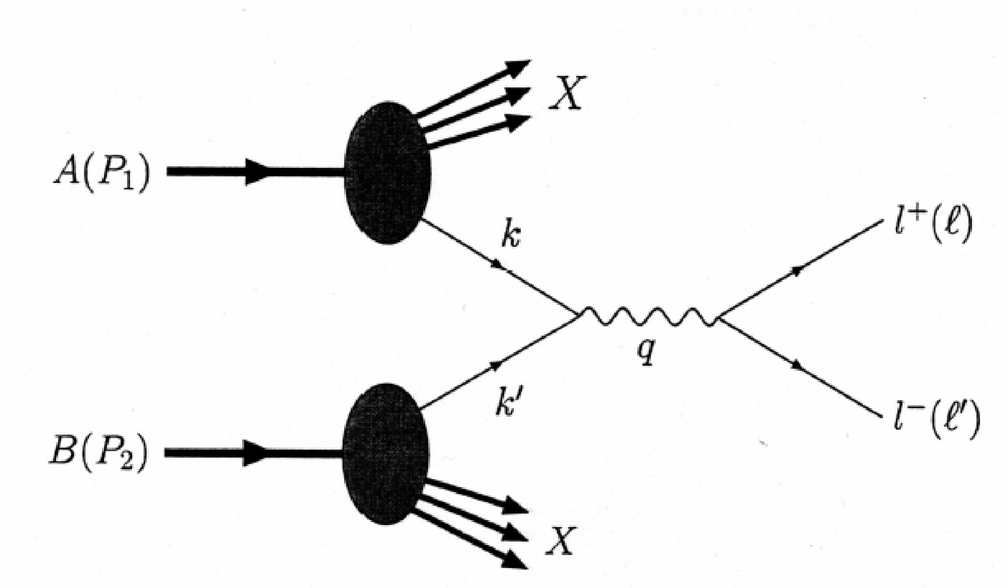
Drell-Yan Di-Lepton Production $\bar{p}p \rightarrow \mu^+\mu^- X$

Why Drell-Yan?

Asymmetries depend on PD only
(SIDIS→convolution with QFF)

Why ?

Each valence quark can contribuite to the diagram



Kinematics

$$x_1 = \frac{M^2}{2P_1 \bullet q} \qquad x_2 = \frac{M^2}{2P_2 \bullet q}$$

$$x_F = x_1 - x_2 \qquad \tau = x_1 x_2 = \frac{M^2}{s}$$

Drell-Yan Di-Lepton Production $\bar{p}p \to \mu^+\mu^- X$

$$\frac{d^2\sigma}{dM^2 dx_F} = \frac{4\alpha^2\pi}{9M^2 s}\frac{1}{x_1 + x_2}\sum_a e_a^2\left[f^a(x_1)f^{\bar{a}}(x_2) + f^{\bar{a}}(x_1)f^a(x_2)\right]$$

Scaling:

