Gauge and motion in perturbation theory

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Abstract:
A gravitating object perturbs the spacetime geometry around it, and that perturbation influences the object's own motion, an effect called the gravitational self-force. However, perturbation theory in general relativity comes with a gauge freedom that allows one to make arbitrary (small) shifts of the object's position, meaning that the self-accelerated trajectory is gauge dependent. Furthermore, the gravitational self-force formalism is most useful for modelling astrophysical binaries in which a stellar-mass object spirals into a supermassive spinning black hole, and in these systems, the gauge that appears to be most promising, called the radiation gauge, becomes highly singular in the presence of the smaller object. In this talk, I present a general picture of gauge transformations, and specific transformation laws for all essential quantities, through second order in the self-force formalism. I also describe rigorous methods of working in the useful but singular radiation gauge.