Polarised Compton Scattering and Annihilation in Flight

Pavel Starovoitov

NC PHEP, Minsk
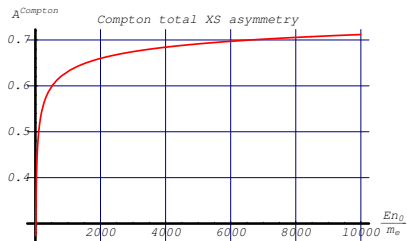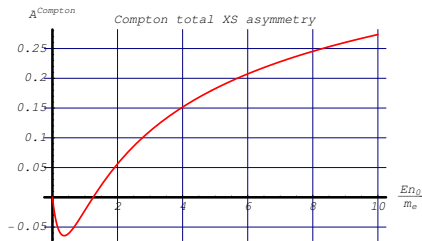
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Outline

Total Cross Section

$$\sigma_{pol}^{Compton} = \sigma_0^{Compton} \left[1 + z_c z_- A^{Compton} \right]$$

$\vec{S}_\gamma = (x_l,\ y_l,\ z_c) \quad \vec{S}_{ele} = (x_-,\ y_-,\ z_-)$

$$\sigma_{pol}^{Annih} = \sigma_0^{Annih} \left[1 + z_+ z_- A_L^{Annih} + (x_+ x_- + y_+ y_-) A_T^{Annih} \right]$$

$\vec{S}_{pos} = (x_+,\ y_+,\ z_+) \quad \vec{S}_{ele} = (x_-,\ y_-,\ z_-)$
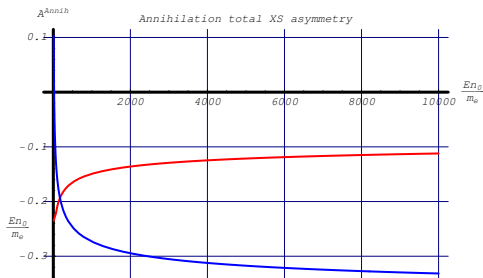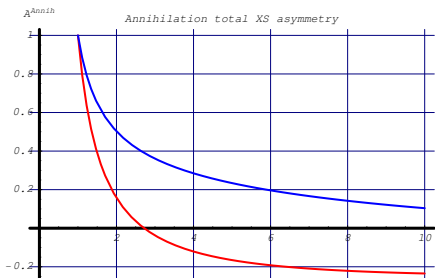
Total Cross Section Asymmerties (Compton)

$$\lim_{En_0 \to 0} A^{Compton} = 0$$

$$\lim_{En_0 \to \infty} A^{Compton} = 1$$

Total Cross Section Asymmerties (Annihilation)

