Influence of Spin Polarization on Surface Wave Propagation in Quantum Plasma Half-Spaces

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The investigation delves into the characteristics of surface plasma wave propagation within a confined plasma environment, considering spin polarization effects resulting from spin mismatch. The developed plasma model integrates density correlation effects through Bohm's potential force, incorporates Fermi pressure using Fermi-Dirac statistics, and considers the exchange potential, all in spin-polarized form interconnected via the spin polarization index. A dispersion relation for surface plasma waves is derived to outline the propagation properties of the configured wave mode. Results indicate that increased spin polarization among electron populations leads to reduced phase velocity of surface plasma waves compared to conventional electron-ion quantum plasmas. Additionally, an increase in the exchange potential contributes to decreased phase speed, while the plasmon to Fermi energy ratio increases the phase velocity of surface plasma waves in spin-polarized quantum plasmas. A comparative analysis with a previous gold–air interface model reveals that our model supports higher frequency surface plasma wave propagation across the wave vector. This study underscores the importance of quantum effects in electrostatic surface plasma waves within dense metallic plasmas at room temperature, with implications for signal transmission in metallic waveguides as observed 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)].