Evaluation of far-field gravitational-wave signals from near-field data

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Abstract: Time-domain simulation of hyperbolic partial differential equations on a finite computational domain requires the introduction of a fictitious outer boundary. A long-standing challenge in the computation of waves is to identify the far-field or asymptotic signal. From data recorded on a sphere defined by the radius r1, we seek to recover the far-field signal which would reach large distances r2 including infinity. Far-field signals are particularly important as they encode information about the physical system. In this talk, I show how exact far-field signal recovery can be handled with a time-domain convolution of the solution recorded on a sphere r1 with a kernel. Using rational approximation techniques developed by Alpert, Greengard, and Hagstrom this kernel can be "compressed" as a sum-of-exponentials even in cases where one does not know the analytic kernel representation. We use this approach to compute signals generated from binary black hole systems in the linear regime, and I will describe recent efforts towards applying this technique to the fully non-linear Einstein equations.