Mott Polarimetry Overview

Z. J. Liptak

Polarization Working Group Meeting

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Theory Overview

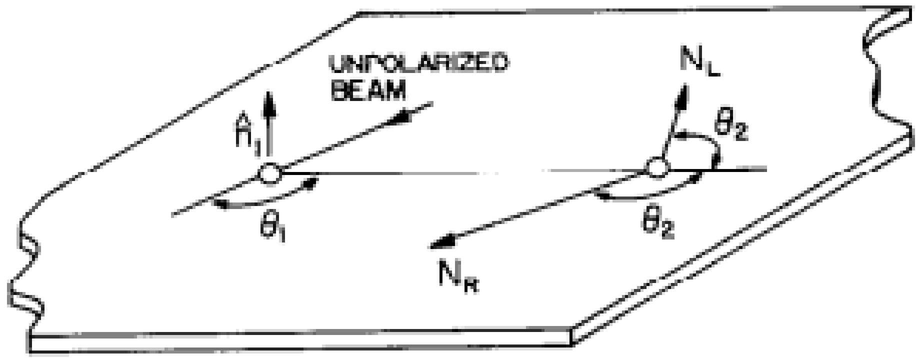


FIG. 1. Schematic diagram of a double-scattering experiment.

From T. J. Gay and F. B. Dunning, "Mott electron polarimetry", Rev. *Sci. Instrum*. **63** (1992)

Mott polarimetry operates by passing a beam of polarized electrons through a sheet of high-Z material (e.g. gold) and measuring the electron-nucleus scattering.

An electron separated from a nucleus by a distance **r** feels a magnetic force
$-1/c\, \mathbf{v} \times \mathbf{E} = (Ze/cr^3)\, \mathbf{r} \times \mathbf{v} = (Ze/cr^3)\, \mathbf{L}$
Where **L** is the electron orbital angular momentum.

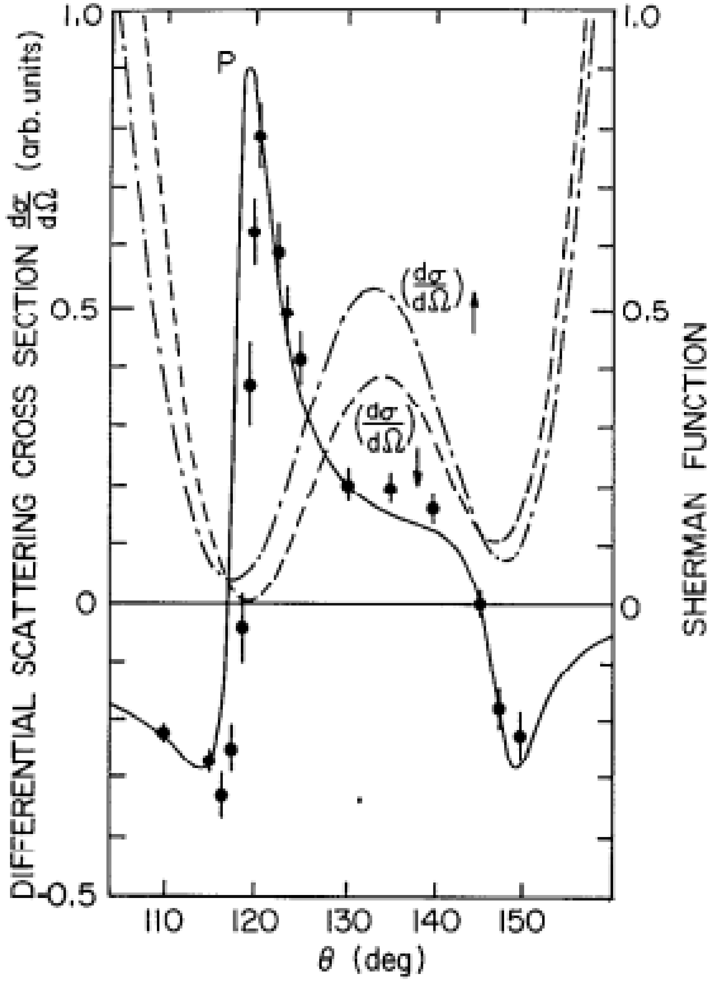
This magnetic field interacts with the electron`s spin magnetic moment $\mu_s = -(ge/2mc)\, \mathbf{S}$, inducing a term $V_{so} = -\boldsymbol{\mu}_s \cdot \mathbf{B} = (Ze^2/2m^2c^2r^3)\, \mathbf{L} \cdot \mathbf{S}$.