longitudinal transverse

$$\lim_{En_0 \to m_e} A_T^{Annih} = 1$$

$$\lim_{En_0 \to \infty} A_T^{Annih} = -\frac{1}{2}$$

$$\lim_{En_0 \to m_e} A_L^{Annih} = 1$$

$$\lim_{En_0 \to \infty} A_L^{Annih} = 0$$

Differential Cross Section (Annihilation)
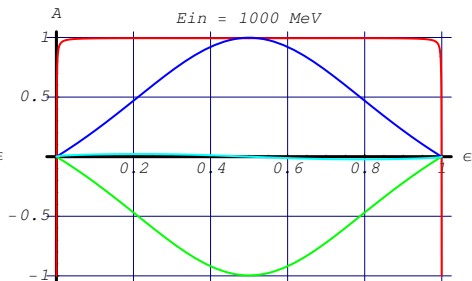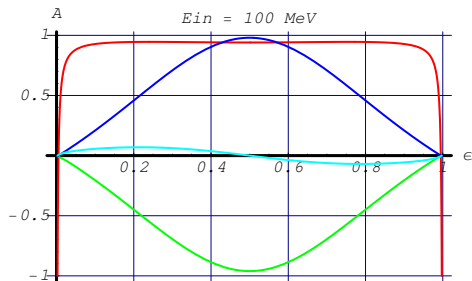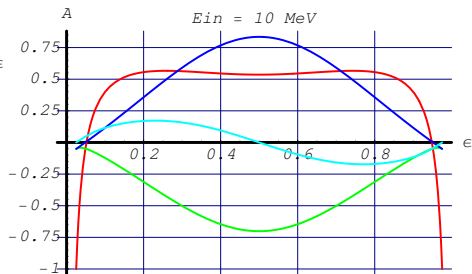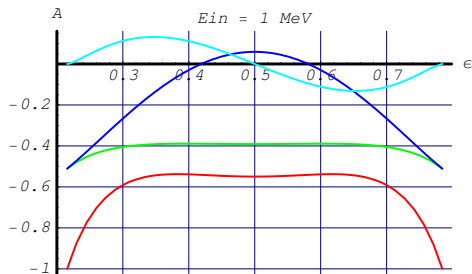
$$\frac{d\sigma^{Annih}(\xi_1^{in}, \xi_2^{in}, \xi_1^{out}, \xi_2^{out})}{d\Omega} = \frac{d\sigma_0^{Annih}}{d\Omega} \left[1 + \boldsymbol{\xi_1^{in}} \mathbf{A} \boldsymbol{\xi_2^{in}}{}^T \right] \times$$

$$\left[\left(C_3 \left(\boldsymbol{\xi_1^{in}}(1) + \boldsymbol{\xi_2^{in}}(1) \right) + C_2 \boldsymbol{\xi_2^{in}}(3) + C_1 \boldsymbol{\xi_1^{in}}(3) \right) \boldsymbol{\xi_1^{out}}(3) \right.$$

$$- \left(C_3 \left(\boldsymbol{\xi_1^{in}}(1) + \boldsymbol{\xi_2^{in}}(1) \right) + C_1 \boldsymbol{\xi_2^{in}}(3) + C_2 \boldsymbol{\xi_1^{in}}(3) \right) \boldsymbol{\xi_2^{out}}(3)$$

$$+ \left(\boldsymbol{\xi_1^{out}}(1) + \boldsymbol{\xi_2^{out}}(1) \right) L_0$$

$$+ \boldsymbol{\xi_1^{out}}(1) \left(\boldsymbol{\xi_1^{in}} \mathbf{L}_1^{\gamma_1} \boldsymbol{\xi_2^{in}}{}^T \right) + \boldsymbol{\xi_1^{out}}(2) \left(\boldsymbol{\xi_1^{in}} \mathbf{L}_2^{\gamma_1} \boldsymbol{\xi_2^{in}}{}^T \right)$$

$$+ \boldsymbol{\xi_2^{out}}(1) \left(\boldsymbol{\xi_1^{in}} \mathbf{L}_1^{\gamma_2} \boldsymbol{\xi_2^{in}}{}^T \right) + \boldsymbol{\xi_2^{out}}(2) \left(\boldsymbol{\xi_1^{in}} \mathbf{L}_2^{\gamma_2} \boldsymbol{\xi_2^{in}}{}^T \right)$$

$$\left. + \boldsymbol{\xi_1^{out}} \mathbf{Correlation}(\xi_1^{in}, \xi_2^{in}) \boldsymbol{\xi_2^{out}}{}^T \right]$$

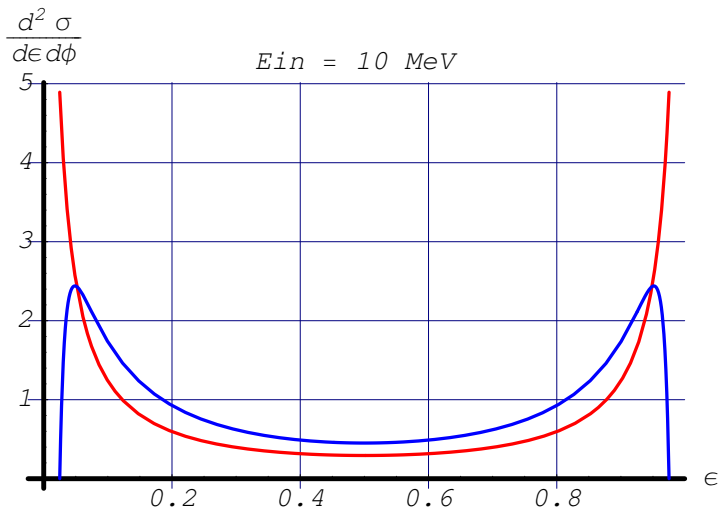# Annihilation Differential Cross Section Asymmetries

