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The Roles of Nuclear Physics during Stellar Core Collapse[1]
WILLIAM HIX, ORNL/UTK, ERIC LENTZ, UTK/ORNL, MARK BAIRD, UTK, BRONSON MESSER, ANTHONY MEZZACAPPA, ORNL/UTK — Nuclear electron capture and the nuclear equation of state play important roles during the collapse of a massive star and the subsequent supernova. The nuclear equation of state controls the nature of the bounce which initially forms the supernova shock while electron capture determines the location where the shock forms. Advances in nuclear structure theory have allowed a more realistic treatment of electron capture in supernovae to be developed. With this improvement, we have shown that electron capture on nuclei with masses larger than 50 dominates electron capture on free protons, producing significant changes in the hydrodynamics of core collapse and bounce. We will present explorations of the impact of weak interactions with heavy nuclei in supernovae, focusing on the consequences across the range of supernova progenitors. Examination of the sensitivity of these effects to variations in the electron capture rates will also be presented. Additionally, we will present simulations showing the impact of a variety of nuclear equations of state on supernova shock propagation and the interplay between electron capture and the equation of state.

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