Type: New
Title: "Extreme-scale Simulation of Supernovae and Magnetars from Realistic Progenitors"

Principal Investigator: Sean Couch, Michigan State University
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Scientific Discipline: Physics: Astrophysics

INCITE Allocation: **159,000,000 processor hours**
Site: Argonne National Laboratory
Machine (Allocation): IBM Blue Gene/Q (150,000,000 processor hours)
Site: Argonne National Laboratory
Machine (Allocation): Cray XC40 (9,000,000 processor hours)

Research Summary:
Core-collapse supernovae (CCSNe) are the explosive deaths of massive stars that drive cosmic chemical evolution and the formation of compact objects. But the mechanism driving these explosions is still uncertain. This project will transform our understanding of supernovae through extreme-scale simulations.

This comprehensive, end-to-end investigation will utilize 3D MHD CCSNe simulations with sophisticated multidimensional neutrino transport and the most realistic initial conditions ever adopted for CCSNe to study the effects of rotation, magnetic fields, and progenitor asphericity on CCSNe. In addition, a multi-year progressive investigation will develop and employ 3D massive stellar progenitor models at the point of core-collapse and address whether rotation and magnetic fields aid successful explosions for "normal" CCSNe. The impact of realistic initial conditions on nucleosynthesis in CCSNe will also be explored.

Results will directly inform our understanding of the characteristics of newborn pulsars and magnetars, information that can be directly compared to observational data. The project will also address whether plausible rotation rates and magnetic field strengths influence the CCSNe mechanism and what impact realistic 3D progenitor structures have on the CCSNe mechanism and observables.