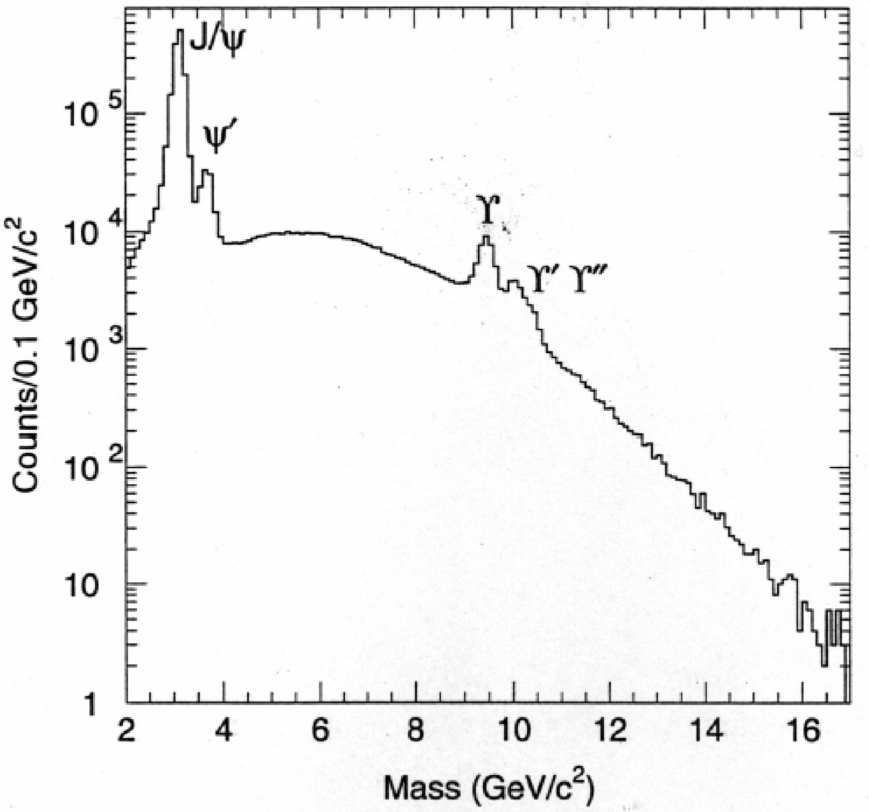
$$\frac{d^2\sigma}{d\sqrt{\tau}dx_F} \propto \frac{1}{s}$$

Full x_1,x_2 range $\Rightarrow \tau \in [0,1]$

$\vec{p}_{BEAM} \geq 40$ Gev/c needed

$$\sigma_{\bar{p}p\to\mu^+\mu^- X} \approx 0.3\,\text{nb}^{[1]}$$

[1] Anassontzis et al., Phys. Rew. D38 (1988) 1377

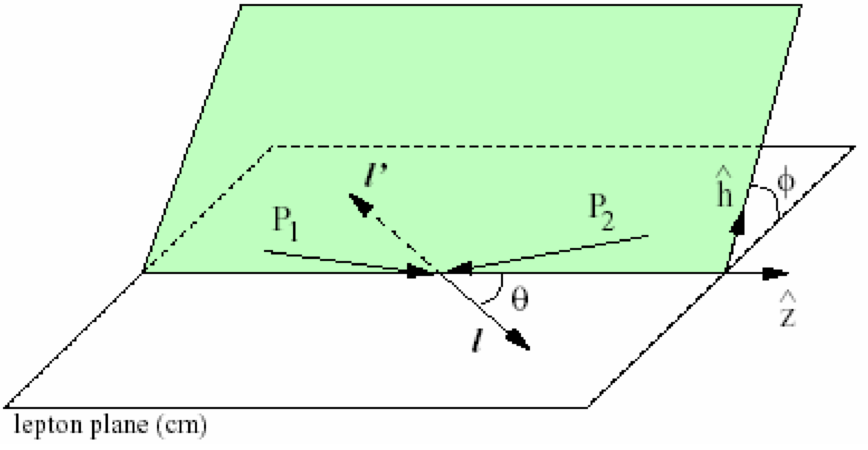


Drell-Yan Asymmetries
Polarised beam and target

$$A_{LL} = \frac{\sum_a e_a^2 g_1^a(x_1) g_1^{\bar{a}}(x_2)}{\sum_a e_a^2 f_1^a(x_1) f_1^{\bar{a}}(x_2)}$$

$$A_{TT} = \frac{\sin^2\theta \cos 2\varphi}{1+\cos^2\theta} \frac{\sum_a e_a^2 h_1^a(x_1) h_1^{\bar{a}}(x_2)}{\sum_a e_a^2 f_1^a(x_1) f_1^{\bar{a}}(x_2)}$$

$$A_{LT} = \frac{2\sin 2\theta \cos\varphi}{1+\cos^2\theta} \frac{M}{Q} \frac{\sum_a e_a^2 \left(g_1^a(x_1) x_2 g_T^{\bar{a}}(x_2) - x_1 h_L^a(x_1) h_1^{\bar{a}}(x_2) \right)}{\sum_a e_a^2 f_1^a(x_1) f_1^{\bar{a}}(x_2)}$$



