Development of a Grating Interferometer for the Measurement of the Neutron Electric Charge


Abstract

Neutron grating interferometers can be employed as powerful tools to perform high-precision measurements of deflection angles and scattering. A novel concept of a symmetric Talbot-Lau interferometer using absorption gratings is under development at the University of Bern. The ultimate goal of this project will be a sensitive measurement of the neutron electric charge. Currently, a proof-of-principle apparatus is being investigated at the cold neutron beamline BOA at the Paul Scherrer Institute. A description of the experiment, alignment procedures and first experimental results concerning the setup are presented.

Motivation

Proof-of-principle apparatus
Deflections $\Delta y$ in the picometer-scale
Improvement of current upper limit$^1$: $Q_n < (-0.4 \pm 1.1) \times 10^{-21} e$
Physics beyond standard model

Working Principle

Transverse scan of grating 2
Oscillating intensity pattern
Visibility: $\eta = \frac{N_{\text{max}} - N_{\text{min}}}{N_{\text{max}} + N_{\text{min}}}$

Alignment (Moiré Pattern)

Alignment procedure visualized with a CCD camera.
The gratings are well aligned if no moiré pattern is visible.

Time-of-Flight Analysis

25 Hz chopped beam
20 $\mu$s time bins
Wavelength dependencies
Visibility
Offset
Amplitude
Compare Gd thickness

Deflection Measurement

Aluminum prism in beam
Deflection = $K \cdot \lambda^2$
$K_{\text{lit}} = 1.19 \, \mu \text{m}/\text{Å}^2$

Status

Considering diffraction using smaller grating constants
Temperature stabilization and drift compensation of the setup
Testing new types of gratings (period, diameter, hybrid)
Implementation of HV electrodes

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