Effects of Spin Polarization on Surface Wave Propagation in Quantum Plasma Semi-Infinite Media

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This study explores the characteristics of surface plasma wave propagation in a confined plasma environment, focusing on the effects of spin polarization due to spin mismatch. The developed plasma model incorporates density correlation effects via Bohm's potential force, Fermi pressure using Fermi-Dirac statistics, and the exchange potential, all in a spin-polarized form linked by the spin polarization index. A dispersion relation for surface plasma waves is derived to describe the propagation properties of the configured wave mode. The findings show that increased spin polarization among electron populations reduces the phase velocity of surface plasma waves compared to conventional electron-ion quantum plasmas. Additionally, an increase in the exchange potential further decreases the phase speed, while the plasmon to Fermi energy ratio increases the phase velocity of surface plasma waves in spin-polarized quantum plasmas. A comparison with a previous gold–air interface model indicates that our model supports higher frequency surface plasma wave propagation across the wave vector. This research highlights the significance of quantum effects in electrostatic surface plasma waves within dense metallic plasmas at room temperature, with potential applications for signal transmission in metallic waveguides, as discussed in relevant literature [Guo et al., "Excitation of graphene magneto-plasmons in terahertz range and giant Kerr rotation," J. Appl. Phys. 125(1), 013102 (2019)].