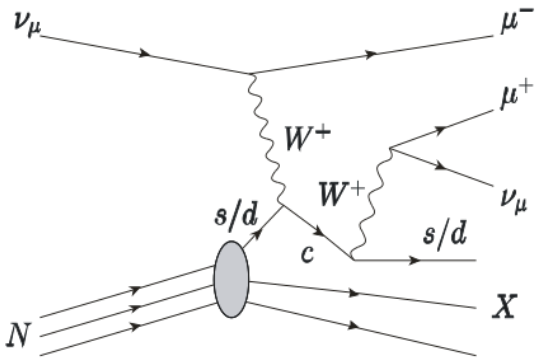
Charm Fragmentation Functions

Oleg Samoylov
DLNP JINR

Charm dimuons for neutrinos



- ν-induced charm dimuon production

$$\frac{d^2\sigma^{\nu N}_{\mu\mu}}{dxdy} = \int dz\; D_c(z) B_\mu \frac{d^2\sigma^{\nu N}_c}{dxdy}, \quad z = \frac{p^h_L}{p^{max}_L}$$

$$D_c = \Sigma f_h D_c^h,$$
$$B_\mu = \Sigma f_h B(h \to \mu^+ X),$$
$$h = D^0, D^+, D_s^+, \Lambda^+$$

- Charm production in (anti)neutrino DIS provides a clean and direct access to ***s(x)***

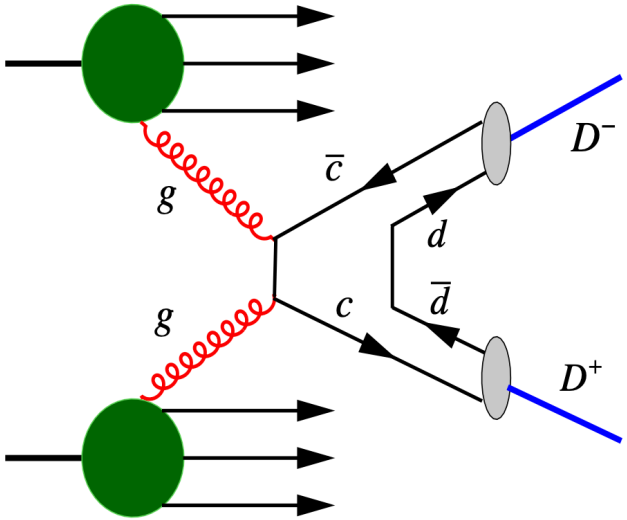
$$\frac{d^2\sigma^{\nu N}_c}{dxdy} = \frac{2G_F \xi s}{\pi}\left[|V_{cs}|^2 s(\xi,\mu) + |V_{cd}|^2 \frac{u(\xi,\mu)+d(\xi,\mu)}{2}\right]$$

$$x \to \xi = x\left(1 + m_c^2/Q^2\right), \quad Q \to \mu = \sqrt{Q^2 + m_c^2}$$

$|V_{cs}|^2$=0.95

$|V_{cs}|^2$=0.05

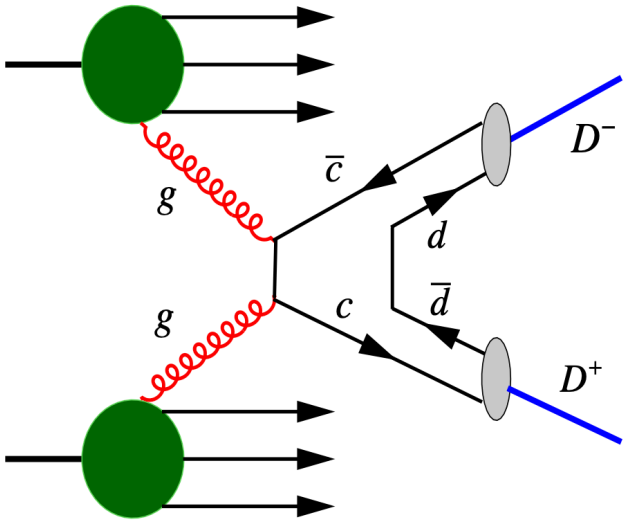
Open charm production



- pp → hX cross section is in the simple parton model

$$E^h \frac{d\sigma^h_{pp}}{d^3P^h} = \frac{1}{\pi} \sum_{ab\to cd} \int_{x_{a,min}}^{1} dx_a \int_{x_{b,min}}^{1} dx_b \frac{1}{z} \times$$
$$\times \left\{ q_a(x_a) q_b(x_b) \left[\frac{d\hat{\sigma}^{cd}_{ab}}{dt} D^h_c(z) + \frac{d\hat{\sigma}^{cd}_{ab}}{du} D^h_d(z) \right] \right.$$
$$\left. + q_a(x_b) q_b(x_a) \left[\frac{d\hat{\sigma}^{cd}_{ab}}{du} D^h_c(z) + \frac{d\hat{\sigma}^{cd}_{ab}}{dt} D^h_d(z) \right] \right\}$$

Open charm production



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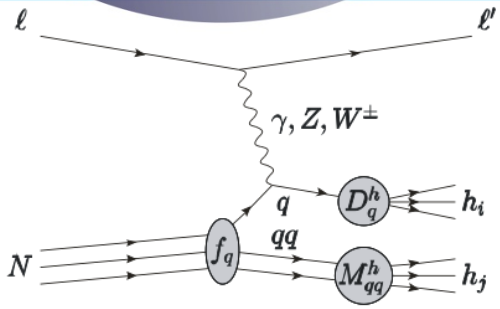
- Real situation is more complicated and it has to be take into account many things: QCD effects, polarization for both parton distributions and fragmentations.