$$\mathbf{A} = \begin{pmatrix} A_{xx} & 0 & A_{xz} \\ 0 & A_{yy} & 0 \\ A_{xz} & 0 & A_{zz} \end{pmatrix}$$

Annihilation Differential Cross Section Asymmetries
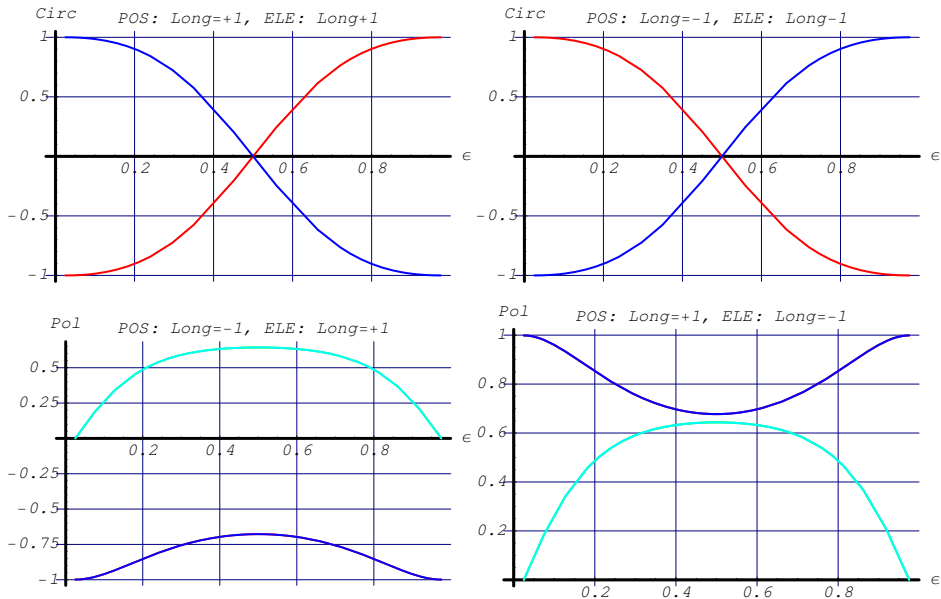
Annihilation Differential Cross Section

100% Longitudinal - 100%Longitudinal   Unpolarised
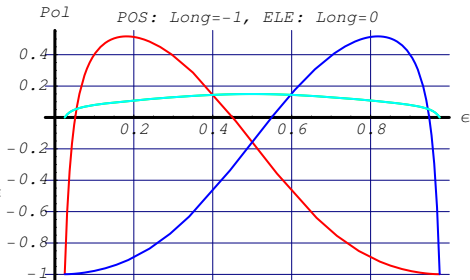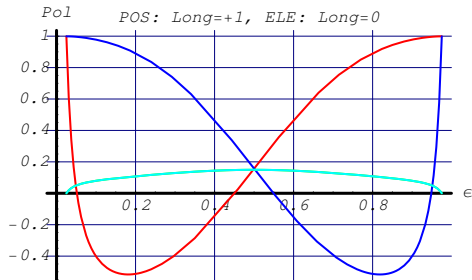
Polarisation Transfer in Annihilation

