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Head On Collision Of Low Frequency Shock Waves In Quantum Dusty Plasma

Sunidhi Singla[1], Papihra Sethi and N.S. Saini
[1] Department of Physics, Guru Nanak Dev University, Amritsar-143005, India
singla.suidhi94@gmail.com

Dusty plasmas are universal in various parts of our cosmic environment, such as in the planetary ring system of Saturn, in Jupiter's moon and in the dust rings of the Martian moon, in circumsolar rings and interplanetary media, in supernova and in interstellar molecular clouds. The micron sized dust particles are present in most of the space and astrophysical plasma environments as well as in laboratory plasmas. The dust grains may be positively or negatively charged due to various charging mechanisms such as charging by collection of background electrons and ions, field emission, thermionic emission, radioactivity. The charging of dust grains relies on the various properties of the dust grains as well as on the surrounding plasma medium. The collection of electrons and ions by dust grains is not only dependent on the electron and ion densities but also on the size and shape of grains. The charging of massive dust particles happens due to the sticking of electrons and ions to the grains surface. The electrons are lighter than ions and have a higher flux which leads to negative charging of the dust particles at equilibrium. These highly charged dust grains give rise to different kinds of wave modes; dust-ion acoustic mode (DIA) is one of such modes. DIA waves can propagate in cosmic plasma environments, in the dusty plasma of Earth’s mesosphere and contribute to the low–frequency noise in the F-ring of Saturn. The quantum effects in plasmas become significant, when the associated de Broglie wavelength of the particles is comparable to the inter-particle distance. In this present investigation, the head on collision of dust ion-acoustic (DIA) shock waves is analyzed in quantum plasma whose constituents are electrons showing quantum behavior, positive ions and negatively charged dust grains. The ions and dust grains are assumed to be mobile, while the electrons are considered to be inertialess. Using an extended Poincare-Lighthill-Kuo perturbation method, two sided Kortweg-de Vries-Burgers equations for shock waves are derived. The analytical phase shifts of DA shock waves after collision have been deduced. The impacts of physical parameters such as the quantum diffraction parameter for electrons, kinematic viscosity, the unperturbed dust to ion density ratio, temperature ratio on the phase shifts occurred during the head-on collision between DIA shock waves are investigated. The results of present investigation may be useful in the understanding of fundamental plasma phenomenon in a dusty plasma environment containing inertialess quantum electrons, inertial ions and dust particulates.

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