Theoretical framework refines understanding of the strong nuclear force

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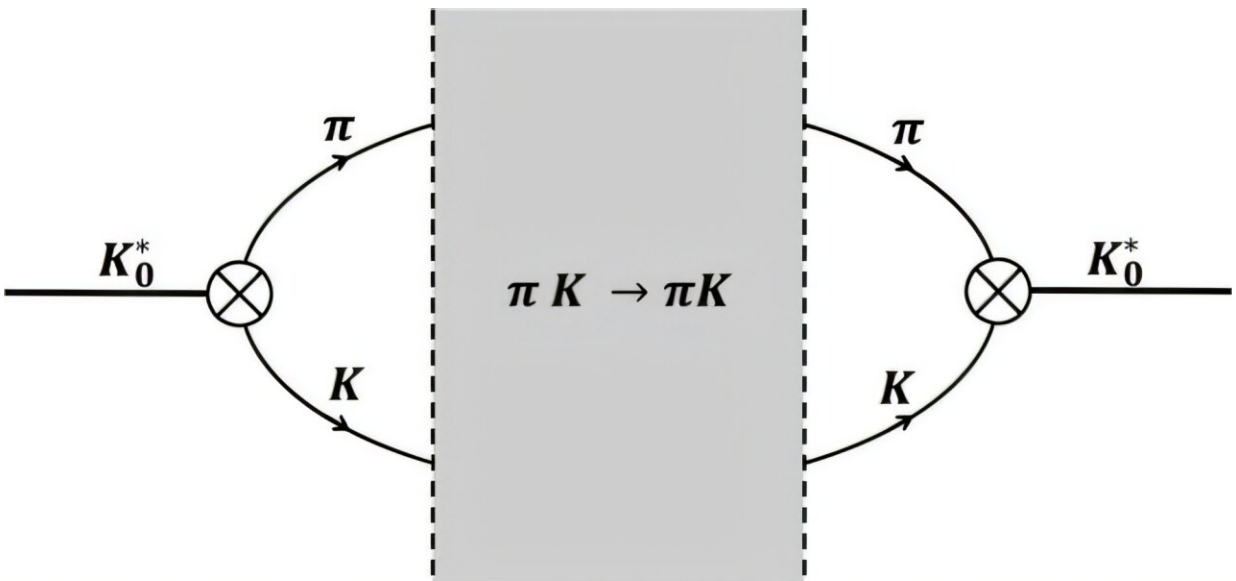

Inclusion of πK intermediate states in the kappa (K_0^*) correlator. Credit: *Physical Review D* (2025). DOI: 10.1103/PhysRevD.111.094023

A new study published in *Physical Review D* titled, "Extending the Bridge Connecting Chiral Lagrangians and QCD Gaussian Sum-Rules for Low-Energy Hadronic Physics," offers significant advancements in the understanding of the strong nuclear force. This fundamental interaction is responsible for holding protons and neutrons together within atomic nuclei and plays a central role in the formation of matter.

Dr. Amir Fariborz, Professor of Physics at SUNY Polytechnic Institute, has co-authored the research, which builds on a theoretical bridge first proposed by Dr. Fariborz and his collaborators in 2016, which connects the complex world of hadrons (composite particles such as protons, neutrons, and mesons) with their underlying quark structure.

The current work enhances this framework by incorporating higher-order effects, which allow for more refined predictions and the potential to study more intricate subatomic phenomena. These include scalar and pseudoscalar mesons that possess hybrid quark-gluon structures and may exhibit mixing with glueballs, a type of particle hypothesized to be composed entirely of gluons.

This investigation falls within the broader field of hadronic physics, which intersects nuclear and particle physics and aims to decode how quarks, bound together by the strong interaction, form the hadrons observed in nature.

Although quantum chromodynamics (QCD), the theory describing strong interactions among quarks and gluons, is well understood at high energies, its behavior at lower energies remains a major theoretical challenge. Perturbative methods, which are effective in high-energy physics, do not work at these scales.

Dr. Fariborz's research directly contributes to addressing this gap, offering a theoretical structure that is consistent with experimental results and capable of evolving alongside future discoveries.

More information: Amir H. Fariborz et al, Extending the bridge connecting chiral Lagrangians and QCD Gaussian sum rules for low-energy hadronic physics, *Physical Review D* (2025). DOI: 10.1103/PhysRevD.111.094023

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