Probing the Nuclear and Electromagnetic Structure of Heavy Nuclei at STAR

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Abstract

Diffractive vector meson photoproduction has long been recognized as an unparalleled probe of the gluon distribution within nuclei, potentially key to elucidating non-linear QCD effects that lead to universal states of dense gluonic matter. ϕ meson photoproduction is particularly useful for studying small-x dynamics, especially gluon saturation, due to its sensitivity to larger dipole sizes compared to, for example, J/ψ and other heavy vector mesons. Compared to the ρ^0 meson, the ϕ meson has a longer lifetime and a larger mass, making it more amenable to theoretical investigation. For these reasons, the measurement of ϕ meson photonuclear production in A+A collisions has been long anticipated. In this talk, we present the measurement of exclusive diffractive photonuclear production of the ϕ meson via the K^+K^- decay channel from Au+Au collisions. We utilize this newly obtained measurement to compare theoretical calculations incorporating gluon saturation effects across orders of magnitude in dipole size, thereby illuminating the small-x gluon distribution within nuclei.

Just as diffractive vector meson production has been employed in high-energy collisions to probe the spatial distribution of gluons within the nucleus, it has recently been demonstrated that photon-photon interactions enable mapping of the photon Wigner distribution within heavy nuclei—a multidimensional image of the electromagnetic fields of high-energy nuclei. To this end, we present the measurement of $\gamma + \gamma \to e^+e^-$ from U+U collisions at $\sqrt{s_{NN}} = 193$ GeV and investigate various approaches for constraining the nuclear (electromagnetic) structure of uranium.