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Kaon and Phi Production in Pion-Nucleus Reactions at 1.7 GeV/*c**

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Abstract. Nuclear reactions, $\pi^- + A$ ($A = C, W$), at an incident beam momentum of 1.7 GeV$/c$ were measured with the HADES setup at SIS18/GSI. Detailed investigations of the K^+, K^- and ϕ production off nuclei are connected to the study of hadron in-medium properties at nuclear saturation density. A contradictory role is played by the ϕ meson since the ϕN absorption cross-section is assumed to be small due to the OZI suppression which is in contrast to experimental observations. We present the analysis method to identify the ϕ meson exploiting the large K^+K^- branching ratio ($\approx$ 50%). The correction for acceptance and efficiency effects of the detector system will be discussed as well.

1 Introduction

Pion-nucleus reactions allow for a quantitative study of open and hidden strange hadron production and properties at a well defined nuclear density. Of particluar interest is the ϕ meson ($s\bar{s}$) with no-net strangeness. According to the Okubo-Zweig-Iizuka (OZI) rule [1] quark exchange and hence the interaction of the ϕ meson with ordinary (non-strange) baryonic matter is suppressed. Consequently, the ϕN cross-section is assumed to be small.
However, the LEPS Collaboration determined on the basis of the A-dependent ϕ photoproduction yield and a Glauber-type model a large in-medium ϕN absorption cross-section of $\sigma_{\phi N} = 35^{+17}_{-11}$ mb [2]. This extraced absorption cross-section is in agreement with photoproduction measurements performed by the CLAS Collaboration [3]. Here, transperency ratios normalized to carbon where analysed as well within a Glauber model with values of $\sigma_{\phi N}$ in the range of $16 - 70$ mb. Also transperency ratios normalized to carbon measured in pA collisions by the ANKE Collaboration point in the same direction with an effective ϕN absorption cross-section in the range of $14-21$ mb [4]. So far, ϕ absorption in different nuclei has not been studied in pion-induced reactions and should therefore provide complementary information to results obtained with photon and proton beams.

2 The Experiment

Experimental data were obtained with the **H**igh-**A**cceptance **D**i-**E**lectron **S**pectrometer (HADES) [5], currently located at the SIS18 accelerator (GSI, Darmstadt). The detector

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setup comprises six idential sectors surrounding the beam axis covering almost the full azimuthal range and polar angles from 18° to 85°. Two layers of **M**ultiwire **D**rift **C**hambers (MDC), in front and behind a toroidal superconducting magnet, allow for momentum reconstruction with a resolution of $\Delta p/p \approx 3\%$ and particle identification via dE/dx. In this experimental campaign, the first level (LVL1) trigger condition required a T_0 signal in the target detector [6] and a minimum multiplicity of two charged particle hits (M2) in the **M**ultiplicity and **E**lectron **T**rigger **A**rray (META) wall consiting of two time-of-flight detectors, RPC and TOF. In total, 10×10^7 and 13×10^7 events were collected in $\pi^- + C$ and $\pi^- + W$ collisions at $p_{\pi^-} = 1.7$ GeV/c, respectively.

3 Exclusive Phi Production

The ϕ mesons were identified via their dominant decay channel into K^+K^- pairs (BR = 48.9 ± 0.5% [7]). Both charged kaons have been selected employing velocity and momentum cuts[1]. The contamination from other particle species was further reduced by selecting a reconstruced (anti-)kaon mass window of $400 < m$ [MeV/c^2] < 600. Further, the nominal mass value m_K = 493.677 MeV/c^2 [7] was then attributed to the identified (anti-)kaon candidates. The resulting K^+K^- invariant mass distribution corresponing to an interval of $750 \leq p$ [MeV/c] < 1250 and $18.8 \leq \theta$ [°] < 27.5 for $\pi^- + C$ collisions is shown in Fig. 1 (left). A clear ϕ peak emerging from the background of non-resonant K^+K^- pairs and track combinations containing misidentified particles is visible. The ϕ signal is described by a double Gaussian accounting for finite resolution effects as well as the collisional broadening due to the scattering of the K^+ and K^- inside the targets, while the background is described by a third-order polynomial together with a Gaussian representing the mass threshold ($2 \times m_K$).

