PDAs & PDFs

- Relationship between leading-twist PDAs and valence-quark PDFs, expressed via a meson's light-front wave function (LFWF):

$$\varphi(x) \sim \int d^2k_\perp \psi(x, k_\perp^2)\,,$$

$$q(x) \sim \int d^2k_\perp |\psi(x, k_\perp^2)|^2$$

- Given that factorization of LFWF is a good approximation for integrated quantities, then at the hadronic scale, ζ_H:

$$q_{\pi,K}(x;\zeta_H) \propto \varphi^q_{\pi,K}(x;\zeta_H)^2$$

  Proportionality constant is fixed by baryon number conservation

- Owing to parton splitting effects, this identity is not valid on $\zeta > \zeta_H$.

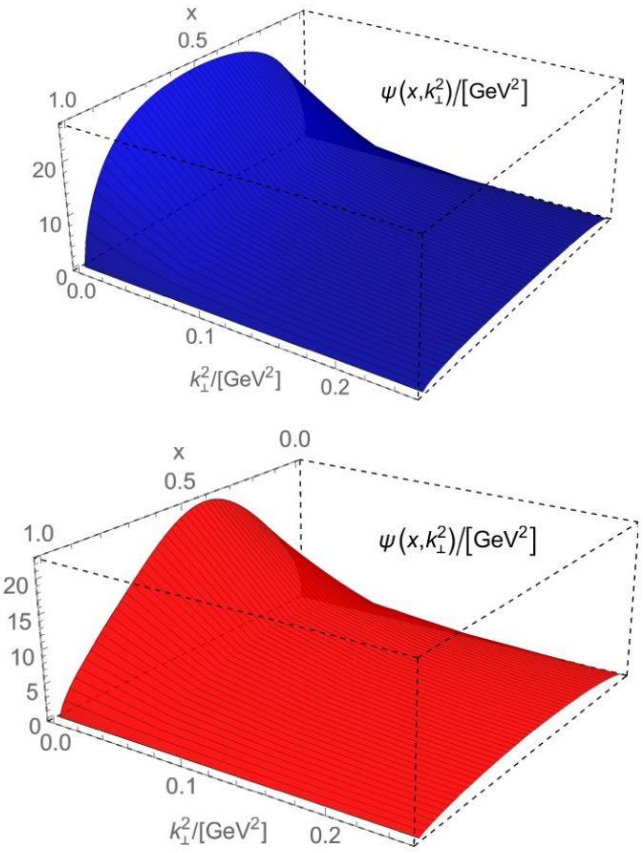
  (Think about DGLAP and ERBL regions for a GPD.)

- Nevertheless, evolution equations are known; so the connection is not lost, it just metamorphoses.

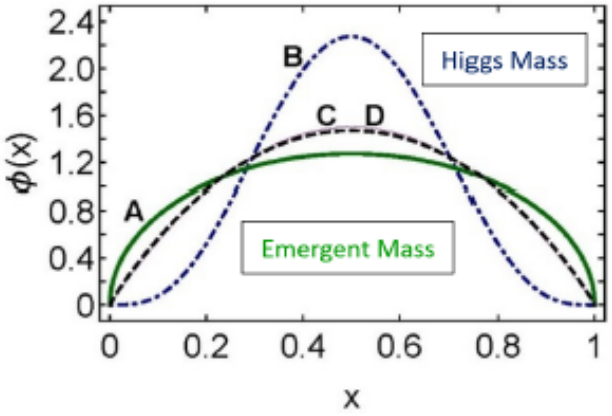
Light Front Wave Function

- In many respects, a hadron's LFWF is the key.
- LFWF correlates all observables
- EHM is expressed in every hadron LFWF
- The "trick" is to find a way to compute the LFWF

- Experiments sensitive to differences in LFWFs are sensitive to EHM
- Excellent examples are π & K PDAs and PDFs
  - Two sides of the same coin
  - Accessible via different processes
  - Independent measurements of the same thing
  - Great check on consistency



Diffractive pi/k scattering : (mass crisis)
COMPASS++/AMBER (pi/kaon DA)



Where *x* is a fraction of hadron's longitudinal momentum carried by the quark in the imf.

