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Scaled momentum distributions for K^0_S and Λ in DIS at HERA

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Results on the K^0_S and Λ production in deep inelastic ep scattering at HERA obtained with ZEUS detector are presented. The scaled momentum distributions x_p are measured in the current fragmentation region of the Breit frame as function of photon virtuality, Q^2, in the kinematic region $10 < Q^2 < 40000$ GeV^2 and $0.001 < x < 0.75$ with x as the Bjorken variable. The data are compared to the leading-logarithm parton-shower Monte Carlo models which are using the same Lund fragmentation model and next-to-leading order QCD calculations. The measured distributions are compared to the those from the inclusive charged particles studies for the region of kinematic overlap, $0.1 < x_p < 0.4$, as functions of Q^2.

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1. Introduction

Particle production at the HERA collider is the effect of a virtual photon and a proton interactions, $\gamma^* p$. For photon virtuality, $Q^2 > 0$ particles are produced in so called deep inelastic scattering (DIS) collisions. The studies of the strange hadrons production in DIS, in the Breit frame can help to better understand the fragmentation process of the strange quarks. This paper concentrates on studies of the fragmentation properties of the K^0_S and Λ hadrons on the base of the measured scaled momentum distributions and test of the universality of the quark fragmentation by comparing to the next-to-leading order (NLO) QCD calculations which are using various fragmentation functions (FFs) tuned to the e^+e^-, pp and ep data.

2. K^0_S and Λ scaled momentum distributions

ZEUS Collab. investigated production of K^0_S and Λ in the current fragmentation region of the Breit frame. The aim was to check the universality of the quark fragmentation function and the factorisation theorem approach used to predict the hadron production in different processes. The scaled momentum distributions were compared to next-to-leading order (NLO) QCD calculations and the leading-log parton-shower: CDM and MEPS as implemented in ARIADNE [2] and LEPTO [3] MC programs respectively. The same Lund colour string fragmentation model [4] as implemented in the JETSET [5] was used in MC simulations. Various fragmentation functions (FFs) obtained from fits to e^+e^- data [6, 7], to e^+e^- and $pp/p\bar{p}$ data [8], or to e^+e^-, $p/p\bar{p}$ and ep data [9] were used in the NLO QCD calculations. Figure 1 shows the scaled momentum distributions, $x_p = 2P^{Breit}/Q$, as a function of Q^2 in different regions of x_p for K^0_S and Λ particles. With increasing Q value the phase space for a soft gluon radiation gets enlarged. This leads

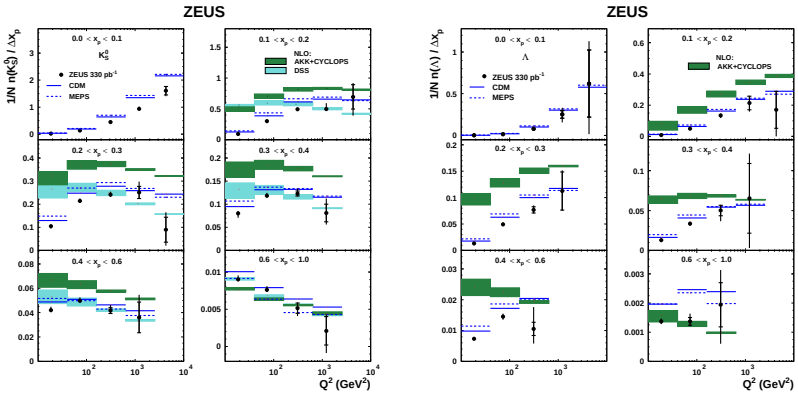

Figure 1: Left: The scaled momentum distributions as function of Q^2 in different regions of x_p for K^0_S particles together with the predictions of NLO QCD and LO QCD models implemented in MC programs. Right: The corresponding scaled momentum distributions for Λ particles.

to the rise in the number of soft particles (small x_p) and to the decrease in the number of those with high x_p. This scaling violation is visible in Fig. 1 for both K^0_S and Λ particles. For K^0_S the QCD NLO predictions using different FFs describe the data only in certain regions of the phase

space. For the AKK+CYCLOPS calculations it is limited to $0.6 < x_p < 1$, whereas the DSS calculations describe the data adequately, except for low x_p and Q^2. The predictions based on CDM and MEPS models give a good description of the data in almost whole phase space. A similar behaviour is also observed for Λ particles in Fig. 1 (right). The data are reasonably well described by the AKK+CYCLOPS calculations only for $0.6 < x_p < 1$.. Again MC models give a better data description.

Figure 2 presents x_p distributions for K^0_S and Λ together with those coming from studies on inclusive charged particles in DIS [10] for the region of kinematic overlap, $0.1 < x_p < 0.4$, as function of Q^2. For $Q^2 > 100$ GeV2, all distributions show a plateau. At lower $Q2$, and small x_p,

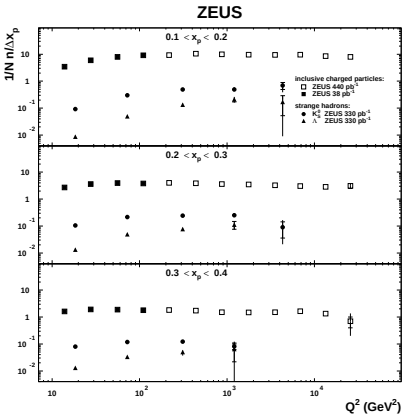

Figure 2: The comparison of the measured scaled momentum distributions for K^0_S and Λ with light charged particles in kinematic region where they overlap.

the expected mass effect [8] is visible. For $0.1 < x_p < 0.2$ the drops to 10 (20)% of plateau values for Λ and K^0_S is observed, while for inclusive charged particles such drop is on the level 40%.

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