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Status of CASPEr-gradient and study of its quantum sensitivity limits

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The cosmic axion spin precession experiment (CASPEr) is a nuclear magnetic resonance experiment to search for axion and axion-like particles (ALPs) that possibly make up a significant portion of dark matter in the Universe [1,2]. Due to the pseudoscalar nature and the light mass of ALPs, they can be treated as a field exerting a time-varying torque on nuclear spins either directly or through the generation of an oscillating nuclear electric dipole moment. In CASPEr-gradient, a sample of nuclear spins is placed in a magnetic field which is tunable over a wide range, thereby changing the Larmor frequency. When the Larmor frequency approaches the Compton frequency of the ALP, a magnetization will build up which we intend to detect using superconducting quantum interference devices (SQUIDs). We are currently characterizing the performance of the setup by measuring spin-projection noise of protons. Recently, we showed how this noise source together with thermal and amplifier noise is expected to present itself in our search for ALPs [3]. We found that suppression of the circuit back-action will be especially important in order for the spin-projection noise limits of searches for axion-like dark matter to reach the quantum chromodynamic axion sensitivity.

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Speaker

Yuzhe Zhang, Hendrik Bekker

Primary authors: AYBAS, Deniz (Boston University); BEKKER, Hendrik (Johannes Gutenberg University of Mainz); BLANCHARD, John W.; BUDKER, D. (Univ. Mainz); CENTERS, Gary P.; Mr DOGAN, Arian (Johannes Gutenberg University Mainz); FIGUEROA, N.L. (Univ. Mainz); GRAMOLIN, Alexandr; Mr KIMBALL, Derek (California State University, East Bay); SUSHKOV, Alexander (Boston University); Mrs TOAHA, Anam (Johannes Gutenberg University Mainz); WICKENBROCK, Arne (Johannes Gutenberg University Mainz); Mr ZHANG, Yuzhe (Johannes Gutenberg University Mainz)

Presenter: BEKKER, Hendrik (Johannes Gutenberg University of Mainz)

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