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Monte Carlo Computation of the Effective Sherman Function

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Abstract content
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Mott polarimetry is used to determine the spin-polarization of electron beams in wide energy range (up to several MeV).

Azimuthal asymmetry (related to the Sherman function) in Mott scattering of a polarized electron beam is measured. As the measurement is performed on targets of finite thicknesses, the effective Sherman function has to be used, in which multiple interactions of the electron are accounted for. These effects cannot be calculated analytically and simulation tools must be used; experimental data covering wide range of scattering angles exist for a few energies only.

PEBSI Monte Carlo simulation was upgraded towards usefulness to compute the effective Sherman function. Description of Mott scattering was improved and polarization transfer in Møller scattering was included in the code.

Reliability of the simulation was proved by comparison with experimental data for a 100 keV polarized electron beam incident on 10 - 500 nm Au targets in the scattering angle range from 20 to 160 degrees; a good agreement was found.

The angular and energy distributions of scattered electrons were studied, both for all particles and based on interaction types which took place in the target. Electrons originating from Møller scattering were found to have important impact on the effective Sherman function if low energy particles are taken into account, leading to significant decrease of the analyzing power of the polarimeter. This effect can be avoided by imposing proper detector cuts on electron energy.

Optimizing the measurement comes down to choosing the optimal scattering angle and target thickness for electrons of a given energy. The angular dependence of the Sherman function was analyzed from this perspective. Simulation allows to exclude regions less suitable for measurement (e.g., where the Sherman function undergoes rapid changes with scattering angle). Dependence of the Sherman function on target thickness (for a given scattering angle) was also analyzed and compared to commonly used parameterizations.

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