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Transient resonances in the inspirals TANJA HINDERER, California Institute of Technology, EANNA FLANAGAN, Cornell University — We show that the two body problem in general relativity in the highly relativistic regime has a qualitatively new feature: the occurence of transient resonances. The resonances occur when the ratio of polar and radial orbital frequencies, which is slowly evolving under the influence of gravitational radiation reaction, passes through a low order rational number. The resonances make the orbit more sensitive to changes in the initial data (though not quite chaotic), and are genuine non-perturbative effects that are not seen at any order in the standard post-Newtonian expansion used for two body systems at large separation. Our results directly apply to an important potential source of gravitational waves, namely the gradual inspiral of compact objects into much more massive black holes. Exploiting observations of these gravitational waves to map the spacetime geometry of black holes is contingent upon accurate theoretical models (templates) of the binary dynamics. At present, only the leading order in the mass ratio gravitational waveforms can be computed. Corrections to the waveform's phase due to resonance effects scale as the square root of the inverse of the mass ratio and are characterized by sudden jumps in the time derivatives of the phase. We numerically estimate the net size of these corrections and find indications that the phase error is of order a few cycles for mass ratios $\sim 10^{-3}$ but will be significant (of order tens of cycles) for mass ratios $\sim 10^{-6}$. Computations of these corrections will require the computation of pieces of the forcing terms in the equations of motion which are currently unknown.

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