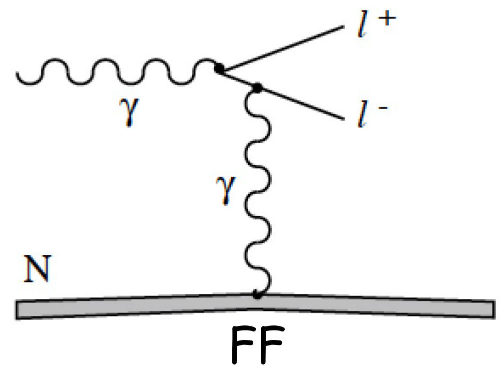
Lepton Pair Photoproduction with Polarized Photons



Define $W_{\text{unp}} = [x^2 + (1-x)^2]|\vec{J}_T|^2 + m^2|J_S|^2;$ $W_{\text{pol}} = -2x(1-x)|\vec{J}_T|^2.$

$$J_S = \frac{1}{\vec{p}_1^{\,2} + m^2} - \frac{1}{\vec{p}_2^{\,2} + m^2} \qquad \vec{J}_T = \frac{\vec{p}_1}{\vec{p}_1^{\,2} + m^2} + \frac{\vec{p}_2}{\vec{p}_2^{\,2} + m^2}$$

In Born approx:

$$\frac{d\sigma_B^c}{dx\, d\Omega_1\, d\Omega_2} = \frac{2\alpha^3 Z^2 \omega^4 x^2 (1-x)^2}{\pi^2 (\vec{q}^{\,2})^2} \times \left[W_{\text{unp}} + P_\gamma W_{\text{pol}} \cos(2\phi)\right]$$

$$\times \left| F_{nuclear}\left(\vec{q}^{\,2}\right) - F_{atomic}\left(\vec{q}^{\,2}\right) \right|^2$$

There are no experimental tests of the ϕ dependence of the fully exclusive reaction for either e^+e^- or $\mu^+\mu^-$

where ϕ is the angle between the photon polarization direction and $\vec{J}_T$

Consider the limit $\vec{p}_1, \vec{p}_2 >> m$

$$\left|\vec{J}_T\right|^2 >> m^2 \left|J_S\right|^2$$

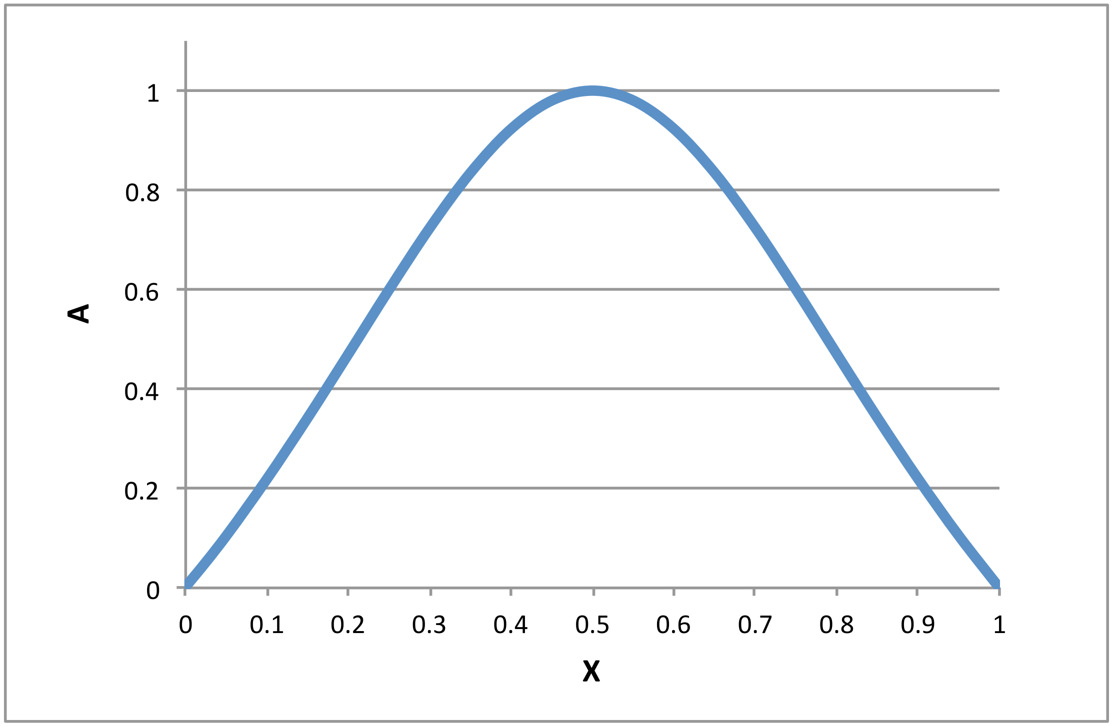
$$\frac{d\sigma_B^c}{dx\, d\Omega_1\, d\Omega_2} = \frac{2\alpha^3 Z^2 \omega^4 x^2 (1-x)^2}{\pi^2 (\vec{q}^2)^2} \times \left|\vec{J}_T\right|^2 \left[x^2 + (1-x)^2\right] \left[1 - \frac{2x(1-x)}{x^2 + (1-x)^2} P_\gamma \cos 2\phi\right]$$

$$\times \left|F_{nuclear}\left(\vec{q}^2\right) - F_{atomic}\left(\vec{q}^2\right)\right|^2$$

