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Nuclear equation of state: from the Lab to the Stars

The nuclear equation of state (EoS) at zero temperature (T) can be expressed as the energy (E) per particle (A) or pressure (P=−∂E/∂V for A=constant) of an uniform system of neutrons and protons in their ground state. This ideal system is of particular interest for different reasons: i) Coulomb and finite-size effects are avoided (by construction) making comparisons among different models easier; ii) sound methods exist to solve the nuclear many-body problem in this limit; iii) neutrons and protons away from the surface of the nucleus approximately behave as those of the uniform system (saturation density); or iv) neutron star outer core is thought to be made of neutrons and few protons in β−equilibrium with electrons and muons; among others.

The properties of this ideal system can be studied from laboratory data and inferred from Neutron Star observations only via nuclear models. Most nuclear models are based on two pillars: the Hamiltonian and a sound many-body method. While accurate and systematically improvable many-body methods exist, this is not exactly the case of the nuclear effective Hamiltonian that has not been fully characterised yet.

In this short introductory presentation I will focus on some selected examples that allow us to learn about the nuclear EoS from experiments and observations.

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