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Effect of Dust Grains on Ponderomotive Acceleration in Quantum Dusty Magnetoplasma

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A dusty plasma is an ionized gas containing dust particles. Dusts are micron-sized particles and are quite common in different environments of space and astrophysical plasmas, such as interstellar medium, interplanetary space, interstellar or molecular clouds, comets, planetary rings, Earth's environments and in low-temperature laboratory dusty plasma devices [1–5]. In the laboratory, the dust grains appear as impurities and can significantly affect the behaviours of the surrounding plasma [6] and collective processes in the plasma system. The collective dust plasma interactions have been extensively studied both experimentally [7] and theoretically [8].

When dusty plasma is cooled down to an extremely low temperature such that the de-Broglie thermal wavelength associated with the charged particle comparable to or larger than the inter particle distance, the study of quantum effects becomes important. The high-density, low-temperature quantum Fermi plasma is significantly different from the low-density, high-temperature "classical plasma". During the last decade, there have been many papers devoted to quantum dusty plasma. The growing interest in investigating new aspects of dense quantum dusty plasmas is motivated due to its applications in industry and in space [9,10].

In the present paper, theoretical analysis of effect of dust grains on ponderomotive acceleration in magnetized quantum plasma is presented. The interaction dynamics have been built using the recently developed quantum hydrodynamic (QHD) model. The QHD model consists of a set of equations describing the transport of charge density, momentum (including the Bohm potential), energy in a charged particle system interacting through a self consistent electrostatic potential. The effect of quantum Bohm potential, Fermi pressure and electron spin-1/2 have been taken into account. The expression for ponderomotive force has been setup and growth rate evaluated. Numerical analysis has been carried out for realistic parameters. It is found that presence of charged dust grains increase the growth of ponderomotive acceleration.

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