Abstract for an Invited Paper
for the DNP08 Meeting of
The American Physical Society

Computational Supernovae: Nuclear Astrophysics’ Grand Challenge

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To address the theoretical supernova explosion problem with physical fidelity requires the development and use of sophisticated numerical radiation/hydrodynamic codes that simulate the multi-dimensional flow in a variety of Mach-number regimes. Though the latest simulations incorporate rotation, multi-group radiative transfer, and magnetic fields, they are not yet general-relativistic, do not solve the Boltzmann equation in its full multi-D context, and are not fully 3D in space. One must eventually do the calculations in six-dimenisional phase space (plus time), and such seven-dimenisonal calculations are currently beyond reach. Nevertheless, there has been much recent progress and this progress has been informed by numerical experiments that will only get better in the next 3-5 years. In this talk, I will discuss the latest physical ideas in the theory of the mechanism of core-collapse supernovae and the variety of results that have emerged from recent massive computations. Moreover, I will motivate what more may need to be done to solve in credible fashion the enigma of stellar death and supernova explosion.

Supported by the SciDAC program of the U.S. D.O.E.