Chapter 2
Dynamical Spectra in Two-Dimensional Dusty Plasmas

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ABSTRACT

*Equilibrium molecular dynamics (EMD) simulation has been employed to explore the dynamical structure factors (DSFs) of two dimensional (2D) dusty plasma systems for a wide domain of plasma parameters of Coulomb coupling (Γ) and Debye screening strength (κ). The influence of varying wave vectors (k) on plasma DSFs S(**k**, ω) have been reported with different combinations of plasma state points (Γ, κ). New simulations has been tested for the influence of different wave vectors on plasma density S(**k**, ω) in addition to different combinations of plasma state points. New results of plasma density S(**k**, ω) show that amplitude of oscillation and frequency will vary with increasing value of Coulomb coupling parameter (Γ) and Debye screening strength (κ). These simulation techniques show that transient behavior has been reported for frequency (ω) with various values of Debye screening strength (κ). Moreover, EMD simulation has been checked in order to investigate the behavior of dusty plasma to evaluate DSFs. The outcomes of EMD simulations are matched to earlier known numerical and experimental data. It has been shown that fluctuation of dynamical density increases at intermediate to higher values of coupling parameter. However, it shows less fluctuation at higher values of Debye screening strength (κ).*

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1. INTRODUCTION

The dynamic structure factors (DSFs) is mainly generalization of structure factor which tell us about correlation in time and space. A mathematical function called DSFs gives information about correlation of inter-particles and time evolution. In simple and complex systems, the information about dynamic and static properties is taken through DSFs. The measurable quantities such as ratio of specific heats, adiabatic sound velocity and thermal diffusivity are given by DSFs in hydrodynamic condition. The various techniques such as inelastic neutron scattering, x-rays and light scattering are mostly used for the evaluation of dynamic structure factor of glasses, liquids and dense plasmas. The evolution of structural behavior of different materials in material science has become tremendous task and also shows different applications in complex (dusty) plasmas. Various approaches like theoretical, experimental and computational have been used to attain various developments in science and technology. Complex plasma usually consists of dust particles of various size (nano to millimeter) and shapes usually circular/ spherical. Particles (dust) in plasma establish their pattern in given system. The interaction of plasma and dust particles has helped effectively to investigate new region of research and developments. In condensed matter physics, the crystalline structure of the complex plasma has proved to be an authentic tool to determine physical process. Various experimental and theoretical (and or simulation) techniques are efficiently used to examine the structural behavior of different materials (including liquid materials). The numerically investigation of structural behavior of the various complex systems has become a significant task in material science. In thermophysics and allied sciences, the exploration of a new system such as non- ideal (complex) plasma usually referred as dusty plasmas helped to discover another research gate. The dust particles in plasma show interaction with the plasma particles (electrons and positive ions).

Dusty plasma usually in extreme limits considered as a many body system for both strong and weak interactions. One is observed gaseous behavior for weak interactions. Reliable and authentic theoretical approaches are basically used based on LRT (linear response theory) to determine dynamical structural properties of the different materials in the absence of effects of the correlation. If interactions are strong then particles get localization and systems turned into crystallize form (Shahzad & He, 2012c). The liquid and solid conditions of the complex plasma (dusty) usually strongly coupled complex (dusty) plasmas have great importance in this regard. The coupling parameter of dusty plasma usually related with temperature (1/T) and describes states in this plasma region. Therefore, the values of coupling parameter help to illustrate the plasma behavior from non-ideal nature to crystal-structure states and ordered state also called crystal state of plasma.