Medium-induced Jet Energy Loss and Flavor Conversion in e+A

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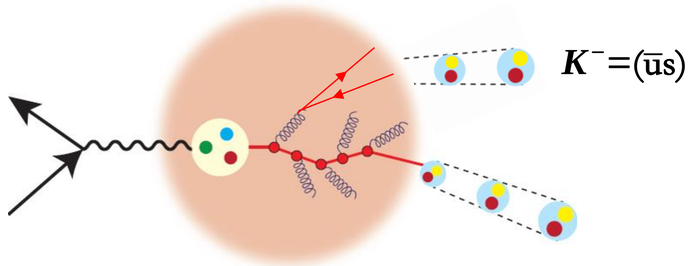
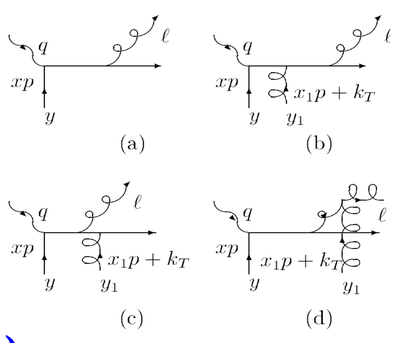
Motivation

- In e+A, the struck quark undergoes multiple scatterings with the QCD medium of the target nucleus remnant.
- This initial quark radiates induced gluons and quark pairs, which not only leading to energy loss of leading parton, but also modify the flavor composion of jet.



- Since constituent quarks $(\bar{u}, s)$ in K^- can only come from pair production in the shower evolution of struck valence quark at large x_B, we check in detail the production of K^- in e+A collisions.

Calculating Framework



Including the leading twist-four contributions, the medium modified fragmentation function (mFF):

$$\tilde{D}_{q\to h}(z_h,\mu^2) = D_{q\to h}(z_h,\mu^2) + \Delta D_{q\to h}(z_h,\mu^2)$$

Medium-modified splitting function:

$$\tilde{\gamma}_{a\to bc}(z,l_T^2) = \gamma_{a\to bc}(z) + \Delta\gamma_{a\to bc}(z,l_T^2)$$

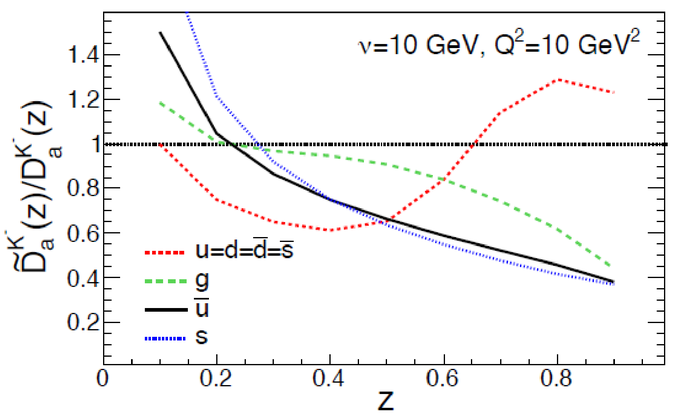
Resum all leading-log and twist-four correlations, we have medium-modified DGLAP (mDGLAP)

$$\frac{\partial \tilde{D}_q^h(z_h,\mu^2)}{\partial \ln\mu^2} = \frac{\alpha_s(\mu^2)}{2\pi}\int_{z_h}^1 \frac{dz}{z}\left[\tilde{\gamma}_{q\to qg}(z,\mu^2)\tilde{D}_q^h(\frac{z_h}{z},\mu^2) + \tilde{\gamma}_{q\to gq}(z,\mu^2)\tilde{D}_g^h(\frac{z_h}{z},\mu^2)\right]$$

$$\frac{\partial \tilde{D}_g^h(z_h,\mu^2)}{\partial \ln\mu^2} = \frac{\alpha_s(\mu^2)}{2\pi}\int_{z_h}^1 \frac{dz}{z}\left[\sum_{q=1}^{2n_f}\tilde{\gamma}_{g\to q\bar{q}}(z,\mu^2)\tilde{D}_q^h(\frac{z_h}{z},\mu^2) + \tilde{\gamma}_{g\to gg}(z,\mu^2)\tilde{D}_g^h(\frac{z_h}{z},\mu^2)\right]$$

Since there exists the process of q->g, and g->qqbar, the flavor of initial quark could be converted to others during the mDGLAP evolution

Flavor Conversion on Parton Level



At intermediate z, the mFF's are all suppressed due to energy loss.

At small z, mFF's are all enhanced due to soft gluon and pair production.

