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Gluonic Gravitational Form Factors and Near-Threshold J/ψ Photoproduction in Holographic QCD

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Abstract:

Gravitational form factors (GFFs) of the nucleon furnish a three–dimensional map of the energy, momentum, pressure, and shear carried by QCD constituents, with gluonic contributions playing a decisive role. Complementing lattice QCD results, we employ a confining bottom-up AdS/QCD model in which the bulk dilaton background simultaneously generates linear Regge trajectories for 2^{++} and 0^{++} glueballs, and implements the QCD trace anomaly. Analytical expressions for the gluon $A(t)$ (energy–momentum) and $D(t)$ (mechanical) form factors are derived, revealing a consistent picture of the nucleon's mass, pressure, and shear distributions.

The same holographic wave functions determine the near-threshold photoproduction amplitude of heavy quarkonia through Witten diagrams. We discuss the recent extraction of gluonic GFFs by the $J/\psi-007$ collaboration at Jefferson Lab (published in Nature 615,813–816 (2023)) , which analyzed exclusive J/ψ production on the proton close to threshold using our holographic amplitude. The experimentally determined tensor (A) and scalar (D) form factors exhibit excellent agreement with lattice gluonic GFFs, reinforcing the validity of the holographic description in the non-perturbative regime. These developments highlight the synergy between gauge/gravity duality, lattice computations, and precision experiments, advancing our understanding of how gluons generate the visible mass and mechanical structure of hadronic matter.

Author: MAMO, Kiminad

Co-author: ZAHED, Ismail

Presenter: MAMO, Kiminad

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