

Multipole Moments, Time-derivative Operators, and the Kerr Compton Amplitud

Thursday 14 December 2023 17:30 (30 minutes)

In Dixon's original papers on the Mathisson–Papapetrou–Dixon worldline equations of motion for extended bodies in general relativity, he found the unique definition for the multipole moments of the stress tensor for a body in general motion in curved spacetime. This definition coincides only with the stationary multipole moments of the body which are determined by the three-point amplitude when the body is itself stationary. Consequently, we find that using Dixon's multipole moments with the Kerr solution allows the determination of additional couplings in the worldline action for a spinning black hole beyond those which are fixed by matching to the stationary stress tensor. Some of these additional couplings contribute linearly independent structures to the spinning black hole Compton amplitude. Beginning at fifth order in spin, the values of these additional couplings affect comparisons to predictions made by Guevara-Ochirov Vines spin-exponentiation, shift-symmetry, or the Teukolsky equation.

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Session Classification: Thursday PM 2