At large z:

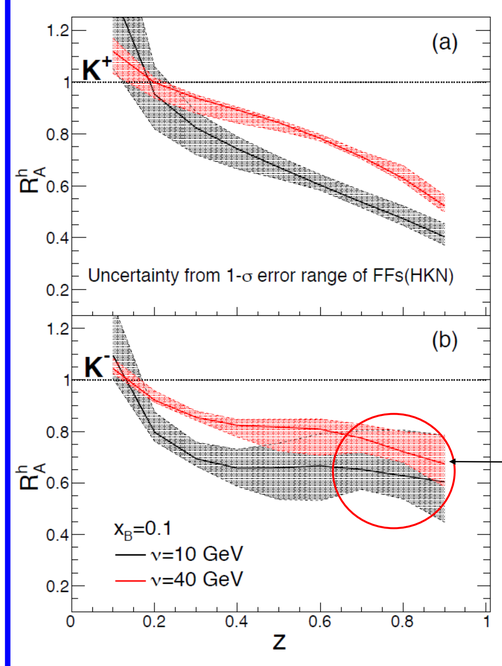
- the mFF of initial (ubar, s) or gluon are suppressed due to energy loss.
- But for initial (u, d …) quarks, there is an enhancement due to flavor conversion.

Flavor conversion on Hadron Level

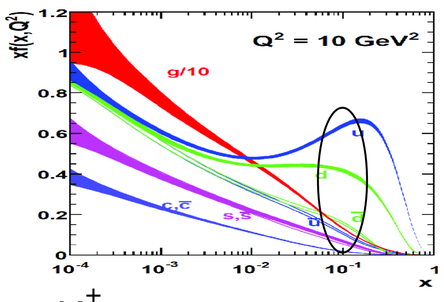
To test the sensitivity of K^- to the flavor conversion, we choose two x regions, to search whether this conversion could be kept from parton level to hadron level.

Medium modification factor in e+A: $$R_M^h = \frac{\sum e_f^2 q_f(x_B,Q^2)\tilde{D}_f^h(z,Q^2)}{\sum e_f^2 q_f^A(x_B,Q^2)}\Big|_A \Big/ \frac{\sum e_f^2 q_f(x_B,Q^2) D_f^h(z,Q^2)}{\sum e_f^2 q_f^A(x_B,Q^2)}\Big|_D$$

At moderate x ~0.1



Both valence quarks **(u, d)** and sea quarks **(ū, s)** are struck as initial jet.

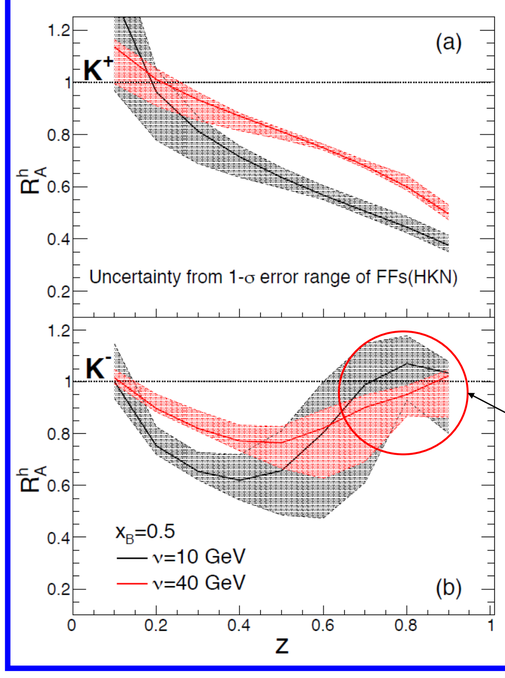


flatter than K^+

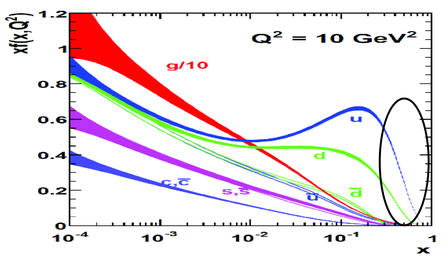
Comes from the competition of :

- Enhancement of (u, d) quarks
- Suppression of (ubar, s) quarks

At large x ~0.5



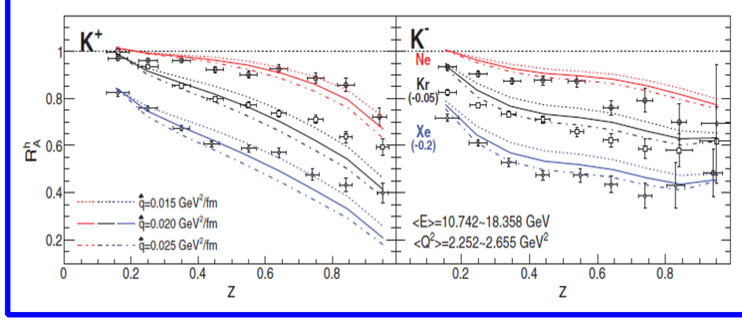
Only valence quarks **(u, d)** are struck as initial jet.



Large enhancement

Comes only from:
The enhancement of (u, d) quarks

The evidence in HERMES



HERMES data at x_B~0.1 shows already a relative rise of K^- spectra compare to K^+ at large z.

Summary

- We discover that production of K^- in e+A at large x_B is very sensitive to the medium-induced flavor conversion. Its spectra could be enhanced comparing to e+p.
- This flavor conversion can provide another independent probe of the properties of nuclear medium at high energies

Reference

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3. N.-B. Chang, W.-T. Deng, X.-N. Wang, Phys.Rev. C89, 034911 (2014)
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