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Nonlinear magnetosonic wave propagation in dense plasmas with two separate electron spin fluids model

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The spin polarization density effect of degenerate electrons on magnetosonic wave propagation with oblique magnetic field is investigated in dense (quantum) plasmas. Electrons like other fermions have intrinsic magnetic moment due to their spin and in the presence of magnetic field, and electrons with spin (magnetic moment) directed along the magnetic field (spin-up state) are usually larger than in the opposite direction (spin-down state). Therefore, different populations of degenerate electrons states with different spin directions (up and down) are taken in the fluid model and electron spin polarization density parameter is also defined. Multi-fluid quantum magnetohydrodynamic (QMHD) equations with two separate degenerate electron fluid equations with spin-up and spin-down states (due to Pauli-paramagnetism) are described including their Fermi pressure due to different spin density populations, while ions are taken to be nondegenerate. Magnetization energy and current density of electrons due to spin-1/2 effects are included in the electron momentum equation and Maxwell equations respectively. The Korteweg-de Vries (KdV) equation is derived for slow and fast magnetosonic waves in dense magnetized plasma, which includes the effect of electron inertia, electrons spin density (for up and down states) parameter effect and magnetic field intensity. It is found that electron spin density parameter has significant effect on the phase velocity of the wave and also on the width and amplitude of the fast and slow magnetosonic wave soliton. Numerical plots are also presented for illustration. The present study has applications in laser produced dense laboratory plasma and in astrophysical dense plasma situations where electron spin polarization density effects can appear significantly.

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