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Result of re-analysis of spectral modification of φ Mesons at finite density using PHSD transport approach in 12 GeV pA reactions

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This presentation reports on a re-analysis of the modification of the φ-meson mass spectrum in finite-density matter observed in the KEK-PS E325 experiment, using PHSD transport calculations.

Hadrons are considered to acquire most of their masses through spontaneous chiral symmetry breaking.
On the other hand, the quark condensate, which serves as an order parameter of spontaneous chiral symmetry breaking, is predicted to be partially restored in hot and/or finite-density environments.
Therefore, a direct measurement of hadron masses in environments such as finite-density matter is important for elucidating the mechanism of hadron mass generation.

The KEK-PS E325 experiment observed a modification of the φ-meson mass spectrum in a finite-density environment.
In this experiment, 12 GeV proton beam was incident on nuclear targets such as copper and carbon, and the invariant mass was measured by detecting the e+e- decays of the produced φ mesons.
Since the typical decay length of the φ meson is large compared with the nuclear size, the φ mesons observed in this experiment decay over a wide range of densities.
In the previous analysis, the measured invariant-mass spectra were classified according to the target nucleus and the βγ of the parent particle.
As a result, a significant spectral modification was observed in the spectrum for the larger nucleus and the slower parent particles, where the probability of in-medium decay was expected to be highest.

To quantitatively evaluate this spectral modification, the spatial distribution of the baryon density is crucial.
In the previous analysis, the Woods-Saxon distribution of the target nucleus was assumed for the density profile.
However, the target nucleus may begin to evolve in time due to the effects of the pA collision, and therefore it may be inappropriate to use the Woods-Saxon distribution as the density profile.
In the present work, we introduced PHSD transport calculations and performed a detailed simulation of the time evolution of the baryon spatial distribution during and after the pA collision.
By incorporating these results into the analysis of the experimental data, we carried out a quantitative evaluation of the spectral modification.
Furthermore, we included the theoretically predicted momentum dependence of the φ-meson mass shift and extracted momentum-dependent modification parameters.
In this presentation, we report on the analysis procedure and the results obtained.

Collaboration

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