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Merging Black Holes[1]

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The final merger of two black holes is expected to be the strongest gravitational wave source for ground-based interferometers such as LIGO, VIRGO, and GEO600, as well as the space-based LISA. Observing these sources with gravitational wave detectors requires that we know the radiation waveforms they emit. And, when the black holes merge in the presence of gas and magnetic fields, various types of electromagnetic signals may also be produced. Since these mergers take place in regions of extreme gravity, we need to solve Einstein's equations of general relativity on a computer. For more than 30 years, scientists have tried to compute black hole mergers using the methods of numerical relativity. The resulting computer codes have been plagued by instabilities, causing them to crash well before the black holes in the binary could complete even a single orbit. Within the past few years, however, this situation has changed dramatically, with a series of remarkable breakthroughs. This talk will focus on new simulations that are revealing the dynamics and waveforms of binary black hole mergers, and their applications in gravitational wave detection, testing general relativity, and astrophysics.

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