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Equations of State of a Strongly Interacting Dense Fermion System

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Our ultimate goal is to study the possibility of color superconductivity in neutron stars. Under the high densities that prevail within some neutron stars the quarks are liberated from the nucleons, and due to their strong interaction they can form di-quark pairs that act as Cooper pairs in a BCS phase. If the interaction between the quarks is stronger than it is for the Cooper pairs, which could be realized if the stars density is decreased, then the pairs can become Bose-Einstein condensates, with totally different characteristics. We investigate the equations of state in the two mentioned regimes of dense matter interacting by the strong nuclear force, find the energies and pressures in the two respective regimes and represent the results as graphs of the crossover parameter and the density. To do so, we made a program to numerically solve a system of integral equations in terms of the energy gap, and chemical potential, from which we can determine the energy and pressure of the core of the star. The outcome of our investigation would be a significant result for the field of astrophysics where the state of matter in the superdense cores of neutron stars still remains unknown.