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Toward the Origin of Mass at J-PARC E16 via Density-induced Chiral Mixing in Di-Lepton Production

The spectral functions of chiral partners should become degenerate when the QCD chiral symmetry is restored. The axial-vector spectra are experimentally more challenging to construct than those of vector mesons that directly couple to virtual photons and then to dileptons. Chiral mixing of the vector with axial-vector mesons is thus a key phenomenon to probe in-medium modifications of vector spectrum due to the onset of chiral symmetry restoration carried by the axial-vector counterpart. The mixing effect is expected to be stronger at higher density due to a mechanism driven by chiral anomalies [1, 2], in striking contrast to the vanishing mixing at chiral crossover driven by thermal pions [3]. This feature encourages us to perform the experimental search in the high-density regime, where the recent experimental trend has begun to shift toward.

We propose that experiments at medium energies with paying attention to the new mixing mechanism, may provide a direct evidence of the chiral symmetry restoration. In this presentation, we focus on the density-induced mixing and the spectral functions of ϕ and its chiral partner $f_1(1420)$. We present the invariant mass distribution of dileptons using a transport approach developed in [4, 5] under the conditions of the J-PARC E16 experiment as a prime example.

We find that the $f_1(1420)$ meson is visible with about 2 σ credibility in dilepton production in a range of mixing strength in our study when the expected statistics at E16 Run-2 are utilized [6]. We advocate that the E16 experiment at J-PARC has discovery potential for the mass degeneracy of chiral partners at finite density as a signature of chiral symmetry restoration.

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Category

Theory

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