Define analyzing power

$$A = \frac{1}{P_\gamma}\left(\frac{\sigma_\perp - \sigma_\parallel}{\sigma_\perp + \sigma_\parallel}\right) = \frac{2x(1-x)}{x^2 + (1-x)^2}$$

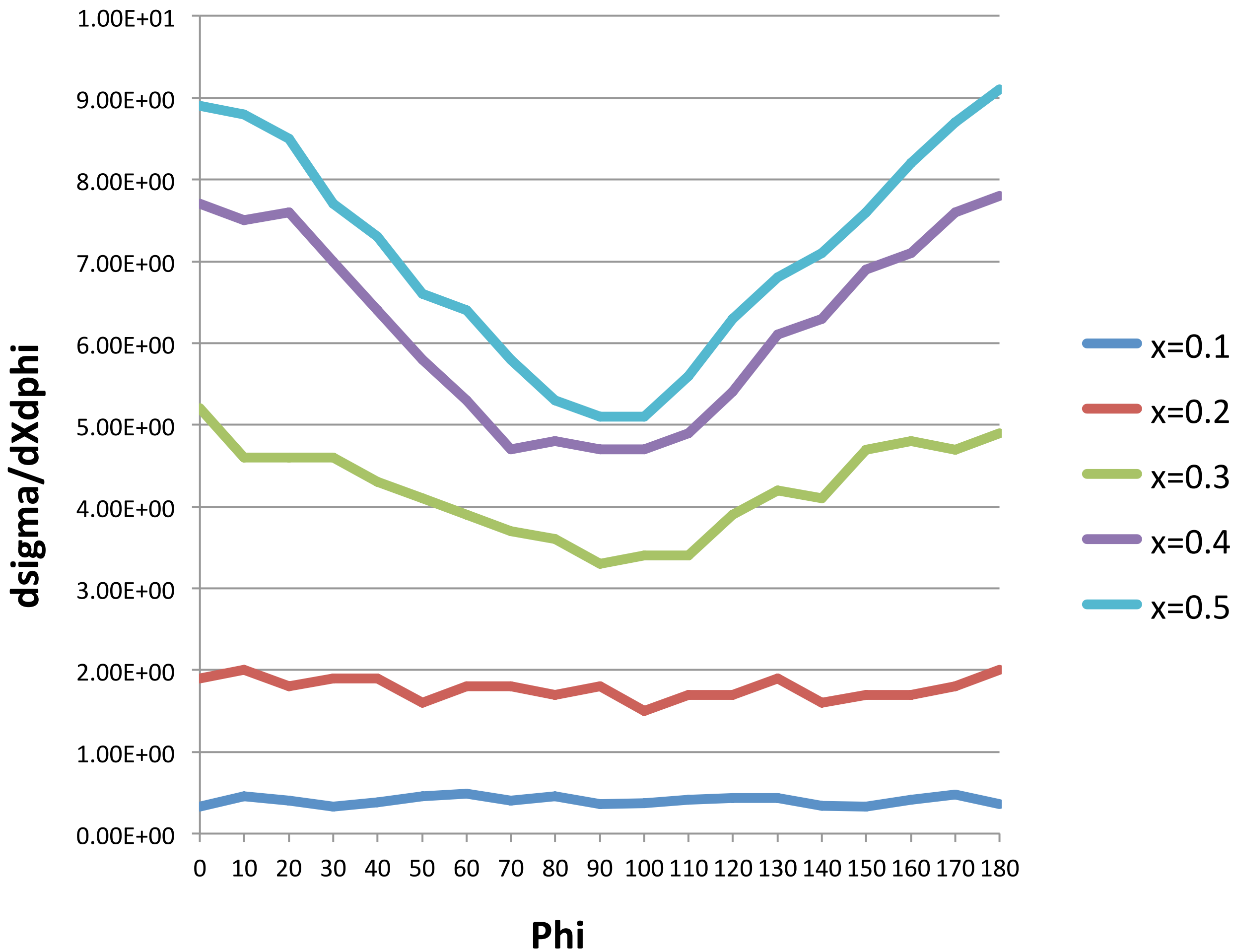
The analyzing power is
100% at x=0.5



What's usually observed experimentally is a single-arm inclusive cross section, where the $\mu^{+(-)}$ is detected, the $\mu^{-(+)}$ is undetected, and the polar angle of the $\mu^{+(-)}$ is integrated over:

$$\int \frac{d^5\sigma_B}{dx d\Omega_1 d\Omega_2} \sin\theta_1 d\theta_1 d\Omega_2 = \frac{d^2\sigma_B}{dx d\phi_1}$$

The azimuthal dependence of the inclusive reaction can give a measure of the beam polarization.



The analyzing power is about 30% at x=0.5