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First observation of universality of short range nucleon correlations in the production of strange mesons

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Nucleon-nucleon short range correlations (SRCs) in nuclei are important part of the nuclear structure and have been a subject of intensive studies in the last years. These objects represent temporary fluctuations in average nuclear matter density that occur when two or more nucleons separated by about 1 fermi ($1\,\text{fm} = 10^{-13}\,\text{cm}$). Spatial overlap of correlated nucleons entails a significant increase in SRC density up to four to five times the average nuclear density, $\rho_0 = 0.16\,\text{fm}^{-3}$, and is comparable to the density of neutron stars. The SRC study will provide valuable information about the largely unexplored region of the QCD phase diagram associated with high baryon density and low temperature. Understanding the internal structure of SRCs – whether they are hadronic or quark objects – is one of the unresolved problems of modern nuclear physics and astrophysics. One of the main properties of SRCs is universality, which means that their properties are independent of the atomic masses of the nuclei reflecting the properties of nuclear matter. So far, the property of universality has been observed in electron-nuclear collisions for the breakup of proton-neutron correlations, as well as in proton-nuclear collisions for the production of cumulative pions with high momenta. Both processes involve only light quarks. Up to now, we have almost no experimental information about the flavor dependence of the SRC properties. In this letter, we report the first observation of SRC universality in kaon production on nuclei in the kinematic region of large energy-momentum transfers thereby extending the investigation of the SRC universality to the sector of strange quarks. To this end we reanalyzed our data on the production of high momentum kaons emitted at 97^0 and 119^0 (in lab) from nuclear targets irradiated by 10-GeV proton beam. The α^A-dependencies of the per-nucleon cross section ratios for K^+ and K^- meson production on nucleus A to that on ^{9}Be in the range of dominant contribution to the cross sections from two-nucleon correlations are shown in Fig. 1 and 2, respectively. The modified light cone variable α^A is defined in the system where nucleus A moves with high velocity. It accounts for the recoil of the residual $A-2$ system in the collision of a proton and two-nucleon correlation as well as finite velocity of the colliding objects. The observed plateaus in the cross section ratio indicate the onset of the SRC universality. This is the first observation of the universality of the

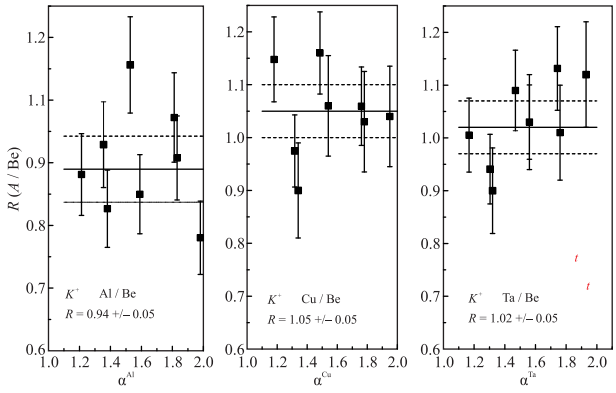

Fig. 1. Ratios of the per-nucleon invariant cross sections for K^+ meson production on nucleus A to that on ^{9}Be as a function of the variable α^A. Over all normalization uncertainty of 12 % is not shown

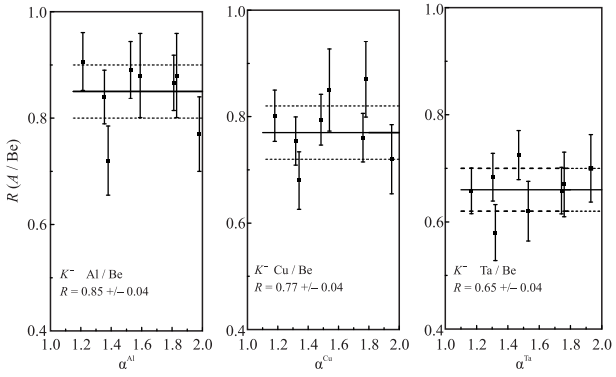

Fig. 2. The same as in Fig. 1, but for K^- mesons

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SRCs in the strange quark sector. Target atomic mass dependencies of the cross sections for kaon production give an evidence for a weak absorption of K^+ and K^- compared to that expected in the hadronic models. The results of the performed analysis support the QCD motivated models of SRC.

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