General Relativity and Quantum Cosmology

The self-consistent general relativistic solution for a system of degenerate neutrons, protons and electrons in beta-equilibrium

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We present the self-consistent treatment of the simplest, nontrivial, self-gravitating system of degenerate neutrons, protons and electrons in β-equilibrium within relativistic quantum statistics and the Einstein-Maxwell equations. The impossibility of imposing the condition of local charge neutrality on such systems is proved, consequently overcoming the traditional Tolman-Oppenheimer-Volkoff treatment. We emphasize the crucial role of imposing the constancy of the generalized Fermi energies. A new approach based on the coupled system of the general relativistic Thomas-Fermi-Einstein-Maxwell equations is presented and solved. We obtain an explicit solution fulfilling global and not local charge neutrality by solving a sophisticated eigenvalue problem of the general relativistic Thomas-Fermi equation. The value of the Coulomb potential at the center of the configuration is $eV(0)\simeq m_\pi c^2$ and the system is intrinsically stable against Coulomb repulsion in the proton component. This approach is necessary, but not sufficient, when strong interactions are introduced.

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