APR12-2012-000586

Abstract for an Invited Paper
for the APR12 Meeting of
the American Physical Society

GRMHD Simulations of Astrophysical Phenomena[1]

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The field of numerical relativity has made great progress in the past several years, driven by advances in numerical techniques and computing resources. Here, we review progress made in general relativistic magnetohydrodynamics (GRMHD) simulations, which have been used to study merging binaries containing neutron stars, accretion disks around black holes and the production of jets, and stellar collapse, among other topics. We describe how GRMHD calculations have helped to reshape our understanding of the evolutionary progression of binary mergers and indicate why such sources are likely short gamma-ray burst candidates, how accretion disk models have shed light on many of the longstanding theoretical questions about such systems, and how collapse calculations have demonstrated the nature of the instabilities that lead to explosions. We also discuss the current state of the numerical techniques that have been created and implemented, and describe active research into expanding the science reach of numerical simulations, with an eye toward the next generation of numerical simulations that will incorporate physically realistic equations of states and nuclear models, as well as electromagnetic radiation and neutrino production.

[1]This work was supported by NSF award PHY-0903782 and by NASA award 08-ATFP08-0093