Light quarks fragmentation for neutrinos

$$F = ED \quad \Rightarrow \quad D = E^{-1}F$$



NOMAD

$$F^{\pi} = (F_{ee}^{\pm}, F_{\ell p}^{+}, F_{\ell n}^{+}, F_{\ell p}^{-}, F_{\ell n}^{-}, F_{\nu p}^{+}, F_{\nu n}^{+}, F_{\nu p}^{-}, F_{\nu n}^{-}, F_{\nu p}^{+}, F_{\nu n}^{+}, F_{\nu p}^{-}, F_{\nu n}^{-})$$

$$D^{\pi} = (D_d^{+}, D_u^{+}, D_s^{+}, D_c^{+}, M_{p,d}^{+}, M_{p,d}^{-}, M_{p,u}^{+}, M_{p,u}^{-}, M_{p,d}^{+}, M_{p,d}^{-}, M_{p,u}^{+}, M_{p,u}^{-}, M_{p,s}^{-})$$

$$F, E, D\ (z, p^T\ ;\ \{\ s\ |\ x, Q^2\ \})$$

Durham HepData ~~http://hepdata.cedar.ac.uk/~~

https://www.hepdata.net/ (more than 100 experimental DATA)

The toy model was proposed in 2010

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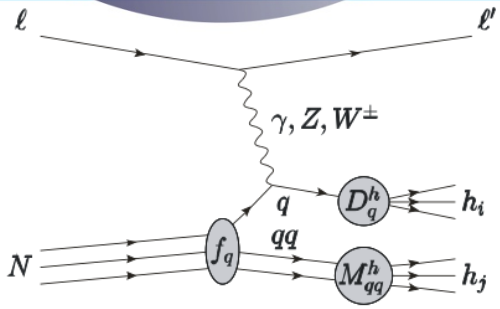

NOMAD

$$F^{\pi} = (F_{ee}^{\pm}, F_{\ell p}^{+}, F_{\ell n}^{+}, F_{\ell p}^{-}, F_{\ell n}^{-}, F_{vp}^{+}, F_{vn}^{+}, F_{vp}^{-}, F_{vn}^{-}, F_{vp}^{+}, F_{vn}^{+}, F_{vp}^{-}, F_{vn}^{-})$$

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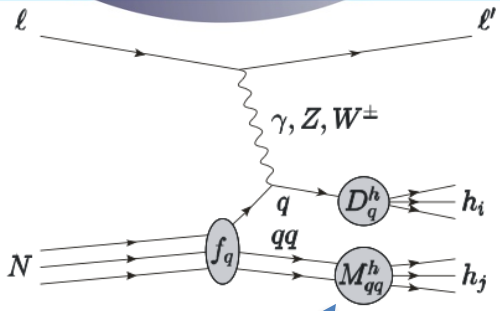

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F, E, D Λ is produced from di-quark also (xF<0)

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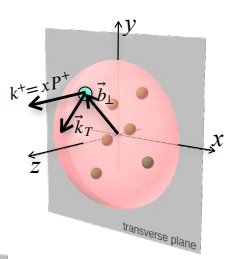
Nucleon structures functions



5D

Wigner distribution

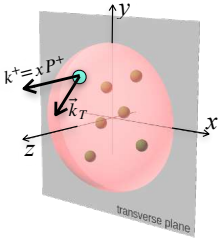
$\rho(x, \vec{k}_T, \vec{b}_\perp)$

$\leftarrow FT \rightarrow$

$\xi = 0$

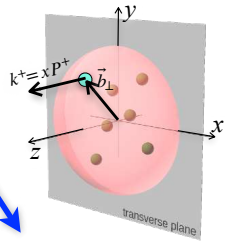
Generalized Transverse Momentum Distributions:

$GTMD(x, \xi, \vec{k}_T, \vec{\Delta}_\perp)$



$\int d^2 b_\perp$

$\int d^2 k_T$



Transverse Momentum Distributions: $TMD(x, \vec{k}_T)$

3D

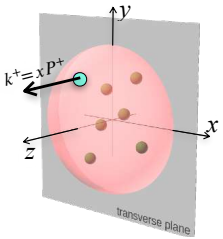
Generalized Parton Distributions:

$GPD(x, \vec{b}_\perp) \leftarrow FT \rightarrow GPD(x, \vec{\Delta}_\perp) \leftarrow \xi = 0 \; GPD(x, \xi, \vec{\Delta}_\perp)$

