The absolute Helicity sign in the Hall C Møller Polarimeter.

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Polarized Cross Section

The polarized cross section can be written in terms of the longitudinal and transverse Analyzing Powers A_{zz} and A_t respectively in the Center of Mass frame (CM) as follows

$$\frac{d\sigma}{d\Omega}(E_{cm}) = \frac{\alpha^2}{4E_{cm}} \cdot \frac{(3 + cos^2(\Theta_{cm})^2}{sin^4(\Theta_{cm})} \cdot \Big(1 - P_z^B P_z^T A_{zz}(\Theta_{cm}) - P_t^B P_t^T A_t(\Theta_{cm}) \; cos(2\phi - \phi_B - \phi_T)\Big)$$

with α the finstructure constant, Θ_{cm} the CM scattering angle, ϕ the azimuth of the scattered electron and P_z, P_t the longitudinal and transverse polarization of the beam and target electrons respectively.

The asymmetry is derived from the count rates with the target and beam electron polarized parallel minus the count rates with the spin anti parallel normalized to the sum lead to a negative value (ignoring transverse):

$$A = \frac{N \uparrow\uparrow - N \downarrow\uparrow}{N \uparrow\uparrow + N \downarrow\uparrow} = -P_z^B P_z^T A_{zz}(\Theta_{cm})$$

The sign of the Hall C Møller Polarimeter

The following points each contribute a sign to the measured asymmetry:

- A positive current given by the powersuply for the super-conducting solenoid leads to a magnetic field direction along the beam momentum. Therefore the target electron magnetic moments are aligned along the beam momentum (parallel to z) and contribute with a negative sign (negative electron charge) as the magnetic moment is defined by

$$\vec{\mu} = \frac{g \cdot e}{2mc} \cdot \vec{s}$$

with $\vec{s}$ the particle spin, e the positive unit charge and m the particle mass.

- The optical fiber signal from the source labeled **No.1** is made 200μs longer using a gate generator and inhibits the second scaler in the camac crate. The optical fiber signal from the source labeled **No.2** again is made 200μs longer and inhibits the first scaler in the camac crate. In this way the values in the first scaler correspond to the electron beam Helicity defined by signal **No.1** and the values of the second scaler correspond to the Helicity defined by signal **No.2**. The asymmetry is calculated as follows

$$A = \frac{scaler1 - scaler2}{scaler1 + scaler2}$$

Therefore a negative asymmetry means that the beam polarization defined by the signal **No.1** is parallel to the target polarization and so anti parallel to the beam momentum. For a positive asymmetry one finds that the Helicity of the beam defined by the signal **No.1** is parallel to its momentum.

During the last polarization measurement 30.March 1997 with nominal beam longitudinal polarized with respect to Hall A and Hall C we measured a negative asymmetry. This leads to the conclusion that:

- Optical Fiber Signal **No.1** defines Helicity $\frac{\vec{\sigma_z}\vec{p}}{p}$ = -1
- Optical Fiber Signal **No.2** defines Helicity $\frac{\vec{\sigma_z}\vec{p}}{p} = +1$