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Application of the GHZ formalism in a puncture scheme

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Extreme-mass ratio inspirals are identified as one of the key targets for the upcoming LISA mission. They will serve as unique probes of black-hole physics and enable tests of general relativity with unparalleled precision. Modelling these systems with sufficient accuracy requires the calculation of up to second-order metric perturbation due to a point particle orbiting a Kerr black hole. Currently, the linear perturbation is obtained via a so-called metric reconstruction procedure that puts it in a "no-string" radiation gauge, in which the perturbation is singular on a surface surrounding the central black hole. As a result, calculating physical quantities in such a gauge requires a subtle procedure of "gauge completion", as well as cancellations of very large numbers. These problems are further exacerbated at second-order. In parallel, a critical weakness of the current no-string construction is that it cannot be applied to spatially extended sources. This limits its utility not only for second-order, but even first-order self-force applications, since it is not applicable for example in a puncture scheme, one of the standard methods of self-force theory. A new reconstruction procedure, called the GHZ formalism, overcomes such limitations by allowing for non-pointlike sources. In this talk, I will summarise the GHZ formalism, and show for the first time its concrete implementation in a puncture scheme in the case of circular orbits in Schwarzschild.

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