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Computational Supernovae: Nuclear Astrophysics' Grand Challenge[1]

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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-dimenional 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.

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