As a result, a spin dependence is introduced in the scattering cross section, which can be written

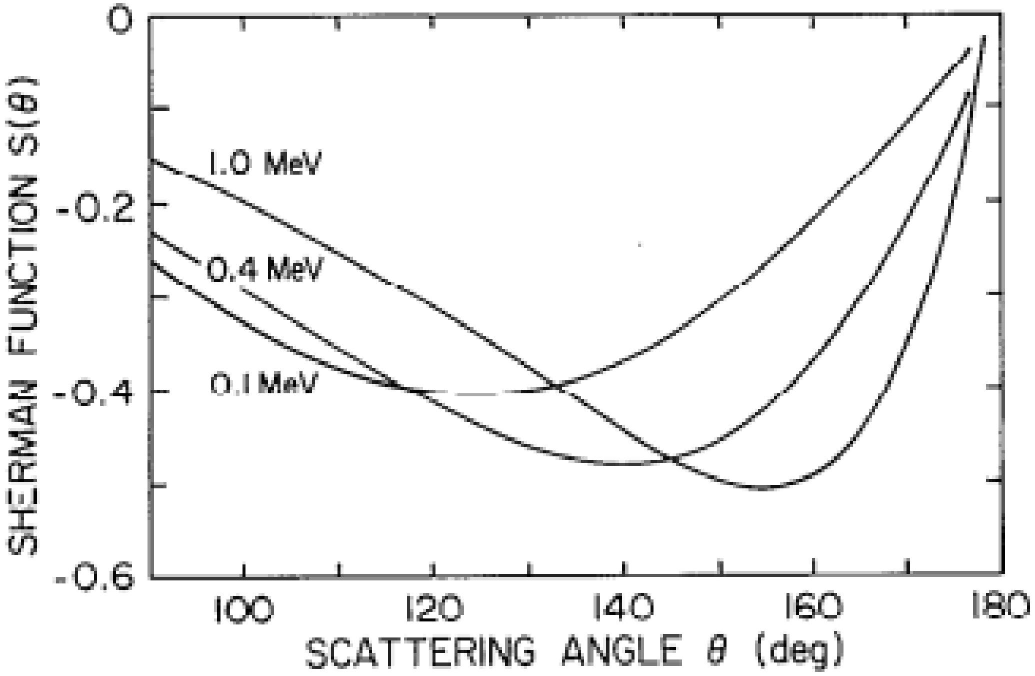
$\sigma(\theta) = I(\theta)[1+S(\theta)\mathbf{P}\cdot\mathbf{n}]$

Where $I(\theta)$ is the spin-averaged scattered intensity, $S(\theta)$ is the asymmetry function, and P is the incident electron polarization.

Sherman Function



J. Kessler, *Rev. Mod. Phys.* **41** (1969)



J. W. Motz, H. Olsen, and H. W. Koch, *Rev. Mod. Phys.* (1964)

Basic Instrument Layout

- Electrons enter from the left and scatter off the target into the detectors. Unscattered electrons are counted in the Faraday Cup.

