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## Numerical Simulations of Binary Systems with Matter Companions

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With the advent of gravitational wave interferometers such as LIGO, VIRGO, and LISA, a revolution in astronomy and relativistic astrophysics is about to begin. Compact objects—black holes (BHs), neutron stars (NSs), and white dwarfs (WDs)—in binary systems are among the most promising sources of gravitational radiation detectable by these interferometers. In addition, merging compact object binaries with matter companions may also emit a detectable electromagnetic counterpart, leading to an exciting possibility: a simultaneous detection of both gravitational and electromagnetic radiation. Such a detection could lead to breakthroughs in our understanding of matter under extreme conditions, as there are currently many competing ideas about how this matter should behave. Determining the correct one will require careful modeling of the gravitational and electromagnetic waves these systems emit through the late- inspiral, merger, and post-merger stages. During these stages, the effects of high-velocity, strong-field gravitation become paramount, and accurate modeling requires large-scale, fully general relativistic simulations. I will review some of the latest results from fully general relativistic simulations of compact object binaries with matter companions, including NSNSs, BHNSs, and WDNSs. These simulations examine the effects of mass ratio, BH spin, equations of state, and magnetic fields on the gravitational waveforms and possible electromagnetic counterparts. Future work will focus on producing longer gravitational waveforms, incorporating more physics, and inventing new algorithms to efficiently handle the disparate length and timescales.