5th Asia-Pacific Conference on Plasma Physics, 26 Sept-1Oct, 2021, Remote e-conference

Asymptotic diffusion limits of Yukawa particles on periodic potentials

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Abstract

In many-body equilibrium or non-equilibrium systems, statistical measurements are made after the system reaches steady state. In equilibrium systems, steady state is reached when conserved quantities like energy become constant in time. But the prediction of steady state in non-equilibrium systems [1] can itself become tricky due to various time scales involved in the system.

In this study, we investigate two different methods of finding diffusion, using generalised Einstein relation [2] of MSD and using particles' displacements with respect to center of mass frame [3] in the context of Yukawa particles on periodic potentials. We observe three diffusive regimes: superdiffusion, subdiffusion and normal diffusion. We present the relation of time scales of these diffusive regimes to velocity relaxation and steady state behaviour. We find that the first method is more intutive in explaining ballistic regime and short time diffusion of particles while the other method is better at describing asymptotic analysis of the system. For systems that conserve momentum or systems with no net drift velocity, difference in diffusion from the two methods approaches zero thus obtaining a convergence between the two at long time limit.

References

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