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Simulations of nearly extremal binary black holes MATTHEW GIESLER, MARK SCHEEL, DANIEL HEMBERGER, Caltech, GEOFFREY LOVELACE, KEVIN KUPER, California State University Fullerton, MICHAEL BOYLE, Cornell University, BELA SZILAGYI, Caltech, LAWRENCE KIDDER, Cornell University, SXS COLLABORATION — Astrophysical black holes could have nearly extremal spins; therefore, nearly extremal black holes could be among the binaries that current and future gravitational-wave observatories will detect. Predicting the gravitational waves emitted by merging black holes requires numerical-relativity simulations, but these simulations are especially challenging when one or both holes have mass m and spin S exceeding the Bowen-York limit of $S/m^2 = 0.93$. Using improved methods we simulate an unequal-mass, precessing binary black hole coalescence, where the larger black hole has $S/m^2 = 0.99$. We also use these methods to simulate a nearly extremal non-precessing binary black hole coalescence, where both black holes have $S/m^2 = 0.994$, nearly reaching the Novikov-Thorne upper bound for holes spun up by thin accretion disks. We demonstrate numerical convergence and estimate the numerical errors of the waveforms; we compare numerical waveforms from our simulations with post-Newtonian and effective-one-body waveforms; and we compare the evolution of the black-hole masses and spins with analytic predictions.

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