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Test of fluctuation–dissipation relation for active dusty plasmas: a molecular dynamics simulation

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Dusty plasma has been studied for decades for its excellent performance to study the fundamental physics involving collective behaviors, phase transitions, and wave propagations. On the problem of mass transport coefficient, there are two alternative methods which are intrinsically identical. One is Einstein equation and the other one is Green-Kubo formula. For the latter one, which is rooted in the Fluctuation-dissipation theorem and the essence is the transport coefficient is determined for fluctuation around equilibrium state. For the system out of equilibrium, however, the applicability of the theorem is debated, just as for the case of active dusty plasma in this study.

Active dusty plasma is composed electrons, ions, neutral gas, and mesoscopic active particles. The active particles are subject to the forces possibly due to the thermal or chemical gradients on their surface, such as photophoretic force [1] and beam force. Therefore, the system composed of the active particles tends to be out of the thermodynamical equilibrium. Figure 1 shows an example that the charged dust particles are driven by an electron beam.

In this talk, the violation and validity of fluctuation–dissipation relation for the active dusty plasmas are studied using the molecular dynamics (MD) simulation. The equations governing the motion of active particles are given firstly. The diffusion, as the main objective of research, is discussed in detail.

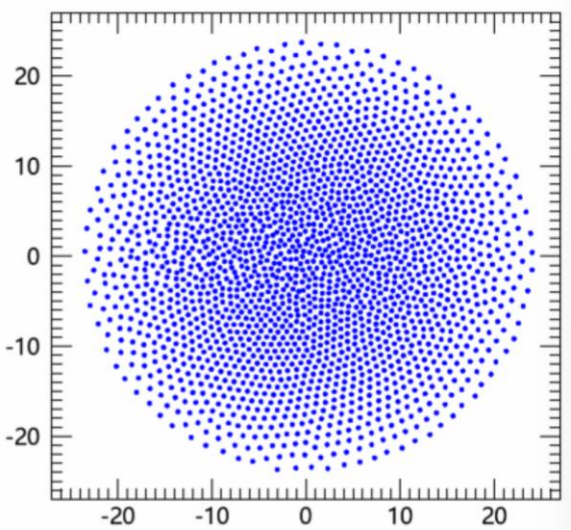

Fig. 1 The charged dust particles are driven into a decaying macroscopic flow by a rightward electron beam, thus the system is out of thermodynamical equilibrium.

References

[1] K. Arkar 1, M. M. Vasiliev, O. F. Petrov, E. A. Kononov, and F. M. Trukhachev, molecules, 26, 561, 2021.