Toward Microscopic Equations of State for Core-Collapse Supernovae from Chiral Effective Field Theory

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ABSTRACT

Chiral effective field theory provides a modern framework for understanding the structure and dynamics of nuclear many-body systems. Recent works have had much success in applying the theory to describe the ground- and excited-state properties of light and medium-mass atomic nuclei when combined with ab initio numerical techniques. Our aim is to extend the application of chiral effective field theory to describe the nuclear equation of state required for supercomputer simulations of core-collapse supernovae. Given the large range of densities, temperatures, and proton fractions probed during stellar core collapse, microscopic calculations of the equation of state require large computational resources on the order of one million CPU hours. We investigate the use of graphics processing units (GPUs) to significantly reduce the computational cost of these calculations, which will enable a more accurate and precise description of this important input to numerical astrophysical simulations.