On the other hand Twist-two PDA is sensitive to the origin of mass of the incoming meson

A solid (green) emergent mass generation is dominant (pion);
B dot-dashed (blue) curve: Higgs mechanism is the primary source of mass generation (C-meson);
C solid (thin, purple) curve (asymptotic prole, 6x(1 - x);
and
D dashed (black) curve (heavy-pion", i.e. a pion-like pseudo-scalar meson in which the valence-quark current masses take values corresponding to a strange quark) the boundary, where emergent and Higgs-driven mass generation are equally important

Diffractive pi/k scattering : (mass crisis)
COMPASS++/AMBER (pi/kaon DA)

The only experiment with two jets in the final state which has been done so far is Fermilab experiment E791 (E791 Collaboration, E.M. Aitala et al., EPJ direct C4, 1 (1999)), recorded 2×10^{10} events from interactions of a 500 GeV/c π^- beam with carbon (C) and platinum (Pt) targets. The trigger included a loose requirement on transverse energy deposited in the calorimeters.

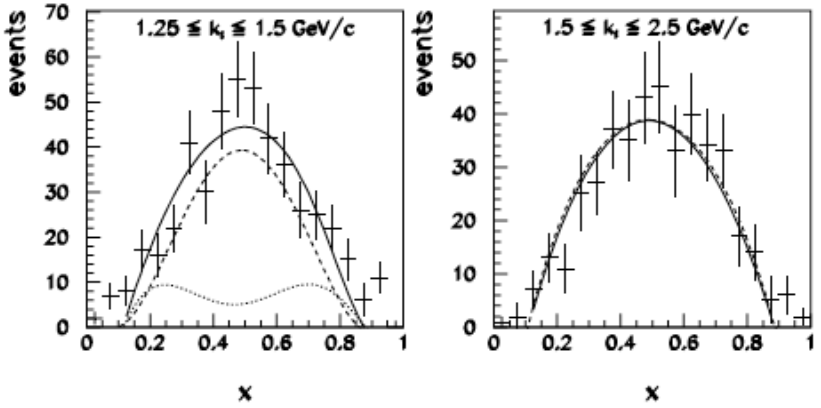


FIG. 3. The x distribution of diffractive di-jets from the platinum target for $1.25 \leq k_t \leq 1.5$ GeV/c (left) and for $1.5 \leq k_t \leq 2.5$ GeV/c (right). The solid line is a fit to a combination of the asymptotic and CZ wave functions. The dashed line shows the contribution from the asymptotic function and the dotted line that of the CZ function.

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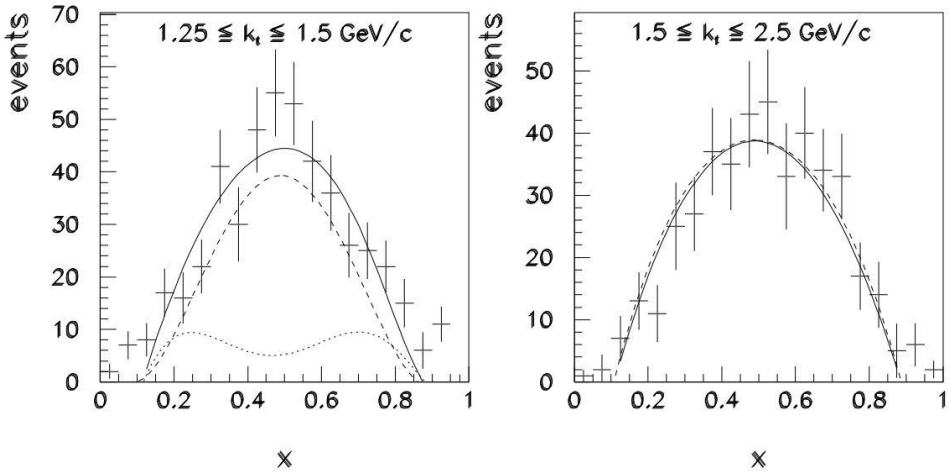
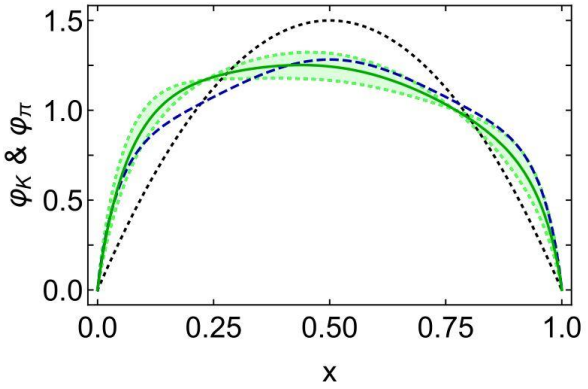
Two-jet events were identified analysing by a number of selection critereas, for example all charged particles carried out 90% of beam particle momentum, cut on k_T, angular distributions analysis etc.

