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Gravitational form factors from light front QCD

The energy-momentum tensor encodes the internal energy, spin, and stress distributions within hadrons, shedding new light on hadron structures and fundamental QCD problems such as confinement and the origin of hadron mass. In recent years, it has become possible to measure this quantity directly from experiments via generalized parton distributions, leading to growing interest in both experimental and theoretical studies. However, the dynamical nature of this observable poses a significant challenge, particularly for strongly coupled hadrons.

In this talk, I will discuss our recent progress in investigating the energy-momentum tensor and the associated gravitational form factors based on a nonperturbative light-front Hamiltonian approach. Our main result is a general, nonperturbative light-front wave function representation, which provides an adequate microscopic description. This representation is derived from a strongly coupled (3+1)-dimensional scalar field theory and is renormalized with a Fock sector-dependent scheme. It can be applied to various systems, including the charmonia, the pion, and the nucleon, with their respective light-front wave functions, offering new insights into the strong force within hadrons.

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