17th Patras Workshop on Axions, WIMPs and WISPs

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Shimming and SQUID detection for CASPEr-Gradient

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\documentclass[a4paper]{article}

\usepackage{amsmath}
\usepackage{amsfonts}
\usepackage{amssymb}
\usepackage{graphicx}
\usepackage[colorlinks=true,urlcolor=blue,linkcolor=blue,citecolor=blue]{hyperref}
\usepackage{xcolor}

\usepackage[
backend=biber,
style=numeric,
sorting=none
]{biblatex}
\addbibresource{sources.bib}

\begin{document}
\pagenumbering{gobble}

\Large
\begin{center}
Shimming and SQUID detection for CASPEr-Gradient\\

\hspace{10pt}

\large
Julian Walter\\

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\small
juwalter@students.uni-mainz.de\\
MAM section, HIM\\
Johannes Gutenberg Universität Mainz

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\normalsize

\noindent The Cosmic Axion Spin Precession Experiment (CASPEr) aims to detect axion-like particles (ALPs) using nuclear magnetic resonance (NMR)\cite{PhysRevD.88.035023}. ALPs are candidates for a light dark matter content of our universe. The CASPEr-Gradient Low-Field setup will probe the effect of local ALP background field gradients on the nuclear spins of hyperpolarized ^{129}Xe atoms, which would drive a precession of the sample spin axes around a leading magnetic field\cite{arXiv:1711.08999v3}.
\medskip\\
The NMR signal is picked up by highly sensitive Superconducting Quantum Interference Devices (SQUIDs), test measurements of pulsed NMR have been made with thermally polarized liquid methanol samples.
\medskip\\
Maximum homogeneity of the leading field in the sample region is required in order to improve the signal-to-noise ratio and reach the necessary precision to resolve ALP signals. To this end, eight independent "shim" magnets are deployed around the main magnet to counteract field inhomogeneities. With automated optimization of the shim fields for each measurement run, we achieve a reduction of NMR signal line width from approximately 1000 ppm to 10 ppm within 50 iterations, which is more efficient than a brute-force approach.

\printbibliography

\end{document}

%%%
%"sources.bib" below
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@article{arXiv:1711.08999v3,
title = {Overview of the Cosmic Axion Spin Precession Experiment (CASPEr)},
author = {D. F. Jackson Kimball et al.},
journal = {Instrumentation and Detectors (physics.ins-det)},
year = {2017},
month = {11},
doi = {10.48550/arXiv.1711.08999},
url = {https://arxiv.org/abs/1711.08999}
}

@article{PhysRevD.88.035023,
title = {New observables for direct detection of axion dark matter},
author = {Graham, Peter W. and Rajendran, Surjeet},
journal = {Phys. Rev. D},
volume = {88},
issue = {3},
pages = {035023},
numpages = {13},
year = {2013},
month = {Aug},
publisher = {American Physical Society},
doi = {10.1103/PhysRevD.88.035023},
url = {https://link.aps.org/doi/10.1103/PhysRevD.88.035023}
}

@InProceedings{10.1007/978-3-030-43761-9_13,
author="Jackson Kimball, Derek F.
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editor="Carosi, Gianpaolo
and Rybka, Gray",
title="Overview of the Cosmic Axion Spin Precession Experiment (CASPEr)",
booktitle="Microwave Cavities and Detectors for Axion Research",
year="2020",
publisher="Springer International Publishing",
address="Cham",
pages="105–121",
abstract="An overview of our experimental program to search for axion and axion-like-particle (ALP) dark matter using nuclear magnetic resonance (NMR) techniques is presented. An oscillating axion field can exert a time-varying torque on nuclear spins either directly or via generation of an oscillating nuclear electric dipole moment (EDM). Magnetic resonance techniques can be used to detect such an effect. The first-generation experiments explore many decades of ALP parameter space beyond the current astrophysical and laboratory bounds. It is anticipated that future versions of the experiments will be sensitive to the axions associated with quantum chromodynamics (QCD) having masses ⊠10−9eV/c2{\$}$\{\backslash\{\}\{\backslash backslash\}lesssim\{\backslash\}\}10\hat{}\{\backslash\{\}-9\{\backslash\}\}\{\backslash backslash\},\{\backslash b$

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Primary author: WALTER, Julian Pascal Maximilian (JGU)

Presenter: WALTER, Julian Pascal Maximilian (JGU)

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