photon #1   photon #2   linear polarisation   Initial energy 10 MeV
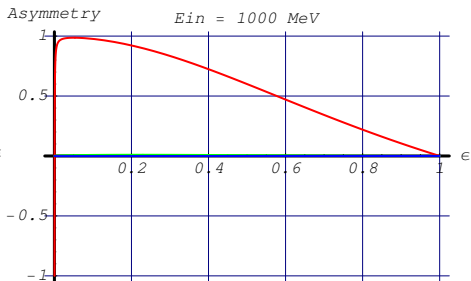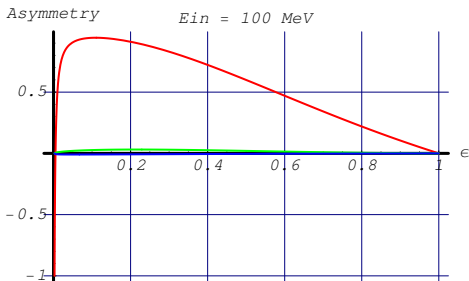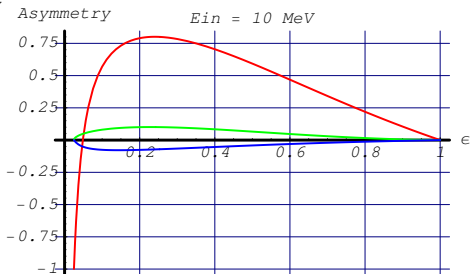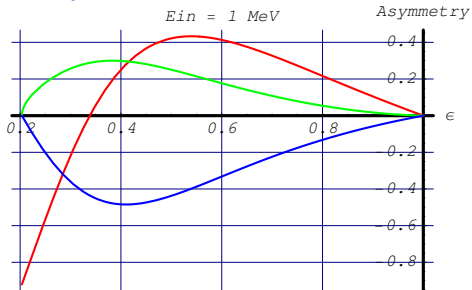
Polarisation Transfer in Annihilation

photon #1   photon #2   linear polarisation   Initial energy 10 MeV

Differential Cross Section (Compton)

$$\frac{d\sigma^{Compton}(\xi_1^{in}, \xi_2^{in}, \xi_1^{out}, \xi_2^{out})}{d\Omega} = \frac{d\sigma_0^{Compton}}{d\Omega} \left[1 + \boldsymbol{\xi_1^{in}}(1)A_0 + \boldsymbol{\xi_1^{in}} \mathbf{A} \boldsymbol{\xi_2^{in}}^T \right] \times$$

$$\left[\boldsymbol{\xi_1^{out}}(1) \left(L_0^\gamma + \boldsymbol{\xi_1^{in}}(1)L_1^\gamma + \boldsymbol{\xi_1^{in}}(3)L_2^\gamma \boldsymbol{\xi_2^{in}}(1) \right) \right.$$

$$\boldsymbol{\xi_1^{out}}(2) \left(\boldsymbol{\xi_1^{in}}(2)M_1^\gamma + \boldsymbol{\xi_1^{in}}(3)M_2^\gamma \boldsymbol{\xi_2^{in}}(2) \right)$$

$$\boldsymbol{\xi_1^{out}}(3) \left(\boldsymbol{\xi_1^{in}}(3)N_1^\gamma + \boldsymbol{\xi_2^{in}}(1)N_2^\gamma + \boldsymbol{\xi_2^{in}}(3)N_3^\gamma + \boldsymbol{\xi_1^{in}} \mathbf{N_4^\gamma} \boldsymbol{\xi_2^{in}}^T \right)$$

$$\boldsymbol{\xi_2^{out}}(1) \left(\boldsymbol{\xi_1^{in}}(3)L_1^e + \boldsymbol{\xi_2^{in}}(1)L_2^e + \boldsymbol{\xi_2^{in}}(3)L_3^e + \boldsymbol{\xi_1^{in}} \mathbf{L_4^e} \boldsymbol{\xi_2^{in}}^T \right)$$

$$\boldsymbol{\xi_2^{out}}(2) \left(\boldsymbol{\xi_2^{in}}(2)M_1^e + \boldsymbol{\xi_1^{in}} \mathbf{M_2^e} \boldsymbol{\xi_2^{in}}^T \right)$$

$$\boldsymbol{\xi_2^{out}}(3) \left(\boldsymbol{\xi_1^{in}}(3)N_1^e + \boldsymbol{\xi_2^{in}}(1)N_2^e + \boldsymbol{\xi_2^{in}}(3)N_3^e + \boldsymbol{\xi_1^{in}} \mathbf{N_4^e} \boldsymbol{\xi_2^{in}}^T \right)$$

$$\left. + \boldsymbol{\xi_1^{out}} \mathbf{Correlation}(\xi_1^{in}, \xi_2^{in}) \boldsymbol{\xi_2^{out}}^T \right]$$