To be corrected for: $\frac{1}{P_B \, f \, P_T}$

NH_3 polarised target: $f = \frac{3}{17} = 0.176$

$P_T \approx 0.85$

Drell-Yan Asymmetries
Unpolarised beam and target

Di-Lepton Rest Frame

$$\frac{1}{\sigma}\frac{d\sigma}{d\Omega} = \frac{3}{4\pi}\frac{1}{\lambda+3}\left(1+\lambda\cos^2\theta+\mu\sin^2\theta\cos\varphi+\frac{\nu}{2}\sin^2\theta\cos2\varphi\right)$$

NLO pQCD: $\lambda \sim 1$, $\mu \sim 0$, $\nu \sim 0$
Experimental data [1]: $\nu \sim 30\ \%$

[1] J.S.Conway et al., Phys. Rev. D39(1989)92.

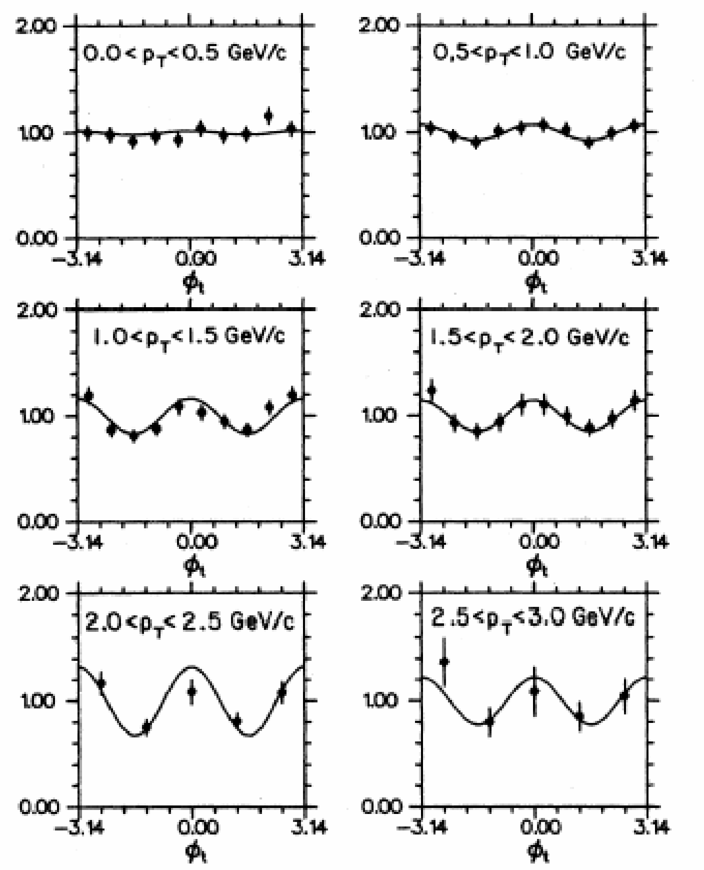
ν involves transverse spin effects at leading twist [2]:
cos2φ contribution to angular distribution provide:

