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Shear Modulus of 2D dusty plasma solids

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In this talk, we will present our investigation [1] of the shear modulus of 2D solid dusty plasmas using Langevin dynamical simulations. First, we provide a theoretical expression of the shear modulus of 2D Yukawa crystals as a function of the screening parameter κ determined from the known transverse sound speeds [2], which can be the standard of their shear modulus for the future study. Using our simulation data, the shear relaxation modulus $G(t)$ of 2D Yukawa liquids are calculated from the shear stress autocorrelation function, which consists of the kinetic, potential, and cross portions. Because of their viscoelasticity, 2D Yukawa liquids would exhibit the typical elastic property when the time duration is much less than the Maxwell relaxation time [3, 4]. As a result, the infinite frequency shear modulus G_{∞} (i.e., the shear relaxation modulus $G(t)$ when $t=0$) of a 2D Yukawa liquid should be related to the shear modulus of the corresponding quenched 2D Yukawa solid (with the same κ value), with all particles frozen at their locations of the liquid state. It is found that the potential portion of the infinite frequency shear modulus for 2D Yukawa liquids at any temperatures well agrees with the obtained standard shear modulus of 2D Yukawa crystals with the same κ. As a result, we find a new method to calculate the shear modulus of 2D Yukawa solids from the motion of individual particles of the corresponding Yukawa liquids using their viscoelastic property. This method may be applicable to other physical systems.

References

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