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Neutron Star Modeling: "Shortcuts" or Precision?

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Neutron stars provide a unique laboratory for probing the properties of dense nuclear matter under extreme conditions of density. Understanding their internal structure requires a description of the Equation of State of matter at very high densities, which remains one of the main challenges in modern nuclear physics and astrophysics.

A Chiral Effective Field Theory approach can quite faithfully fit the properties of the Equation of State at very high densities, and thus is easily applied to find the Equation of State of a neutron star.

However, using Chiral Effective Field Theory alone to parameterize the entire stellar structure may be insufficient. To improve the model, MUSES Calculation Engine [1] is a very important and modern tool that can be used for these purposes. This approach uses three different theories to describe the three different density profiles, leading to more reliable results.

In my presentation, I will show the results obtained employing both approaches to calculate key neutron star observables (mass, radius, love numbers and others), and compare them with observational astrophysical data.

[1] *Pelicer, Mateus Reinke, et al. "Building neutron stars with the MUSES calculation engine." Physical Review D 111.10 (2025): 103037.*

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