Duality in Meson Electroproduction
P00-004

Response to

Readers' Comments

➠ **What do we gain from kaon measurement?**

- We would be able to extract ratios of strange to valence quark distributions.

➠ **What is magnitude of expected radiative corrections?**

- At inclusive kinematics close to our worst case, we see radiative correction factors of about 50%. Therefore (since this is a coincidence experiment) our largest corrections will be less than that. No problem there.

➠ **What is the theoretical basis for (e, e') and $(e, e'\pi)$ duality?**

- (see slide) Under some conditions $[\frac{\sigma(e^-e^+ \to \text{hadrons})}{\sigma(e^-e^+ \to \mu^-\mu^+)}]$ we expect global duality from unitarity. Global duality in inclusive electron scattering can be explained in terms of moment analysis,[6] but we believe that a fundamental understanding of the underlying dynamics is lacking. In general, we want to investigate duality by exploring where it does and does not work (meson-tagged reactions? longitudinal vs. transverse? spin-dependence? where in Q^2?).

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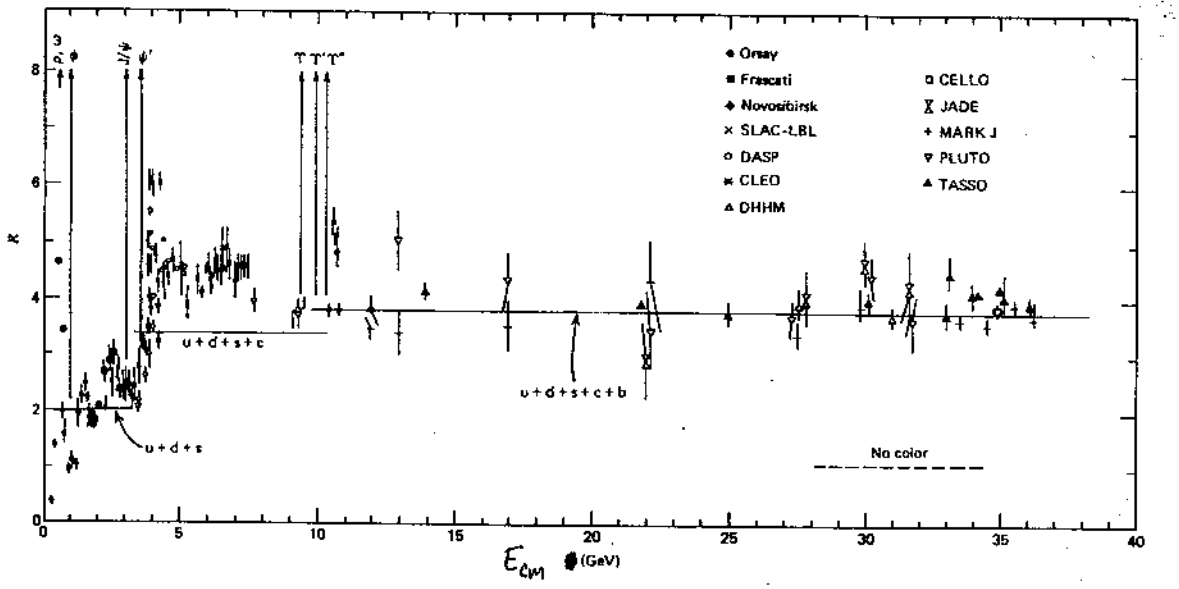
[6] A. De Rújula, H. Georgi, and H. D. Politzer, Annals Phys. **103**, 315 (1977).

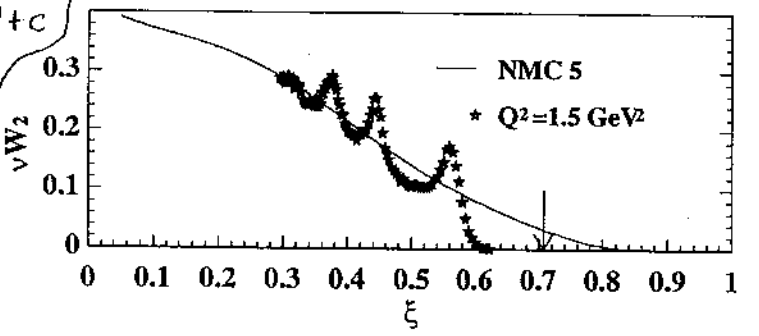
Our Understanding of Duality

Unitarity $\Rightarrow R = \dfrac{\sigma(e^-e^+ \to \overbrace{\text{hadrons}}^{q\bar{q}})}{\sigma(e^-e^+ \to \mu^-\mu^+)}$ averages to QPM prediction:



Inclusive duality in terms of moment analysis:

If $\int_0^1 x^n F_2(x,Q^2)dx \approx A_n(Q^2) + c$
then we expect duality
over large range in x



But we have no fundamental understanding of local duality at low Q^2, and certainly no understanding of special cases: semi-exclusive reactions, longitudinal vs. transverse, spin-dependence.

