ϕ-meson width in nuclear matter*

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One of the goals of the experiment on ϕ meson production in *pA* collisions is to study the ϕ properties in nuclear matter at normal density [1]. According to theoretical predictions the ϕ meson modification in mass is small and the main medium effect is a significant increase of its width up to an order of magnitude compared to the free (vacuum) value.

The experiment was carried out at an incident proton energy of 2.83 GeV with the ANKE spectrometer in 2007. The data set was collected with a special two-particle trigger which contains K^+K^- correlations with hardware K^+ selection using the delayed veto technique and the absolute measurements of K^+K^- TOF difference. The measurements were performed with four thin strip targets: C, Cu, Ag and Au. K^+K^- invariant mass spectra look similar for all four targets. As an example the spectrum for the Au target is presented in

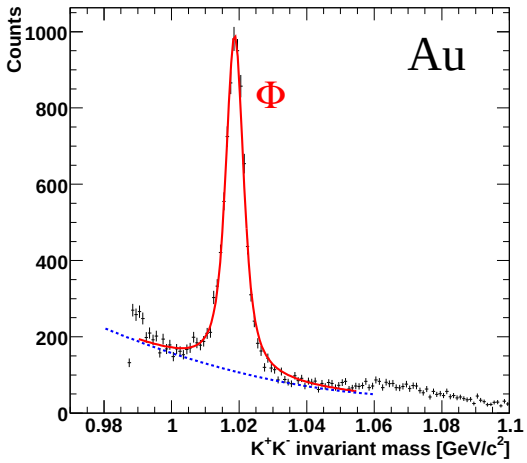

Fig. 1: Invariant mass distribution for K^+K^- pairs from *p*Au collisions.

Fig. 1. The ϕ positions and the widths (taking into account our resolution of 1.5 MeV) coincide within 0.5 MeV with the vacuum values since ϕ mesons are reconstructed from almost undistorted K^+ and K^- mesons from ϕ's decaying outside the nuclear volume. The dashed line in Fig.1 represents the sum of the physical background from the non-resonant kaon pair production and relatively small amount of misidentified events. The numbers of selected ϕ mesons for the C, Cu, Ag and Au targets are given in Table 1.

Table 1: Numbers of ϕ-mesons selected for analysis

solid strip targets				
A	C	Cu	Ag	Au
N	6700	5000	5000	6000

During its propagation out of nucleus the ϕ meson acquires an additional width connected to the imaginary part of the meson-nuclear potential which is responsible for the meson absorption in nuclear matter. Thus, the information about a modification of the ϕ width can be obtained from the *A*-dependence of the cross sections for ϕ production off nuclei with different atomic mass number A. To obtain this *A*-dependence the data on ϕ production were normalized to fluxes of π^+ mesons with momenta of 500 ± 25 MeV/c for angles $\leq 4^\circ$ simultaneously measured for each target. The production cross sections of these π^+ mesons were determined from the analysis of all available data obtained at the initial proton energy range 1-5 GeV. In Fig. 2 the measured

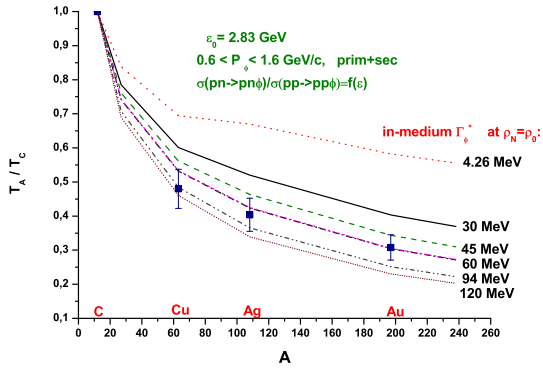

Fig. 2: Comparison of the measured transparency ratios R (preliminary) with the calculation in [2].

cross sections per nucleon for ϕ production on nucleus A normalized to the corresponding cross section on carbon $R = (12/A)(\sigma^A)/(\sigma^C)$, which is usually termed as a transparency ratio T_A/T_C, are presented together with the theoretical calculations performed in [2]. The quantity $\Gamma^*_\phi = \Gamma^*_{dec} + \Gamma^*_{coll}$ stands for the total width in the ϕ rest frame and includes both decay and collisional parts.

To determine the ϕ width in nuclear medium the set of the theoretical curves as well as experimental ratios were approximated by the function $(A/12)^{\alpha-1}$. The comparison of the experimental value of α with theoretical dependence of α on Γ^*_ϕ yields magnitude of $\Gamma^*_\phi = 65^{+17}_{-13}$ MeV taking into account the uncertainties of the performed fits (Fig. 3). Under

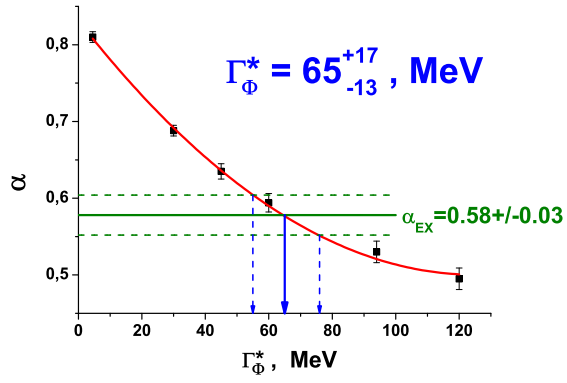

Fig. 3: Exponent α as a function of in-medium ϕ width Γ^*_ϕ.

the assumption that the decay width is not modified in nuclear matter (keeps its vacuum value 4.26 MeV) the effective

ϕN cross section in nuclear matter is found to be 21^{+5}_{-4} mb. This preliminary value exceeds that in vacuum (10 mb) by a factor of about 2. As a next steps we intend to study the momentum dependence of the ϕ meson width in the nuclear medium as well as determine the absolute values of the cross sections for ϕ meson production on C, Cu, Ag and Au nuclei.

References:

[1] M. Hartmann, Yu.Kiselev *et al.*, COSY Proposal **No. 147**.

[2] E. Ya. Paryev, J. Phys. G: Nucl. Part. Phys. **36** (2009) 015103.

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