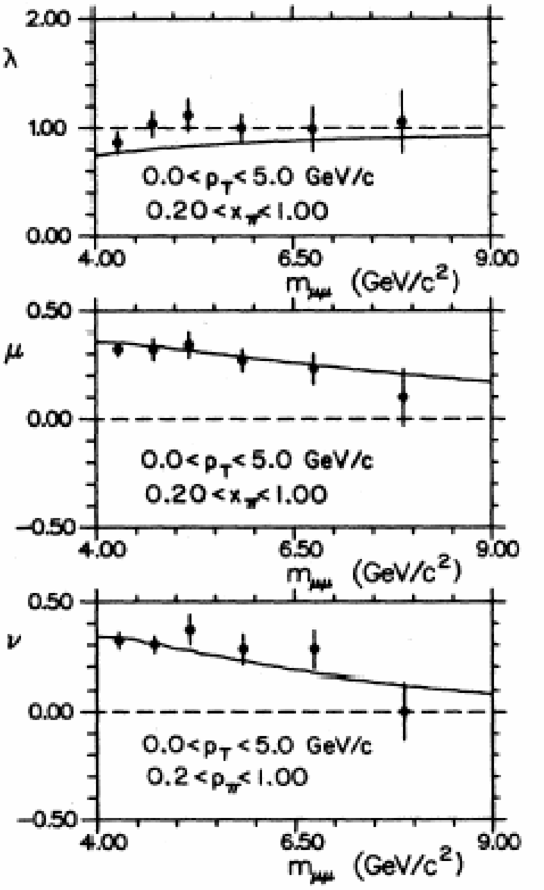
$$h_1^{\perp}(x_2, \kappa_\perp^2)\overline{h}_1^{\perp}(x_1, \kappa_\perp'^2)$$

[2] D. Boer et al., Phys. Rev. D60(1999)014012.

Angular distribution in CM frame

$\pi^- + N \rightarrow \mu^+ + \mu^- + X$ @ 252 GeV/c





$-0.6 < \cos\vartheta < 0.6$

$4 < M < 8.5$ GeV/c^2

- cut on $\mathbf{P}_T$ selects asymmetry
- 30% asymmetry observed

Conway et al, Phys. Rew. D39 (1989) 92

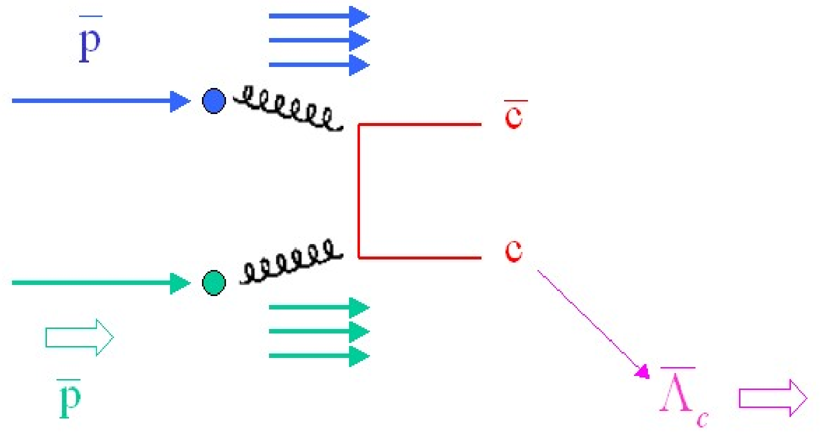
Drell-Yan Asymmetries
Unpolarised beam, polarised target

$$A_T = |S_{1T}| \frac{2\sin 2\theta \sin(\varphi - \varphi_{S_1})}{1+\cos^2\theta} \frac{M}{Q} \frac{\sum_a e_a^2 \left[x_1 f_1^{a\perp}(x_1) f_1^{\bar{a}}(x_2) + x_2 h_1^a(x_1) h_1^{\bar{a}\perp}(x_2)\right]}{\sum_a e_a^2 f_1^a(x_1) f_1^{\bar{a}}(x_2)}$$

Even unpolarised beam is
a powerful tool to investigate
κ_T dependence of QDF

D. Boer et al., Phys. Rev. D60(1999)014012.

OPEN CHARM ΔG



$\vec{p}$, $\vec{\Lambda}_c$ *longitudinally polarized*

Weak decay

$\Lambda_c^+ \rightarrow \Lambda\, \pi^+$ B.R. = 0.9 %

$\alpha = -.98$

$\sigma_{\bar{p}p\rightarrow\Lambda_c}$ at 40 Gev ?

Assume 1 μb [1] $\Rightarrow$ # ev. $5 \bullet 10^{-3}$ /s $L = 2.25 \bullet 10^{31}$ cm^{-2} $\bullet$ s^{-1}

⇓

36000 events / 100 days

[1] Smith and Vogt Z. Phys. C75 (1997)271