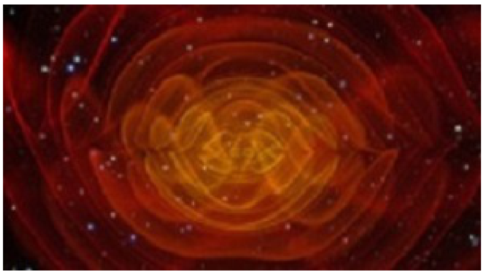

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Scalar self-force and QNM excitation for highly eccentric orbits in Kerr spacetime

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We present a computation of the self-force for a scalar-field particle on a bound eccentric orbit (which need not be a geodesic) in Kerr spacetime. Our main interest is in the case of highly eccentric orbits; here we present results for eccentricities as high as 0.98. We use a Lorenz-gauge Barack-Golbourn-Vega-Detweiler effective-source regularization followed by an $e^{im\phi}$ ("m-mode") Fourier decomposition and a separate time-domain numerical evolution in $2{+}1$ dimensions for each m. We introduce a finite worldtube which surrounds the particle worldline and define our evolution equations in a piecewise manner so that the effective source is only used within the worldtube. Viewed as a spatial region the worldtube moves to follow the particle's orbital motion. Our numerical evolution uses Berger-Oliger mesh refinement with 4th˜order finite differencing in space and time. We use slices of constant Boyer-Lindquist time near the black hole, deformed (following Zenginoglu) so as to be asymptotically hyperboloidal and compactified near the horizon and near $\mathcal{J}^+$. Our present implementation is restricted to equatorial geodesic orbits, but this restriction is not fundamental. For those configurations where the central black hole is highly spinning, the particle's periastron passage is near to or within the light ring, and the orbital eccentricity is ≥ 0.4, we find that the particle's periastron passage excites quasinormal modes of the background (Kerr) spacetime, causing large oscillations ("wiggles") in the self-force on the outgoing leg of the orbit, and smaller but still detectable oscillations in the radiated field at $\mathcal{J}^+$.

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