

Quark matter and non-radial oscillations in hybrid stars

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We study the possibility of the existence of a deconfined quark matter in the core of neutron star (NS)s and its relation to non-radial oscillation modes in NSs and hybrid star (HS)s. We use relativistic mean field (RMF) models to describe the nuclear matter at low densities and zero temperature. The Nambu-Jona-Lasinio (NJL) model is used to describe the quark matter at high densities and zero temperature. A Gibbs construct is used to describe the hadron-quark phase transition (HQPT) at large densities. Within the model, as the density increases, a mixed phase (MP) appears at density about 2.5 times the nuclear matter saturation density (ρ_0) and ends at density about $5\rho_0$ beyond which the pure quark matter phase appears. It turns out that a stable HS of maximum mass, $M = 2.27M_\odot$ with radius $R = 14$ km (for NL3 parameterisation of nuclear RMF model), can exist with the quark matter in the core in a MP only. HQPT in the core of maximum mass HS occurs at radial distance, $r_c = 0.27R$ where the equilibrium speed of sound shows a discontinuity. Existence of quark matter in the core enhances the non-radial oscillation frequencies in HSs compared to NSs of the same mass. This enhancement is significantly large for the g modes. Such an enhancement of the g modes is also seen for a density dependent Bayesian (DDB) parameterisation of the nucleonic EOS. The non-radial oscillation frequencies depend on the vector coupling in the NJL model. The values of g and f mode frequencies decrease with increase the vector coupling in quark matter.

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