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Analyzing the speed of sound in neutron stars using machine learning

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The matter at Neutron star (NS) cores are at highly compressed state and due to gravity, the density can be built up to a few times the nuclear saturation density. They are very compact and have been observationally identified with pulsars with their mass being in the range from 0.7 - 3 solar masses and a radius between 10-15 km. They are therefore one of the best laboratories to test the theory of strong interaction at high-density low temperature regimes. The information about the structure of an NS can be given by their equation of states (EoSs). At high densities, the first principle pQCD calculations are consistent and at lower densities field theory calculations are consistent. The central density of the NS lies somewhere between these two densities and in this regime the lattice QCD calculations fail. Hence, we need to resort to model-based or agnostic approaches to construct EoSs. In this talk, I will present how we can effectively create several new EoSs from the information on the speed of sound. Using the created EoSs, we create several datasets to train our neural network. I will also talk about the neural network model using which we can effectively predict a new EoS. Using these we study the variation in the speed of sound inside the NS.

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