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Nuclear-Physics Predictions for the Equation of State of Neutron Stars[1]

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Neutron stars contain the largest reservoirs of degenerate fermions, reaching the highest densities we can observe in the cosmos, and probe matter under conditions that cannot be recreated in terrestrial experiments. Throughout the Universe, a large number of high-energy, cataclysmic astrophysical collisions of neutron stars are continuously occurring. These collisions provide an excellent testbed to probe the properties of matter at densities exceeding the density inside atomic nuclei, are an important site for the production of elements heavier than iron, and allow for an independent measurement of the expansion rate of our Universe. To understand these remarkable events, reliable nuclear-physics input is essential. In this talk, I will explain how to use chiral effective field theory and advanced Quantum Monte Carlo many-body methods to provide a consistent and systematic approach to strongly interacting systems with controlled theoretical uncertainties. I will present nuclear-physics predictions for the dense nucleonic matter relevant for neutron stars, and discuss how multi-messenger observations of binary neutron-star mergers can be used to further elucidate the properties of matter under extreme conditions and to measure the expansion rate of the Universe described by the Hubble constant.

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