$\int d^2 k_T$

$\int d^2 b_\perp$

$\int dx$



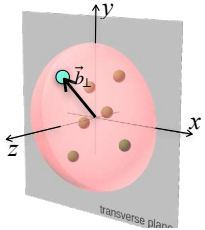
Parton distributions

$PDF(x)$

1D

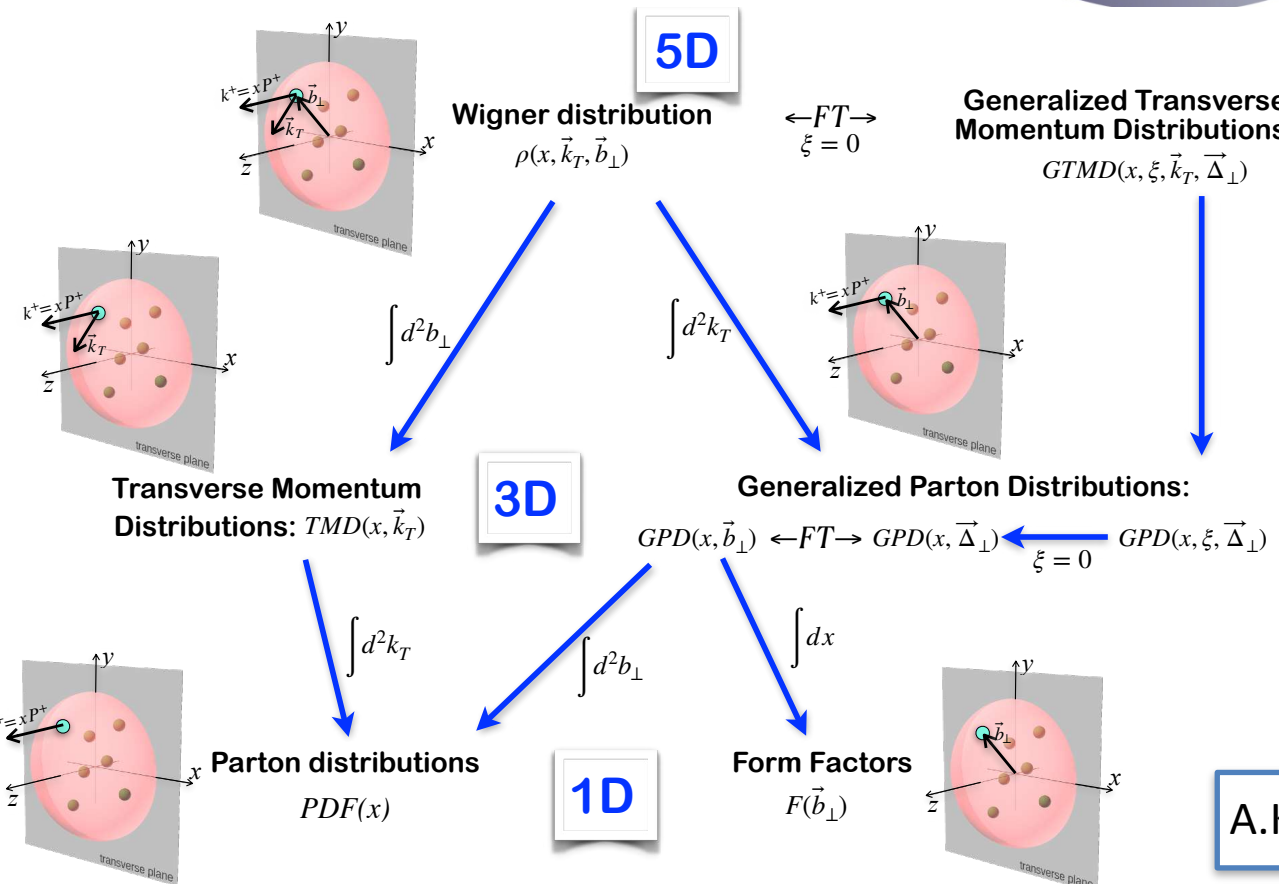
Form Factors

$F(\vec{b}_\perp)$



A.Korzenev

Nucleon structures functions



- First stage of the SPD is for light hadrons productions (asymmetries)
- And other physics also

A.Korzenev

Digging into SPD soft

- Plan to install and look into SPDroot
- Pythia 8 (inside the SPDroot) includes spin-independent, but not spin-dependent FFs
- Found spin-dependent patch for Pythia: StringSpinner.
- This made base on COMPASS data. Not sure if it would work in SPD case.

- My activities commonly are analyses of DATA/MC
- Still open for physics task (or another one..)
- Any suggestion to study…

Summary

- J/ψ and prompt photon productions are not sensitive to Fragmentation Functions
- Open charm (D-mesons) are strongly depended on FFs
- More contributions of FFs are in light mesons productions
- Pythia 8 (in SPD soft) includes spin-independent, but not spin-dependent FFs
- There are some extensions to add spin-dependent FFs into Pythia (StringSpinner, others?)
- Λ production depends also on so-called di-quark (target remnant) fragmentation (Fracture Functions)

- Note: The summary represents my own opinion, formed after approximately one month of studying the topic. Open to discuss and investigate physics.
- Thank you for your attention! This is last talk in the meeting