Controversy over PDAs

Left: Nonpertubative (broadening) important
Right: Asymptotic profile sufficient

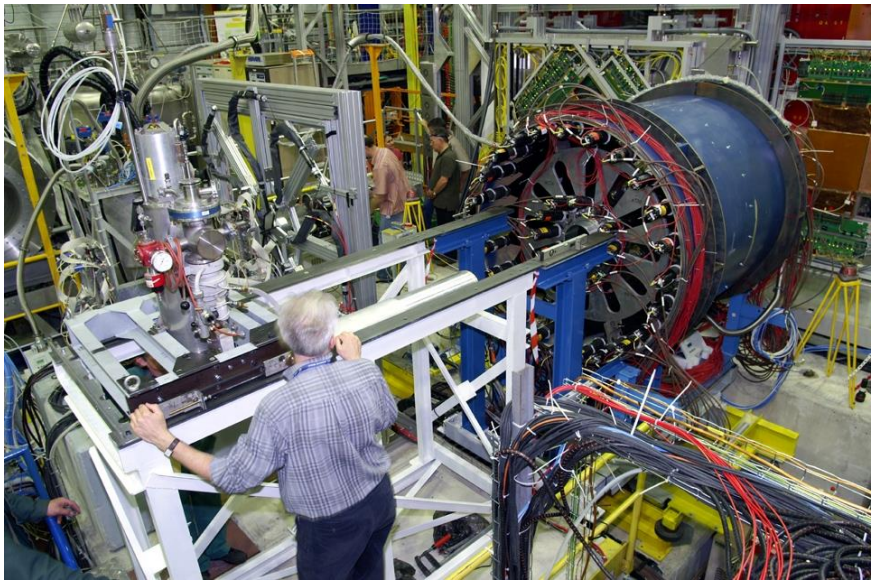


- E791 Collaboration, E. Aitala *et al.*, Phys. Rev. Lett. 86, 4768 (2001).
  - Claim: $\varphi_\pi(x)$ is well represented by the asymptotic profile for $\zeta^2 > 10$ GeV^2
- Modern continuum predictions and analyses of lQCD
  - PDAs are broadened at ζ^2=4 GeV^2
  - Evolution is logarithmic ⇒ if true at ζ^2=4 GeV^2, then true at ζ^2=10 GeV^2
- Simple theory shows that E791 conclusion cannot be correct
  - The E791 images cannot represent the same pion property
  - Not credible to assert that $\varphi_\pi(x)$ is well represented by the asymptotic distribution for $\zeta^2 > 10$ GeV^2

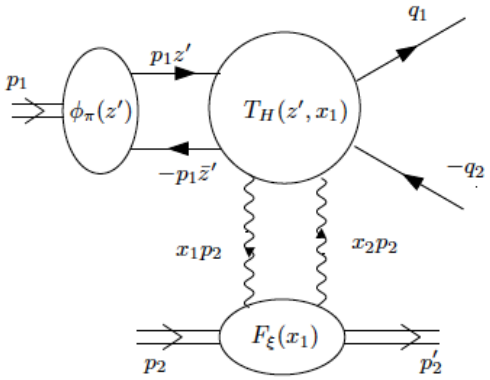


- Hard exclusive processes only sensitive to low-order PDA moments.
- Diffractive processes much better because sensitive to x-dependence (check this claim)

Diffractive pi/k scattering : COMPASS++/AMBER (pi/kaon PDA)



Probe: diffractive pion dissociation on a heavy target with very small *t'*,
This is a coherent process where two quarks break apart producing jets/hadron in the final state



This kind of process is might give an access to the Pion light-cone wave function (squared), related to the Parton Distribution Amplitude (PDA).

Diffractive pi/k scattering : (mass crisis)
COMPASS++/AMBER (pi/kaon DA)

In case of COMPASS++/AMBER as our incoming beam energy is much smaller (typically 190 GeV) the hadron multiplicities will be lower in the final state, on the other hand we can select for example 2 hadron in the final state events,
So we would like to know:

1. if such topology events can give an access to PDA
2. Observable – (similar to two-jets)
3. The range in which observables has to be measured

THANKS!