Motivation & Theory

Experimental Setup

Dark Matter Problem:



possible solution

- \rightarrow axions / axion-like particles (ALPs):
- originally suggested to solve the strong CP problem [1]
- ultra-light pseudoscalar particle
- coherent oscillating field

Axion Lagrangian:



Ramsey's Technique [4]:



Search with Beam EDM Setup for Oscillating Neutron EDM:



- many astrophysical constraints but only one lab experiment [3]
- higher frequency range than
- nEDM experiment
- model independent interaction
- benefits from existing Beam EDM apparatus





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Axion Dark Matter Search using Cold Neutrons

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PSI2019 Workshop

— Universität Bern —

Analysis & Results

Further Experiments

Least-Squares Spectral Analysis:





- fit a sinusoidal with a fixed frequency
- plot the amplitude of the fit
- scan a discrete frequency spectrum
- calculate coupling from amplitude

Artificial Axion Signal via Magnetic Interaction:

Auxiliary Experiment using Protons NMR Techniques:





Results:

- cut-off at 10 Hz due to aluminum shielding
- \rightarrow no influence on the real axion measurement
- cut-off at 100 Hz due to precession time
- \rightarrow scales inversely with the time



time dependent moment





- extensions of the SM predict new particles \rightarrow new exchange bosons (spin 1) [5]
- one candidate \rightarrow Yukawa-like pseudo-magnetic interaction
- polarized probe particle are protons in $H_2O \rightarrow NMR$ technique to analyze proton spin

[1] Peccei, R. D. & Quinn, H. R. CP Conservation in the Presence of Pseudoparticles. *Phys. Rev. Lett.* **38**, 1440–1443 (1977). [2] Stadnik, Y. V. & Flambaum, V. V. Axion-induced effects in atoms, molecules, and nuclei: Parity nonconservation, anapole moments, electric dipole moments, and spin-gravity and spin-axion momentum couplings. *Phys. Rev. D* **89**, 043522 (2014). [3] Abel, C. et al. Search for axion-like dark matter through nuclear spin precession in electric and magnetic fields. *Phys. Rev. X* 7, (2017). [4] Ramsey, N. F. A Molecular Beam Resonance Method with Separated Oscillating Fields. Phys. Rev. 78, 695-699 (1950).

[5] Dobrescu, B. A. & Mocioiu, I. Spin-Dependent Macroscopic Forces from New Particle Exchange. Journal of High Energy Physics 2006, 005 (2006).

