Novel Numerical Technique for Dusty Plasma Dynamics (Yukawa Liquids): Microfluidic and Role of Heat Transport

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Abstract : Currently, dusty plasmas motivated the researchers' widespread interest. Since the last two decades, substantial efforts have been made by the scientific and technological community to investigate the transport properties and their nonlinear behavior of three-dimensional and two-dimensional nonideal complex (dusty plasma) liquids (NICDPLs). Different calculations have been made to sustain and utilize strongly coupled NICDPLs because of their remarkable scientific and industrial applications. Understanding of the thermophysical properties of complex liquids under various conditions is of practical interest in the field of science and technology. The determination of thermal conductivity is also a demanding question for thermophysical researchers, due to some reasons; very few results are offered for this significant property. Lack of information of the thermal conductivity of dense and complex liquids at different parameters related to the industrial developments is a major barrier to quantitative knowledge of the heat flux flow from one medium to another medium or surface. The exact numerical investigation of transport properties of complex liquids is a fundamental research task in the field of thermophysics, as various transport data are closely related with the setup and confirmation of equations of state. A reliable knowledge of transport data is also important for an optimized design of processes and apparatus in various engineering and science fields (thermoelectric devices), and, in particular, the provision of precise data for the parameters of heat, mass, and momentum transport is required. One of the promising computational techniques, the homogenous nonequilibrium molecular dynamics (HNEMD) simulation, is over viewed with a special importance on the application to transport problems of complex liquids. This proposed work is particularly motivated by the FIRST TIME to modify the problem of heat conduction equations leads to polynomial velocity and temperature profiles algorithm for the investigation of transport properties with their nonlinear behaviors in the NICDPLs. The aim of proposed work is to implement a NEMDS algorithm (Poiseuille flow) and to delve the understanding of thermal conductivity behaviors in Yukawa liquids. The Yukawa system is equilibrated through the Gaussian thermostat in order to maintain the constant system temperature (canonical ensemble ≡ NVT)). The output steps will be developed between 3.0×105/ωp and 1.5×105/ωp simulation time steps for the computation of λ data. The HNEMD algorithm shows that the thermal conductivity is dependent on plasma parameters and the minimum value of lmin shifts toward higher G with an increase in k, as expected. New investigations give more reliable simulated data for the plasma conductivity than earlier known simulation data and generally the plasma λ0 by 2%-20%, depending on Γ and κ. It has been shown that the obtained results at normalized force field are in satisfactory agreement with various earlier simulation results. This algorithm shows that the new technique provides more accurate results with fast convergence and small size effects over a wide range of plasma states.

Keywords : molecular dynamics simulation, thermal conductivity, nonideal complex plasma, Poiseuille flow
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