Polarized neutrons

Jan Burle, Jonathan M. Fisher, Marina Ganeva, Gennady Pospelov, Walter Van Herck and Joachim Wuttke

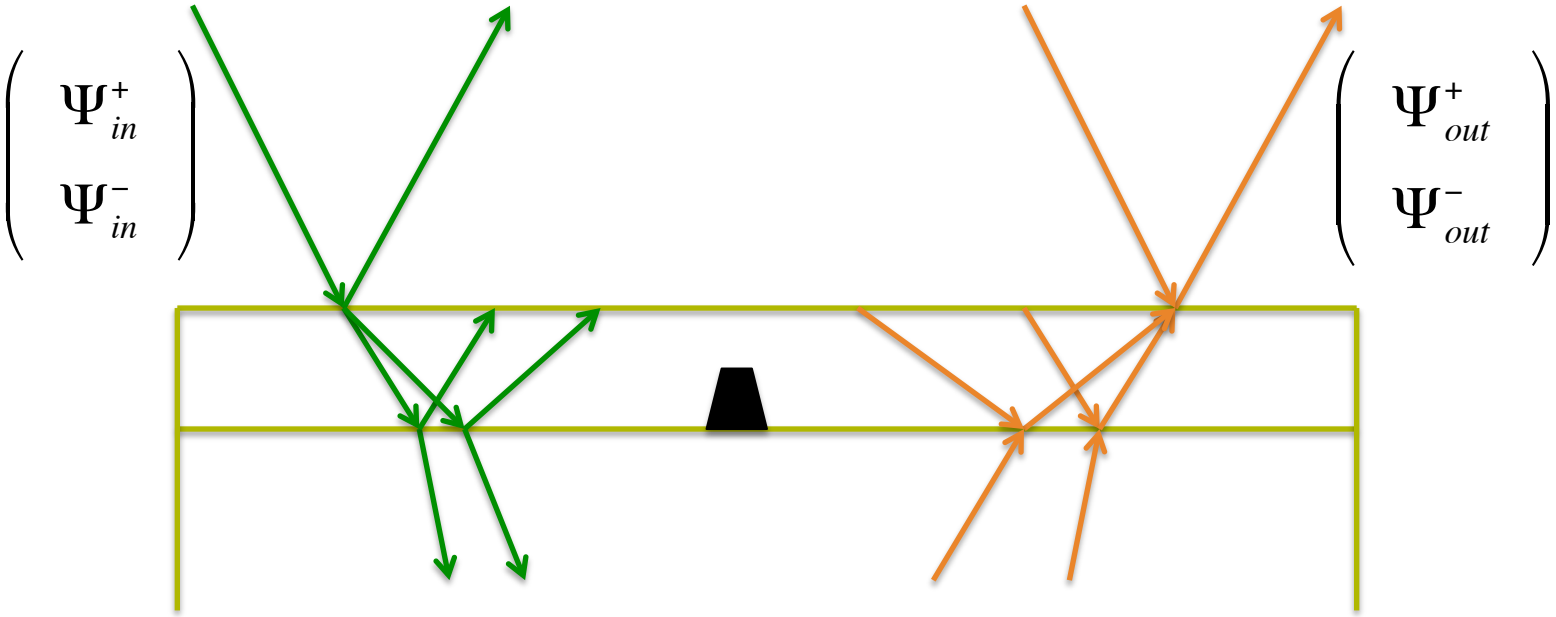
Overview

- Magnetic interaction
- Fresnel coefficients
- Scattering from nanoparticles
- Beam polarization
- Polarization analysis
- BornAgain usage (python)

The magnetic interaction

- Magnetic interaction potential: $H_M = -g_n \mu_N \sigma_p \cdot B$

- Causes birefringence:



New Fresnel coefficients

- Calculation of Fresnel coefficients now requires 4x4 matrices:

$$T_1 = \begin{pmatrix} \frac{1}{4} - \frac{b_z}{4b} & -\frac{b_x - ib_y}{4b} & \frac{(b_z - b)\lambda_1}{4b} & \frac{(b_x - ib_y)\lambda_1}{4b} \\ -\frac{b_x + ib_y}{4b} & \frac{1}{4}\left(\frac{b_z}{b} + 1\right) & \frac{(b_x + ib_y)\lambda_1}{4b} & -\frac{1}{4}\left(\frac{b_z}{b} + 1\right)\lambda_1 \\ \frac{b_z - b}{4b\lambda_1} & \frac{b_x - ib_y}{4b\lambda_1} & \frac{1}{4} - \frac{b_z}{4b} & -\frac{b_x - ib_y}{4b} \\ \frac{b_x + ib_y}{4b\lambda_1} & \frac{-b - b_z}{4b\lambda_1} & -\frac{b_x + ib_y}{4b} & \frac{1}{4}\left(\frac{b_z}{b} + 1\right) \end{pmatrix}$$

Scattering from nanoparticles

- DWBA now gives 16 terms (compare with 4 from scalar interactions)
- BornAgain now supports only homogeneous magnetic fields inside particles
- Future could bring: magnetic domains, non-homogeneous magnetic field configurations (skyrmions), magnetic roughness

Beam polarization

- Defined by Bloch vector (within the unit sphere): *p*
- Density matrix: $\hat{\rho} = \frac{1}{2}\left(1 + p \cdot \sigma_p\right)$

Polarization analysis

- Direction of polarization
- Polarization efficiency:

$$P = \frac{T_+ - T_-}{T_+ + T_-}$$

- Total transmission:

$$T = \frac{T_+ + T_-}{2}$$

BornAgain usage