Time Domain Calculations of Scalar Self-Force and Radiation from an Orbiting Point Charge in Schwarzschild Spacetime

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Gravitational waves offer promising new ways to detect astronomical phenomena such as binary black hole systems, supernovae, and background gravitational waves from the Big Bang. We focused on theoretical time domain calculations involving waves stemming from extreme mass ratio inspirals (EMRIs), investigating scalar radiation from a charged particle in a circular orbit around a massive central Schwarzschild black hole. Specifically, we used a time domain method that solves the scalar Regge-Wheeler equation with a point source in a circular orbit, and utilized an algorithm that includes the source term by using time-dependent boundary conditions. We wrote a code to implement the algorithm, which calculated the scalar energy fluxes to infinity, which we compared to the frequency domain calculations done by Barack and Warburton (2010). We found error on the order of 10^−5 between the Barack and Warburton fluxes and the numbers calculated in this paper, which is very good considering the mesh resolution error on the order of 10^−4. Overall, the high accuracy of this time domain method is promising for the application of the method to eccentric orbits and self-force calculations.

Awards Won:

Third Award of $1,000