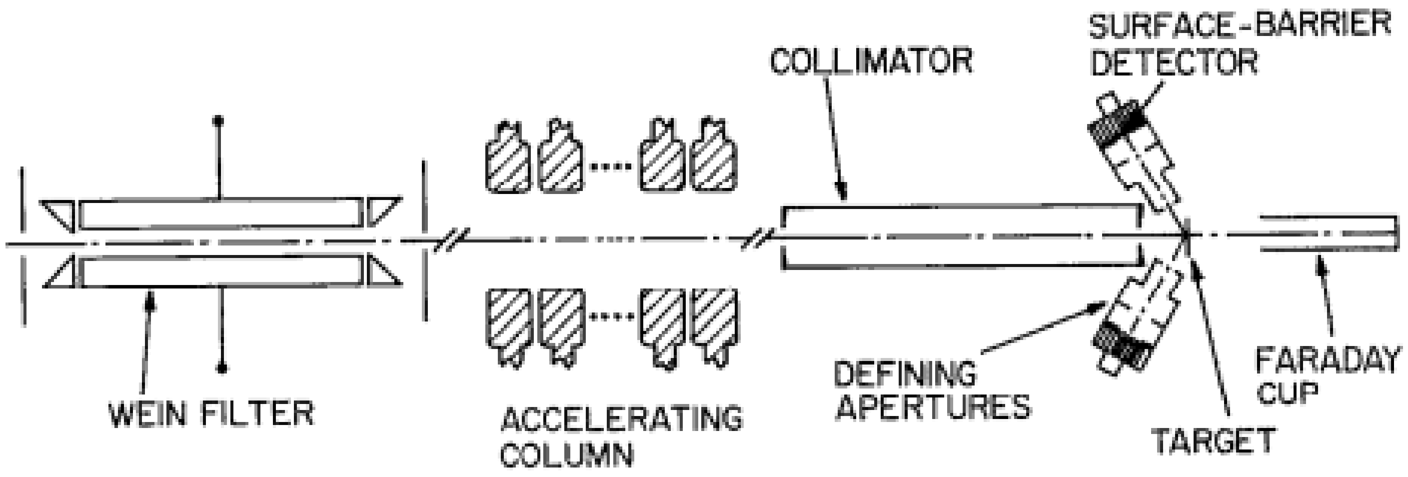


FIG. 4. Schematic diagram of a conventional high-energy Mott polarimeter (see Ref. 71).

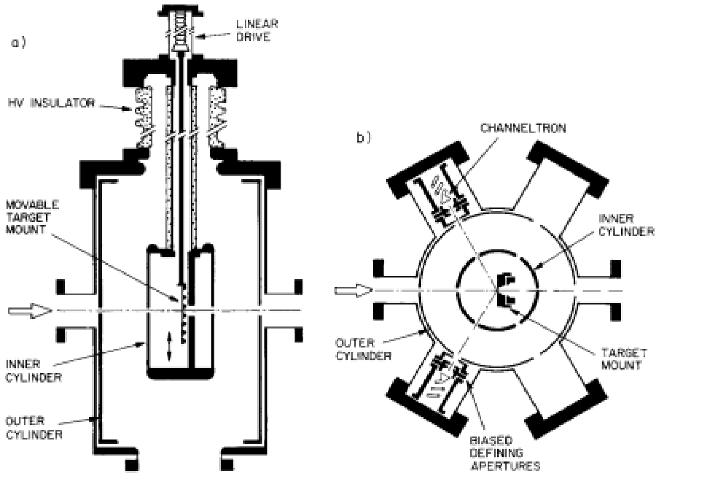


Fig. 3. (a) and (b): Schematic diagram of a cylindrical-geometry retarding-potential Mott polarimeter [3].

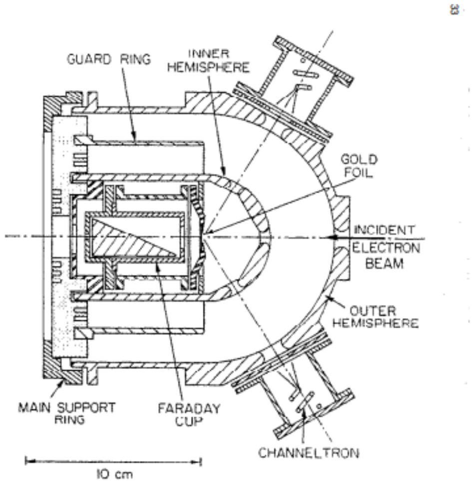


FIG. 8. Schematic diagram of a spherical retarding potential polarimeter (taken from Ref. 107). The major components of the apparatus are symmetrical about the horizontal axis.

Retarding-potential Mott Polarimeters

- A more recent and compact setup involves keeping an inner surface at a potential, creating a radial retarding field. Only electrons at high enough energies to overcome the field are detected.
- Excellent discrimination but low efficiency.