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Learning about Black-Hole Formation from Gravitational Waves[1]

MICHAEL KESDEN, University of Texas at Dallas

The first observing run of the Advanced Laser Interferometer Gravitational-wave Observatory (LIGO) discovered gravitational waves from two binary black-hole mergers. Although astrophysical black holes are simple objects fully characterized by their masses and spins, key features of binary black-hole formation such as mass transfer, natal kicks, and common-envelope evolution can misalign black-hole spins with the orbital angular momentum of the binary. These misaligned spins will precess as gravitational-wave emission causes the black holes to inspiral to separations at which the waves are detectable by observatories like LIGO. Spin precession modulates the amplitude and frequency of the gravitational waves observed by LIGO, allowed it to not only test general relativity but also reveal the secrets of black-hole formation. This talk will review those elements of binary black-hole formation responsible for initial spin misalignments, how spin precession and radiation reaction in general relativity determine how spins evolve from formation until the black holes enter LIGO's sensitivity band, and how spin-induced gravitational-wave modulation in band can be used as a diagnostic of black-hole formation.

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