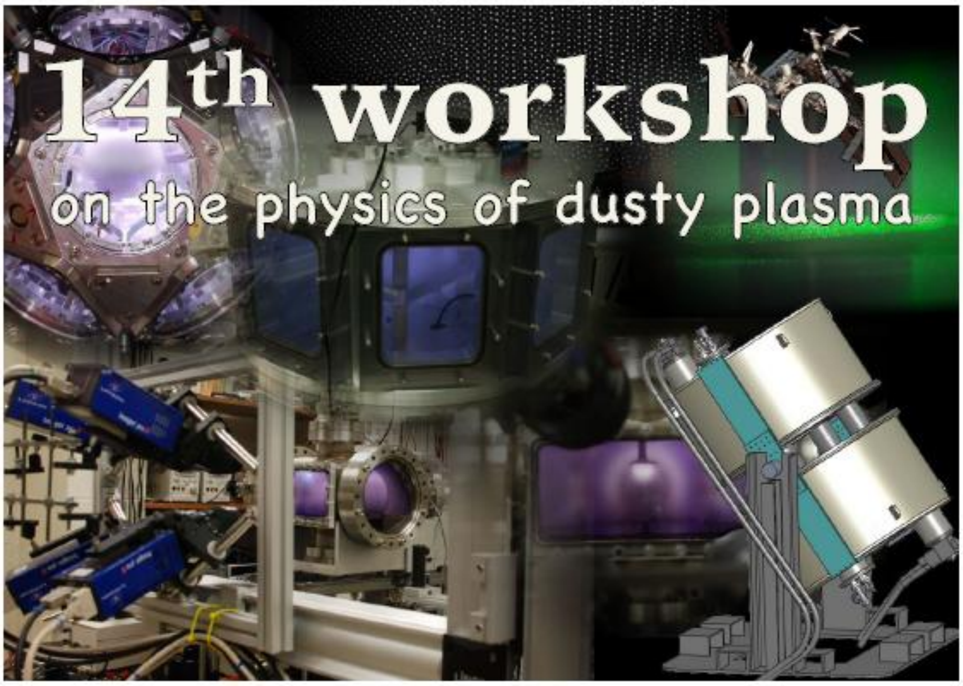

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Static properties of dusty plasmas

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One of the hot problems of modern plasma physics is the study of various properties of dusty plasmas, which contain, along with electrons and ions, micro-sized particles. For this purpose, so-called effective potentials are widely used to designate that the interaction of micro-sized charged particles in plasmas differs from the pure Coulomb interaction. Such effective potentials inevitably take into account the collective events that result in various self-consistent field theories like the well-known Yukawa potential corresponding to the pair correlation approximation valid for rather small number densities [1]. However, such potentials do not incorporate the finite size of dust particles. It is therefore of interest to construct an effective potential taking into account the finite size of the dust particles. To do so there is a practicable tool which is the dielectric medium approximation that provides the following simple formula for the Fourier transform $\tilde{\varphi}_{dd}(k)$ of the effective interaction potential between two dust grains:

$$\tilde{\varphi}_{dd}(k) = \tilde{\phi}_{dd}(k)\varepsilon^{-1}(k,0), \qquad (1)$$

where $\varepsilon(k,0) = 1 + 1/(k^2 r_D^2)$, stands for the static dielectric function of the plasma with r_D being the Debye radius, $\tilde{\phi}_{dd}(k)$ denotes the Fourier transform of the interaction potential between two dust particles of radius R in a vacuum which is found within the charge image approximation in the form [2]:

$$\tilde{\varphi}_{dd}(k) = \frac{4\pi Z_d^2 e^2}{k^2} - \frac{8\pi Z_d^2 e^2 R}{k}[\mathrm{Ci}(2kR)\sin(2kR) + \\ + \frac{1}{2}\cos(2kR)(\pi - 2\mathrm{Si}(2kR))]. \qquad (2)$$

Here $\mathrm{Ci}(x) = -\int_x^\infty \frac{\cos t}{t}dt$ and $\mathrm{Si}(x) = \int_0^x \frac{\sin t}{t}dt$ are cosine and sine integrals, respectively, and $-Z_d e$ is the charge of the dust particles expressed in terms of the elementary charge (e).

Knowledge of the effective interaction potential allows one to calculate the radial distribution function of charged dust particles within the Ornstein-Zernike relation. Such an approach assures that the finite dimensions of the dust particles are thoroughly treated and the obtained results are in good agreement with the known data [3].

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