Computation Challenges of Modeling Astrophysical Explosions

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Abstract

Stellar explosions come in a wide variety, powered by either by gravitational collapse or thermonuclear energy release. These are truly multiphysics problems---modeling them requires the coordinated input of gravity solvers, reaction networks, transport, and hydrodynamics together with microphysics recipes to describe the physics of matter under extreme conditions. Furthermore, these models involve following a wide range of spatial and temporal scales, which puts tough demands on simulation codes. As a result, a variety of methods have been developed to model the different phases of these explosions. In this talk I will give a discuss the algorithmic and computational challenges involved in modeling stellar explosions and then discuss the specific technique we've been developing, low Mach number hydrodynamics methods, for modeling the early phases of astrophysical thermonuclear explosions. I will also describe how the particular problem of convection in X-ray bursts is leading us to explore new techniques for maximizing performance on the titan machine.