Compton Differential Cross Section Asymmetries

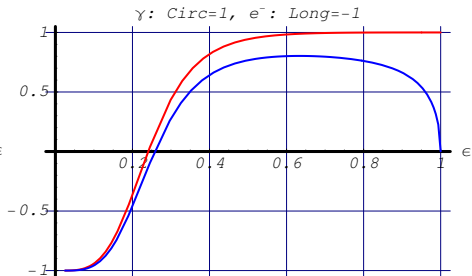# Compton Differential Cross Section

Polarisation Transfer in Compton Scattering
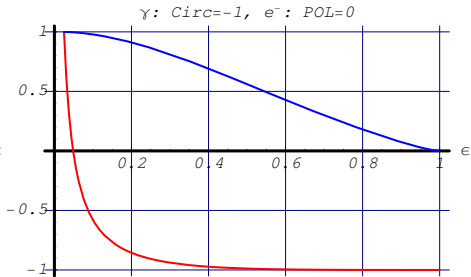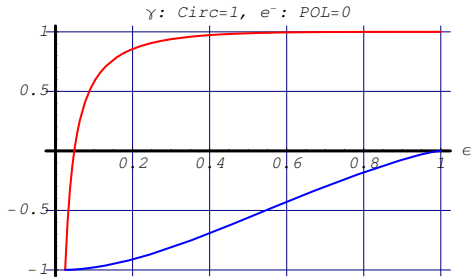

photon   electron   Initial energy 10 MeV

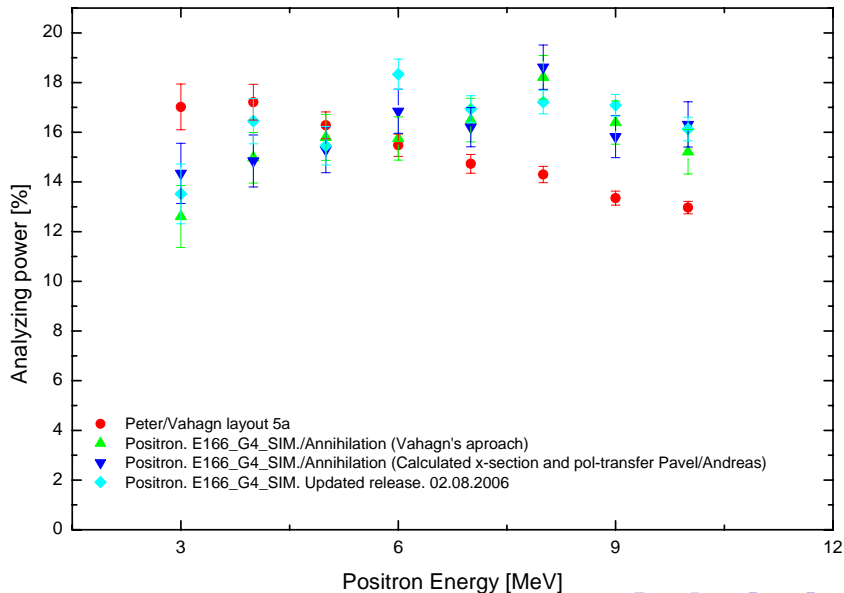# Polarisation Transfer in Compton Scattering

photon   electron   Initial energy 10 MeV

Simulations. E166 Analyzing Power (Karim)

Next steps

- Check everything
- GEANT4 version 4.8.1
- Think on Polarimeter design
- Prepare publications