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Two stream instability in magnetized quantum plasma with spin-up and spin-down exchange interaction

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In plasmas, when the de Broglie wavelength of the charge carriers is comparable to the dimension of the plasma system, quantum mechanical effects are expected to play a major role in the behavior of charged plasma particles. The QHD model, which consists of a set of equations dealing with the transport of charge, momentum and energy in a plasma is the most widely used model to describe quantum effects in plasma. In recent years, quantum effects have proved to play a crucial role in ultrasmall electronic devices, laser plasmas and dense astrophysical plasmas. The one and two stream instabilities in quantum plasma have been studied by various authors but all the previous studies considered electrons as a single fluid of macroscopically averaged spin-1/2 plasma. The earlier papers did not show a full picture and didn't took spin-up and spin-down interaction force into account. Very recently, a modified separate spin evolution (SSE) treatment of electrons in accordance with Pauli equation has been developed [1,2].

In the present paper, using the modified SSE-QHD model we have studied the two-stream instability for a circularly polarized electromagnetic wave propagating through a high density magnetized quantum plasma. Spin-up and spin-down electrons have been taken to be separate species of particles and spin-spin interaction picture has been developed. The effects of quantum Bohm potential, electron Fermi pressure and spin have also been taken into account. We have obtained the dielectric constant tensor using which the dispersion relation of two-stream as well as the beam-plasma instability has been obtained. Our results indicate that quantum effects and thermal effects play important roles alongwith the spin polarization produced by the spin interaction of spin-up and down species of the electron. The critical wave number for beam-plasma instability in magnetized quantum plasmas has also been described in the paper and effect of spin polarization has been analyzed.

[1] P. A. Andreev, Phys. Plasmas **22**, 062113 (2015).
[2] P. A. Andreev, Phys. Rev. E **91**, 033111 (2015).