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Molecular Dynamics of Nuclear Pasta in Neutron Stars[1] CHRISTIAN BRIGGS, ANDRE DA SILVA SCHNEIDER, Indiana Univ - Bloomington — During a core collapse supernova, a massive star undergoes rapid contraction followed by a massive explosion on the order of a hundred trillion trillion nuclear bombs in less than a second. While most matter is expelled at high speeds, what remains can form a neutron star. The bulk of a neutron star does not contain separate nuclei but is itself a single nucleus of radius $\sim$10 km. In the crust of a neutron star, density is low enough that some matter exists as distinct nuclei arranged into crystalline lattice dominated by electromagnetic forces. Between the crust and core lies an interesting interface where matter is neither a single nucleus nor separate nuclei. It exists in a frustrated phase; competition between electromagnetic and strong nuclear forces causes exotic shapes to emerge, referred to as nuclear pasta. We use Molecular Dynamics (MD) to simulate nuclear pasta, with densities between nuclear saturation density and approximately one-tenth saturation density. Using MD particle trajectories, we compute the static structure factor S(q) and dynamical response function to describe both electron-pasta and neutrino-pasta scattering. We relate the structure and properties of nuclear pasta phases to features in S(q). Finally, one can integrate over S(q) to determine transport properties such as the electrical and thermal conductivity. This may help provide a better understanding of X-ray observations of neutron stars.

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