

Revealing the supercritical dynamics of dusty plasmas and their liquidlike to gaslike dynamical crossover and the diffusion mechanism of two-dimensional dusty plasma fluids

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Using molecular dynamics simulations, we verify the supercritical nature of dusty plasmas and reveal the existence of a dynamical liquidlike to gaslike crossover which perfectly matches the salient features of the Frenkel line in classical supercritical fluids. We present several diagnostics to locate this dynamical crossover spanning from local atomic connectivity, shear relaxation dynamics, velocity autocorrelation function, heat capacity, and various transport properties [1]. All these different criteria well agree with each other and are able to successfully locate the Frenkel line in both two-dimensional (2D) and three-dimensional (3D) dusty plasmas [2], the results are shown in Figs. 1(a) and (b).

In addition, using molecular dynamical simulations of 2D Yukawa fluids under a wide range of conditions, self-diffusion of 2D dusty plasma fluids at longer time scales is systematically investigated with a new efficient data analysis method. It is found that, at longer time scales, anomalous diffusion of 2D Yukawa fluids always transforms to the normal diffusion. Following the Zwanzig's method, the diffusion coefficient of 2D Yukawa fluids is analytically derived, which is mainly determined by the lifetime of the local atomic connectivity, and weakly related to the system size. This derived diffusion coefficient is further quantitatively

verified by the simulations performed here, indicating that the mechanism of diffusion of 2D Yukawa fluids is just the local configurational excitation and the long-wave fluctuations, the result is shown in Fig. 1(c).

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References

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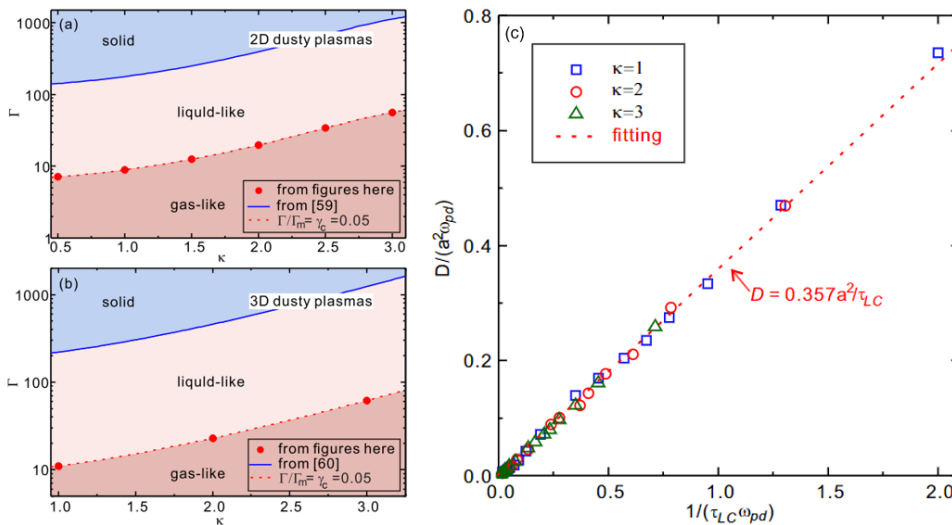


Figure 1. Obtained phase diagrams for 2D (a) and 3D (b) dusty plasmas and the diffusion coefficients D as the function of reciprocal of the lifetime of the local atomic connectivity τ_{LC} for 2D Yukawa fluids.