For acceptance and efficiency corrections the Pluto [8] event generator was used. Therefore, the exclusive ϕ production channel $\pi^- + p(^{12}C) \rightarrow \phi[\rightarrow K^+K^-] + n(^{11}B)$ was simulated. The momentum and angular distribution of the generated ϕ mesons is shown in Fig. 2 (left). The K^+K^- pairs originating from ϕ mesons were then processed through simulations modelling the detector response. In Figure 2 (right) the obtained acceptance and efficiency correction matrix is presented. One can see that the acceptance and efficiency corrections strongly depend on phase space, hence a differential correction becomes mandatory. Due the limited ϕ statistic, a double-differential analysis would lead to acceptance and efficiency correction factors averaged over wide and non-constant region in the phase space. This is overcome by weighting each ϕ candidate with its corresponding correction factor in phase space building an integrated and corrected K^+K^- invariant mass distribution (see Fig. 1 (left)).

4 Summary and Outlook

In this contribution, we presented the on-going analysis of ϕ production in $\pi^- + C$ reactions at $p_{\pi^-} = 1.7$ GeV/c measured with the HADES setup. The neutral ϕ is reconstructed via the invariant mass of charged kaon candidates (M_{K^+K-}). On the basis of simulations modelling the detector response in combination with Pluto as an event generator, the acceptance and efficiency corrected ϕ yield can be extracted. In the next step we plan to determine absolute normalized yields. The final goal will be the extraction of an effective ϕN absorption cross-section by comparing the ϕ production in $\pi^- + W$ with respect to $\pi^- + C$ collisions in combination with reaction models providing complementary information to photon- and proton-induced measurements.

[1] $p/\sqrt{p^2 + m_K^2} \pm 0.5 \gtrless \beta$

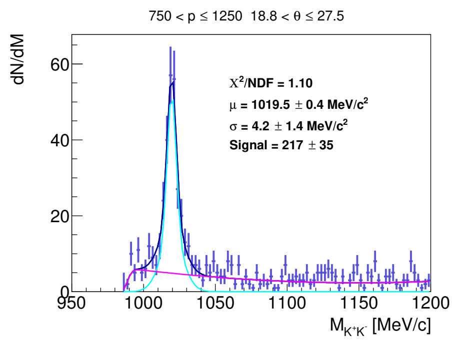

Figure 1. (Color online) Invariant mass distributions for K^+K^- pairs produced in π^-C collisions w/o (left) and with event-by-event acceptance and efficiency corrections (right). The fit consists of two Gaussian for the ϕ signal (light blue line) together with the background described by a polynomial and Gaussian function (pink line). Details see text.

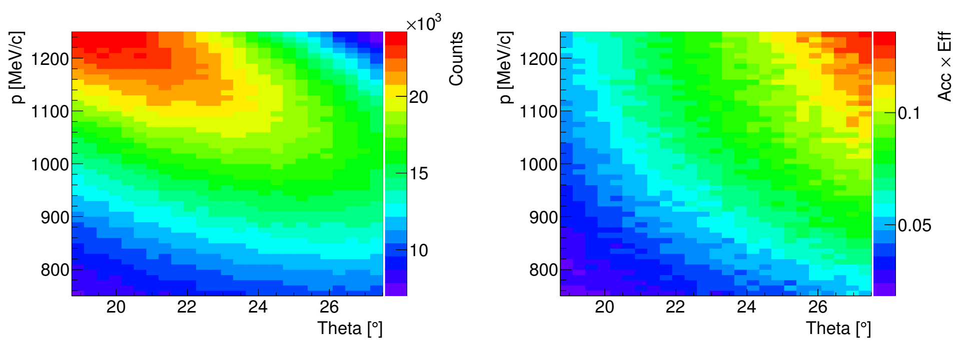

Figure 2. (Color online) The $p-\theta$ distribution of the ϕ mesons generated with the Pluto event generator (left). Combined acceptance and efficiency correction matrix for the ϕ mesons decaying in K^+K^- pairs as a function of $p-\theta$ (right).

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