Abstract for an Invited Paper
for the APR07 Meeting of
The American Physical Society

Spin- orbit interactions in black-hole binaries

CARLOS LOUSTO, The University of Texas

We present the first fully-nonlinear numerical study of the dynamics of highly spinning black-hole binaries. We evolve binaries from quasicircular orbits, and find that the last stages of the orbital motion of black-hole binaries are profoundly affected by their individual spins. In order to cleanly display its effects, we consider two equal mass holes with individual spin parameters $S/m^2 = 0.757$, both aligned and anti-aligned with the orbital angular momentum (and compare with the spinless case), and with an initial orbital period of $125M$. We find that the aligned case completes three orbits and merges significantly after the anti-aligned case, which completes less than one orbit. The total energy radiated for the former case is $\sim$7% while for the latter it is only $\sim$2%. The final Kerr hole remnants have rotation parameters $a/M = 0.89$ and $a/M = 0.44$ respectively, showing the unlikeliness of creating a maximally rotating black hole out of the merger of two spinning holes. To calculate the transfer of angular momentum from orbital to spin, we start with two quasi-circular configurations, one with initially non-spinning black holes, the other with corotating black holes. In both cases the binaries complete almost two orbits before merging. We find that, during these last orbits, the spin-orbit coupling is far too weak to tidally lock the binary to a corotating state during the late-inspiral phase. We also use the 'moving puncture' approach to perform fully non-linear evolutions of spinning quasi-circular black-hole binaries with individual spins not aligned with the orbital angular momentum. We evolve configurations with the individual spins pointing in the orbital plane and 45-degrees above the orbital plane. We introduce a technique to measure the spin direction and track the precession of the spin during the merger, as well as measure the spin flip in the remnant horizon. These simulations show for the first time how the spins are reoriented during the final stage of binary black hole mergers verifying the hypothesis of the spin-flip phenomenon. We also compute the track of the holes before merger and observe a precession of the orbital plane with frequency similar to the orbital frequency and amplitude increasing with time.