DYNAMICAL PROPERTIES OF HARMONICALLY CONFINED CHARGED PARTICLES IN PLASMA

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In the first approach, experimental dusty plasma structures are often described as systems of parabolically confined particles, interacting by the screened Coulomb potential. On the effect of the confinement, the systems acquire inhomogeneity of their structural properties [1]. Spatial distribution of their dynamical properties, such as magnitude of thermal oscillations and Lindemann parameter, is discussed in paper [2]. There is a simplified analytical model in [2], which describes radial profile of amplitudes and frequencies of thermal oscillations.

In this work the analytical model is evolved. Besides it, in the work MD simulations are provided to obtain velocity autocorrelation function and amplitudes of thermal oscillations of each particle in the system. The Fourier transform of VACF can be interpreted as vibrational density of states (VDOS) $g(\omega)$, which is used to perform averaging of frequency [3]. We calculate two different values of frequency:

$$\left\langle \frac{1}{\omega^2} \right\rangle = \int \frac{g(\omega)}{\omega^2} d\omega$$

and

$$\left\langle \omega^2 \right\rangle = \int g(\omega)\omega^2 d\omega.$$

This is necessary for explanation of the difference between amplitudes of thermal oscillations in finite systems in the trap and infinite bulk. To perform an explanation we divide the finite system into thin rings to obtain "rings with constant density of particles". It is demonstrated that the value of $\langle \frac{1}{\omega^2} \rangle^{-1}$ in bulk is greater than the one in the central ring of the finite system (ring and bulk have similar density). It is also shown that, in contrast, the value of $\langle \omega^2 \rangle$ in bulk is equal to the one in a finite ring (of respective density).

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