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Phase stability in pulsar and magnetar crusts TYLER ENGSTROM, VINCENT CRESPI, BENJAMIN OWEN, JAMES BRANNICK, XIAOZHE HU, Penn State — The outermost several hundred meters of a neutron star crust is similar to a white dwarf interior, consisting of nuclei screened by a relativistic, degenerate electron gas. Free neutrons don't appear until a density of 4×10^{11} g/cc. Below a depth of several tens of meters, corresponding to 10^6-10^8 g/cc, the nuclei are thought to crystallize. Unlike white dwarfs, most observed neutron stars have enormous magnetic fields. On the surface of a typical pulsar, the field is $\sim 10^{12}$ gauss, while for magnetars it is several orders of magnitude stronger. Sub-surface fields are likely to be of a similar or greater strength. Quantum ab-initio methods for this regime are still in a state of infancy. In this talk we describe a solution of the nonlinear Thomas-Fermi PDE for completely degenerate, super-strongly magnetized electrons, using a domain decomposition technique with boundary conditions appropriate to close-packed lattices of nuclei. Excited Landau levels are included in the model. Our numerical method makes use of Hypre multigrid-preconditioned solvers. Equation of state and phase diagram calculations will be presented, and implications for astrophysical observations discussed.

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