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Thermodynamic equations of state for the dust grain using Langevin Dynamics simulations[1] RANGANATHAN GOPALAKRISHNAN, VIKRAM SURESH, ZHIBO LIU, Univ of Memphis — The complex plasma is modeled as an isotropic system of N charged grains (radius a_p and charge z_p) interacting with each other through a screened Coulomb potential with a fixed Debye length λ_D in an isotropic periodic domain, without including a confining potential and the systematic drift of charged species. The equilibrium thermodynamic state is investigated using Langevin Dynamics simulations to capture the effect of grain-neutral gas interactions (parameterized by the grain Knudsen number $Kn\equiv\frac{\lambda_g}{a_p}$) across the various $\Gamma\equiv\frac{z_p^2 e^2}{4\pi\varepsilon_o k_b T_d n_p^{-\frac{1}{3}}}$, $\kappa=\frac{n_p^{-\frac{1}{3}}}{\lambda_D}$-based electrostatic coupling regimes, where n_p is number concentration and $k_B T_d$ is the kinetic temperature of the grains. The Langevin-computed internal energy u_d, pressure p_d and $k_B T_d$ of the grain phase are parameterized as equations of state $f\,(u_d,\mathrm{p_d},\mathrm{k_B T_d})=0$ and compared with experimental reports of dust kinetic temperature to refine the modeling assumptions. The non-trivial influence of grain-neutral gas interactions is discussed by calculating the pair correlation functions in the gas, liquid, and solid-like regimes of grain correlated behavior. A unified thermodynamic model will further the understanding of phase transitions and the transport properties of the dust phase across the entire $\Gamma, \kappa, \mathrm{Kn}$ regimes.

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