

## Differences in population of the phase space for $K^\pm$ -mesons produced in $\pi$ -induced reactions with heavy and light targets. \*

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Partial restoration of chiral symmetry in hot and dense environment is believed to influence the in-medium properties of hadrons. Various theoretical approaches agree qualitatively on the decrease(increase) of the effective  $K^-$  ( $K^+$ ) - mass with increasing nuclear matter density, resulting in the attraction(repulsion) of  $K^-$  ( $K^+$ ) toward nucleons[1].

The FOPI Collaboration in cooperation with the GEM-TPC Collaboration has performed an experiment bombarding heavy and light targets with an intense pion beam. About  $4 \times 10^6$  events in  $^{208}\text{Pb}$ -target and  $3 \times 10^6$  events in  $^{12}\text{C}$ -target were recorded. The beam momentum of 1.7 GeV/c was chosen such that the direct production of  $K^+K^-$ -pairs is possible. Thereby the recorded sample of charged kaons, produced close to threshold, is highly sensitive to the  $KN(\bar{K}N)$ -potential and allows to study in-medium effects at normal nuclear matter density.

In  $\pi$ -induced reactions with a heavy target K-mesons are produced on the surface of the nucleus and have to propagate through the nucleus to be detected. If the kaon is attracted(repelled) by the nuclear matter, its momentum distribution in the final state will be shifted to smaller(larger) momenta. These changes in the phase space distribution can be quantified by comparing the momentum spectra of kaons produced in a heavy target to a reference system provided by a light target.

First results, from the recent experiment, of such momentum ratios  $R((dN/dp)_{Pb}/(dN/dp)_C)$  are presented in Fig. 1 for  $K^+$ -mesons (left panel) and  $K^-$ -mesons (right panel). In case of  $K^+$ -mesons repulsion from nuclear matter due to strong interaction(the KN-potential), and an additional repulsion due to the Coulomb-interaction are expected. Therefore, the low momentum region of the phase space of  $K^+$ -mesons from the heavy target is populated weaker than the one from the reference system, i.e. light target. The ratio of the momentum distributions has small values and rises as the momentum increases. Particles with larger momentum leave the interaction region rapidly and therefore are not influenced by the repulsion. The phase space distributions in both systems are equal and the momentum ratio reaches a constant value. The discussed effects from the strong interaction has been observed before by the FOPI Collaboration for  $K_S^0$  [3] and the interplay of strong and Coulomb interactions for  $K^+$ -mesons by the ANKE collaboration [2]. Transport model calculations confirm the expectations for different attraction scenarios.  $K^+$  and  $K_S^0$  were found to be good probes for in-medium effects due to relatively long mean free path in

nuclear matter at small momenta. Our new measurement is in qualitative agreement with the previous one. The momenta with the highest ratio and the region with a constant ratio are compatible to ANKE results, however the earlier observed strong decrease at smaller momenta could not be confirmed.

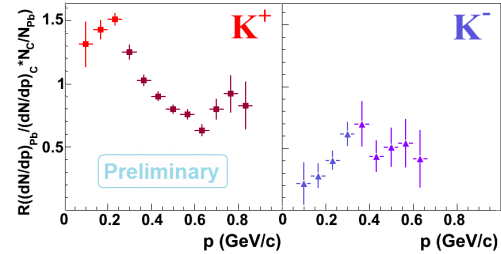


Figure 1: The ratio of  $K^+$  ( $K^-$ ) yields, per event, produced by pions on heavy and light targets as a function of the momentum in the lab system. Different colors indicate a separate analysis of different detector components.

In case of the attracted particles, like  $K^-$ , one would expect the largest value for the momentum ratio at smallest momentum and a continuous decrease with increasing momenta, as far as the  $\bar{K}N$ -potential is concerned. On the other hand,  $K^-$ -mesons have a very short mean free path in nuclear matter of about 0.6 fm for  $p_{K^-} = 0.1\text{GeV}/c$  and therefore they are expected to suffer collisions in both heavy and light targets. Part of  $K^-$ -mesons are absorbed in inelastic scattering processes another part exchanges momentum as a consequence of elastic scattering. Both processes influence the momentum distribution in the final state. Recent version of transport model calculations, taking into account scattering and the effect from repulsive  $\bar{K}N$ -potential, predict a steady decrease of the ratio with increasing momentum. Our recent measurement (Fig. 1, right) shows no sign of expected behavior.

To draw any quantitative conclusions on the influence from the  $KN(\bar{K}N)$ -potential on this observable detailed comparison to transport model calculations is necessary and will hopefully lead to a consistent description of especially  $K^-$  in nuclear matter.

## References

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\* Work supported by BMBF 06HD71411.

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