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Rayleigh-Taylor instability in degenerate strongly coupled quantum plasma

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The Rayleigh–Taylor (R-T) instability and internal waves in both the incompressible and compressible dense degenerate strongly coupled quantum plasma have been investigated considering isothermal ion fluid compressibility. The quantum hydrodynamic model is formulated considering weakly coupled degenerate electrons and strongly coupled non-degenerate ions using smooth quantum potential for mixed quantum states. The modified dispersion relations of the internal waves and R-T instability are analytically derived using Fourier analysis and discussed in both the incompressible and compressible limits. In the incompressible limit, it is observed that the unstable R-T modes grow below the critical wavenumber modified by the quantum corrections and strong coupling effects. The influence of compressibility, quantum corrections, and compressional wave velocity is observed in the condition of R-T instability in the compressible limit. The growth rates of unstable R-T modes are solved numerically and plotted which shows suppression due to the quantum Froude number (quantum corrections), strong coupling effects, and isothermal compressibility of the medium. The results are analyzed for understanding the suppression of the R-T instability in dense white dwarfs which consist of degenerate electrons and strongly coupled ions.

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