How locally does duality work? How low in Q^2 does it work?

What does it mean if $(e, e'\pi)$ duality does not hold?

- We would clearly want to understand why it would hold for the inclusive case and fail in the case of one particular channel. It could be that, to the extent that duality arises from a superposition of states, we will not see dual behavior when we have closed off some of those states. Hopefully, input from theory is forthcoming.

Does duality imply $\sigma \propto f(z, Q^2)\, g(x, Q^2)$?

- No, not necessarily. We suspect, though, that if factorization does hold at low energies, it may be related to duality.

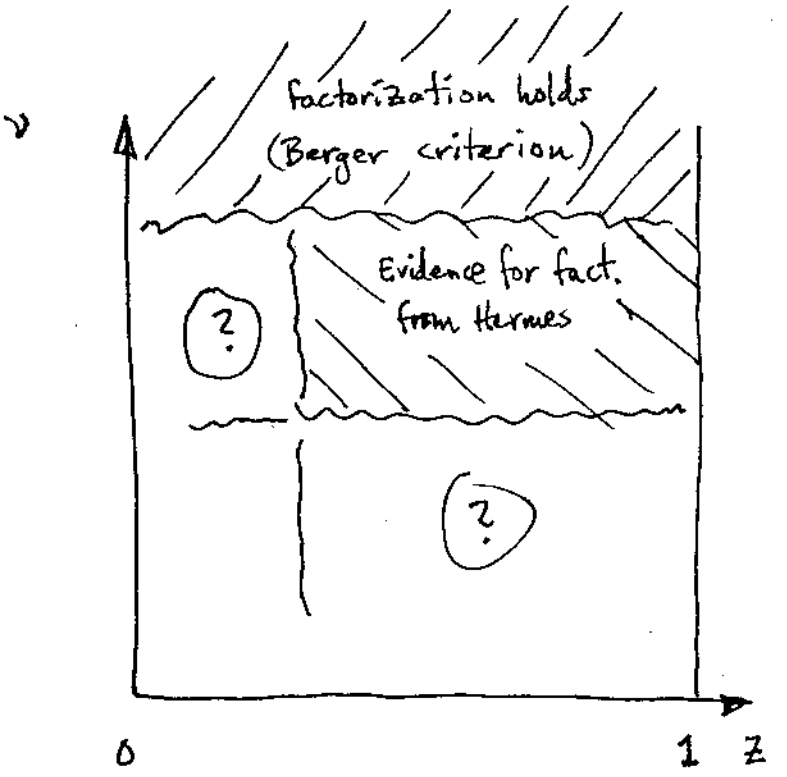
Where is factorization expected to hold?

- (see slide) Primarily at very high ν. We do have indications from experiment that it also holds at moderate ν and z. We will be testing it at moderate z and low ν.

Previous data?

- Yes, some '70s-era data from SLAC and Harvard exist. The experiments had low statistics and limited kinematical coverage, but the greater problem is that the published data do not include the corresponding inclusive data, which makes the extraction of fragmentation functions difficult and unreliable.

Factorization



- **Scale of lepton-hadron interaction set by lepton-quark interaction?**

  - By this we simply mean that in a kinematic regime where we naively picture the photon as interacting with a trio of (massive) constituent quarks, we might expect the scale of the interaction to be different from scattering in a regime where we believe we are scattering from a current quark.

- **Hermes data relevant?**

  - No, not strictly, since they are at larger energy loss than we are. But the fact that they see some factorization at energies lower than expected begs the question whether we will also.

- **Only 6 GeV?**

  - Ideally we would be able to make use of much greater beam energies and work downwards, finding out where and how factorization failed. Nevertheless, if we do find that factorization works at low energies, it offers us the possibility of doing physics at 6 GeV (flavor decomposition) that we otherwise could not.

- **Figure 6 of proposal – arbitrary normalization?**

  - No, the fragmentation functions are absolutely normalized.

- **Figure 6 of proposal – difference between $D_f^{\pi^+}$ and $D_f^{\pi^-}$?**

  - Favored vs. unfavored fragmentation functions: $u \to \pi^+ X$ is more likely than $u \to \pi^- X$.

Figure 6 of proposal – do data really agree with curve?

- Roughly, yes. We point out that at the lowest-z datum, the outgoing pion momenta were getting down in the region that you expect to correct for πN final state interactions. At the highest-z datum, W' was in the resonance region, so we could be seeing some effect from that. At the two innermost points, our points agree with the fragmentation functions to roughly 20%.

Collaboration sufficient?

