T 117: Dark Matter I

Time: Thursday 15:50–17:20 Location: POT/0361

T 117.1 Thu 15:50 POT/0361

Investigating Dielectric Loss in Travelling Wave Parametric Amplifiers for MADMAX — •Georg Monninger[1], Gwenael Le-Gal[2], Giulio Cappelli[2], Béla Majorovits[1], and Nicolas Roch[2] for the MADMAX-Collaboration — [1]Max-Planck-Institut für Physik, Munich, Germany — [2]Institut Néel, 38000 Grenoble, France

MADMAX is an experiment for the search of dark matter axions. In order to have the required senstivity, preamplifiers are required that operate at or close to the quantum limit. To reach standard quantum limit, a major open challenge is to improve the added noise in TWPA. One of the main phenomena, which could contribute to the noise, is capacitive dielectric loss. Losses become especially large when going to higher frequencies, as we are looking for when probing the axion mass in the range of $40 - 400\,\mu$eV at MADMAX. To investigate their origin, $\lambda/2$-Josephson resonators were built to measure $\tan(\delta)$ via extraction of quality factors. Two geometries were compared. This talk shows the measurement procedure and the obtained results.

T 117.2 Thu 16:05 POT/0361

Bead pull method on an open dielectric haloscope — •Jacob Egge for the MADMAX-Collaboration — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee149, 22761 Hamburg

The **MA**gnetized **D**isk and **M**irror **A**xion e**X**periment is a dielectric haloscope that aims to search for axionic dark matter. It uses a stack of movable dielectric disks, called a booster, to enhance the weak axion signal. In order to calibrate the setup, the electromagnetic field inside the booster needs to be known. This is a difficult challenge as the complex design and open nature of the booster do not permit a simple mode analysis as in the traditional, closed cavity haloscopes. However, having an open and tunable setup also provides unique opportunities for additional measurements of the electromagnetic field of the booster. In this talk, I will present the first results of so-called bead pull measurements on a minimal dielectric haloscope and how they can be used to calibrate the setup.

T 117.3 Thu 16:20 POT/0361

Measurements of dielectric properties of single crystal sapphire (Al2O3) for the axion dark matter search experiment, MADMAX — •Haotian Wang, Alexander Schmidt, and Erdem Oez for the MADMAX-Collaboration — III. Physikalisches Institut A ,RWTH, Aachen, Germany

Axions are one of the candidates for cold dark matter and will be searched in the range of microwave frequencies from 10 to 100 GHz in the magnetized disk and mirror axion (MADMAX) experiment. Multiple dielectric disks will be used to amplify the axion signal. The dielectric properties, dielectric constant and loss tangent, of the disk materials affect the boost factor, so precise knowledge of them is crucial for the detection of axion. Here we present measurement results of dielectric properties of sapphire (Al2O3), a candidate material for the dielectric disks, at room temperature (295-297 K) and at 18 K. The measurements are done in the 10 to 40 GHz range using a microwave resonator.

T 117.4 Thu 16:35 POT/0361

Further dark matter searches using ALPS II's TES detector — •Christina Schwemmbauer for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The elusive **D**ark **M**atter (DM), proposed due to its gravitational interaction with ordinary matter, supposedly makes up $\sim$ 25% of our universe. Various models aim to explain the origin and properties of DM, many of these proposing beyond standard model particles to make up most of the DM in our universe. The ALPS II (**A**ny **L**ight **P**article **S**earch II) light-shining-through-walls experiment will use **T**ransition **E**dge **S**ensors (TESs) to detect low-energy single-photons originating from axion(ALP)-photon conversion with rates as low as 10^{-5} cps.

Even beyond ALPS II, these superconducting microcalorimeters, operated at cryogenic temperatures, could help search for further particle-DM candidates. Much of the work to ensure the viability of the TES detector for use in ALPS II, such as calibrating the detector and mitigating external sources of backgrounds, also leads to the ability to utilize the TES for an independent direct-DM search. For this purpose, the superconducting sensor, sensitive to sub-eV energy depositions, can be used as a simultaneous target and sensor for DM-electron scattering for sub-MeV DM. Hence, direct DM searches with TES could explore parameter space as-of-yet inaccessible by nucleon-scattering experiments.

T 117.5 Thu 16:50 POT/0361

Heterodyne detection of weak fields in ALPS II — •Isabella Oceano for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light Shining through a Wall experiment at DESY in Hamburg, which will hunt for axions and axion-like particles in the sub-meV mass range with an axion-photon-photon coupling $g_{\alpha\gamma\gamma} > 2 \times 10^{-11}$ GeV^{-1}. To do this, a high-power laser will be directed through a strong magnetic field where some of the photons can convert into a beam of axion-like particles. After this, the beam will cross a light-tight barrier and another strong magnetic field where some of the axion-like particles can convert back into photons and be detected. During the first data acquisition, planned for early 2023, a HETerodyne (HET) interferometer will be used to detect the reconverted photons. This very sensitive interferometer can detect very weak signals at the exact signal frequency.

The HET principle and its implementation in ALPS II will be discussed in this talk.

T 117.6 Thu 17:05 POT/0361

Impact of axion decay on the extragalactic background light — •Sara Porras Bedmar, Manuel Meyer, and Dieter Horns — Institut für Experimentalphysik, Universität Hamburg, Luruper Chaussee 149, D-22761 Hamburg

The Extragalactic Background Light (EBL) is an isotropic diffuse radiation field of extragalactic origin. Assuming that dark matter consists of axions with masses on the order of electron volts, we expect an additional contribution to the EBL due to their decay into two photons.

Here, we model the main light-emitting processes that constitute the EBL: stellar populations, intra-halo light, and dust. Utilizing the Starburst99 and SWIRE code libraries we create synthetic spectra to characterize the stellar components. Our model critically depends on structure formation and evolution, encoded in the star formation rate history, as well as star metallicity, and the distribution and composition of dust. We explore the dependencies of our model on these parameters, as measurements of these quantities are highly uncertain. In addition to these astrophysical EBL components, we include the contribution of decaying dark matter axions. Through a comparison of our model with the most recent direct and indirect EBL measurements, we are able to constrain the photon-axion coupling in the mass range from $\sim 0.1 - 10$ eV.