- The collaboration is lean at the moment. However, many of us have extensive contacts with other Hall C experimenters, and we anticipate no problem enlarging the collaboration (to ≈ 50 people over the next six months or so).

TAC Comments

➠ **HMS at 10.5 deg?**

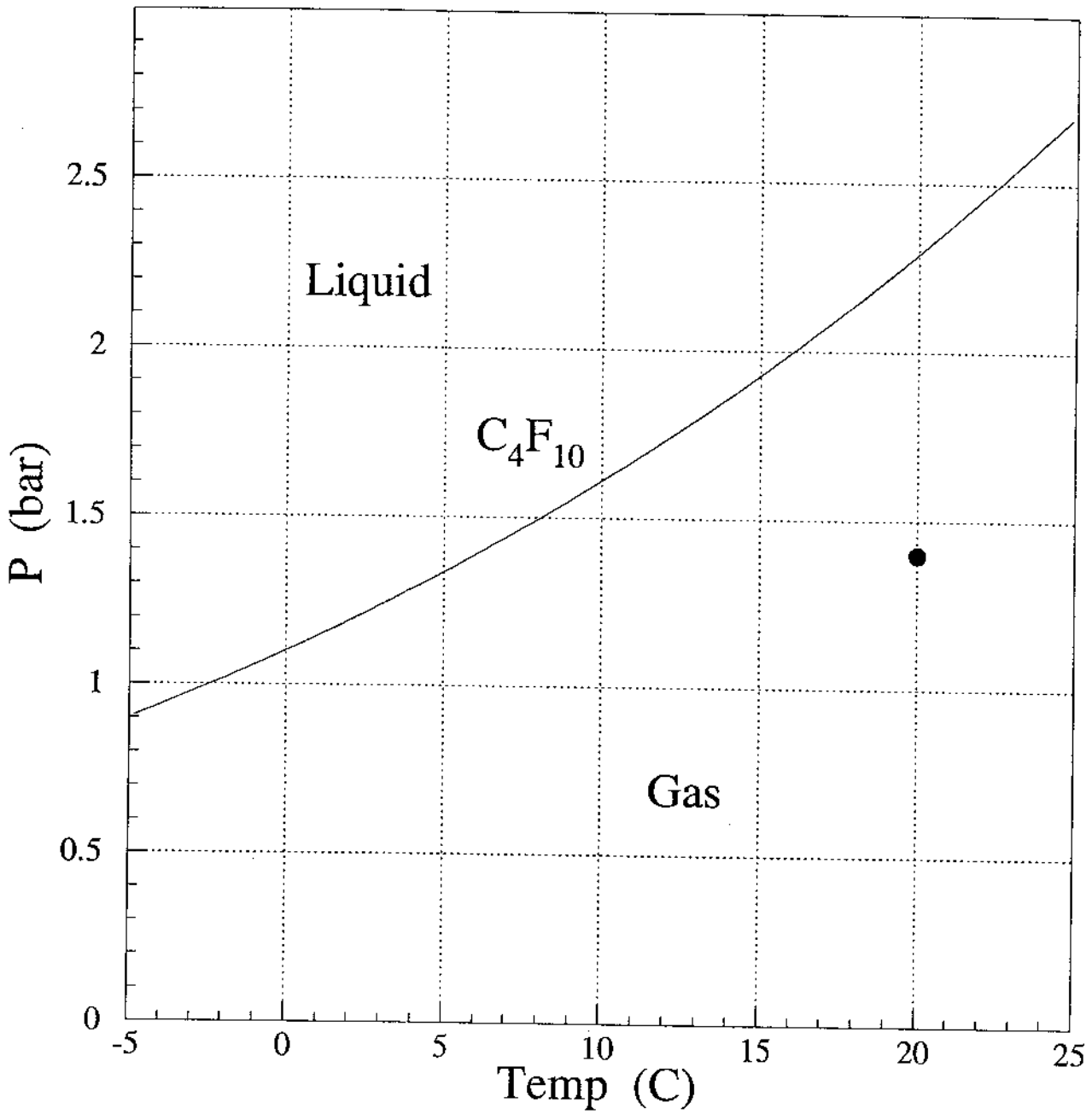
- Paul Brindza: ≈ 3 day setup/certification (return to Nov. 97 config.) before the experiment, and another 3 days at the end if we want to change back.

➠ **π/k separation?**

- (see slide) C_4F_{10} is gaseous at room temp, 1.4 atm.

➠ **k/p separation?**

- Just behind DC2 (before S1X) we have 9 inches, plus another 2 inches if we move the chambers forward on their slides. If we can design an aerogel Čerenkov to fit there, we'd like to do it.


Liquid
C_4F_{10}
Gas
P (bar)
Temp (C)
2.5
2
1.5
1
0.5
0
-5
0
5
10
15
20
25