T 38: Search for New Particles 3

Time: Tuesday 16:15–18:00 Location: T-H23

T 38.1 Tue 16:15 T-H23

Searching for Axion-Photon Couplings — •Robin Löwenberg, Tom Krokotsch, Daniel Klein, Gudrid Moortgat-Pick, and Krisztian Peters — Deutsches Elektronen-Synchrotron (DESY), Hamburg, Germany

The nature of dark matter is not yet known. Extensive studies have been done searching for a weakly interactive massive particle (WIMP) but are still waiting for a positive signal.

Another popular approach is assuming that dark matter consists of light particles rather than WIMPs. These particles are called weakly interactive slender particles (WISPs). One of the most promising candidates is the axion which was proposed in the seventies to solve the so-called strong-CP-problem. It later turned out to be a good dark matter candidate in a certain mass range.

Experiments searching for axions and axion-like particles like ALPS 1 (2007-2010) and ALPS 2 (since 2021) are provided by Deutsches Elektronen-Synchrotron (DESY) in Hamburg with further experiments on the way. Most of them are based on the assumption that axions show photon-like couplings and therefore would interact with electromagnetic fields.

This talk aims to explain the concept of axions and in which mass ranges and coupling strengths they might be a good dark matter candidate. Furthermore, a quick overview will be given of current and possible future experiments promising to detect the particle if it exists.

T 38.2 Tue 16:30 T-H23

The ALPS II experiment at DESY - Status and prospects — •Kanioar Karan for the ALPS-Collaboration — DESY / Cardiff University, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a laboratory-based light shining through a wall experiment (LSW) to probe the existence of Axion-Like-Particles (ALPs) with a coupling to electromagnetic fields as low as $g_{a\gamma\gamma} \approx 2\times10^{-11}\text{GeV}^{-1}$ that is hinted at some astrophysical anomalies such as stellar evolutions and the TeV transparency of the universe. This LSW experiment is based on the simple idea that a high power laser field that propagates through a static magnetic field can partly oscillate into an ALP field. The ALP field then crosses an opaque wall to a second static magnetic field and can partly reoscillates into an electromagnetic field which can be detected with a detector. In order to achieve the anticipated sensitivity, two 125m long optical cavities, operated in a vacuum system, are used: one with an expected circulating power of 150kW for the ALPs production and one with an expected power build-up of 40,000 to enhance the regeneration of the electromagnetic field. The circulating field in each cavity is directed through a string of 12 superconducting HERA dipole magnets providing a magnetic field of 5.3T. The ALPS II experiment is located at DESY in Hamburg and is currently in the commissioning phase. In this talk, we will present the current status, challenges and perspectives of the ALPS II experiment with the focus on the optical setup.

T 38.3 Tue 16:45 T-H23

Analysis and simulation of TES data in the ALPS II experiment — •José Alejandro Rubiera Gimeno for the ALPS-Collaboration — Deutsches Elektronen-Synchrotron, Hamburg, Germany

The Any Light Particle Search II (ALPS II) is a Light-Shining-through-a-Wall experiment under construction at DESY, Hamburg. Its goal is to probe the existence of Axion Like Particles (ALPs), a possible candidate for dark matter. In the ALPS II region of study, a rate of photons reconverting from ALPs on the order of 10^{-5} cps is expected. This requires a sensor capable of measuring low-energy photons (1.165 eV) with high efficiency and a low dark count rate. We investigate a tungsten Transition Edge Sensor (TES) system as a photon-counting detector that promises to meet these requirements. This detector exploits the drastic change in its resistance caused by the absorption of a single photon when operated in its superconducting transition region at millikelvin temperatures. In this work, the analysis procedure applied to measured TES pulses, in time and frequency domain, is presented. This analysis allows extracting characteristic parameters used for signal discrimination against backgrounds. The energy resolution computed from data is compared to simulations of electronic noise superimposed with ideal photon pulses.

T 38.4 Tue 17:00 T-H23

Status and Prospects of a TES-based Detector System for ALPS II — •Gulden Othman for the ALPS-Collaboration — University of Hamburg, Hamburg, Germany

The Any Light Particle Search II (ALPS II) experiment will search for QCD axions and axion-like particles (ALPs) in an important parameter space that is relevant in understanding anomalous astrophysical phenomena, including stellar evolution and dark matter. ALPS II takes advantage of the axion coupling to photons using a Light-Shining-through-a-Wall technique. Photons created using a strong laser may convert into ALPs in the presence of a strong magnetic field. The ALPs can traverse a light-tight barrier, reconvert into photons within a second magnet string, and be subsequently detected. The rate of re-converted photons is extremely low, on the order of 10^{-5} counts/second, and their observation requires the use of sensitive photon detectors with high efficiency and low backgrounds. The first stage of ALPS II, currently under construction at DESY, Hamburg, will use a heterodyne detection method. In the subsequent phase, ALPS II can utilize advances in cryogenic quantum sensing by employing Transition Edge Sensors (TESs). We are currently developing a TES-based detector system that can meet the requirements for ALPS II, offering single-photon detection with high efficiency and low-backgrounds at the 1064 nm (1.165 eV) energy of interest. In this talk, we present the feasibility, challenges, and current status of the TES-based detector system for ALPS II at DESY, Hamburg.

T 38.5 Tue 17:15 T-H23

Monte Carlo based ray tracing for BabyIAXO — •Johanna von Oy, Klaus Desch, Jochen Kaminski, Tobias Schiffer, and Sebastian Schmidt — Physikalisches Institut der Universität Bonn

The premise of the International AXion Observatory (IAXO) and its intermediate experimental stage BabyIAXO is to detect the undiscovered particle axion, which can be a good candidate for dark matter. This will be done by utilizing the inverse Primakoff effect to reconvert them into X-rays in the magnetic field of a movable magnet. Following this, they would get focused by an X-ray optic and detected in, for example, a window sealed gaseous detector.

To simulate this whole process, ray tracing based on the Monte Carlo method is a useful tool, as a certain number of axions would be generated and get assigned different probabilities and changes of direction depending on the setup. This talk will focus on the individual steps, starting with the production in the sun and following the axion's path to the detector.

T 38.6 Tue 17:30 T-H23

Anisotropy effects in a dielectric haloscope for dark matter searches — •bernardo ary dos santos for the MADMAX-Collaboration — RWTH III. Physikalisches Institut A, Aachen, Germany

The MADMAX collaboration intends to build a dielectric haloscope targeted to detect galactic axion dark matter, in the mass range $40-400\mu$eV . This experiment consists of a series of dielectric discs and a mirror placed inside a strong homogeneous magnetic field that would produce the emission of coherent electromagnetic radiation with a frequency related to the mass of the axion. One of the current challenges is to simulate this experiment taking into account realistic settings. We present an improved simulation that is able to include the effects of anisotropic dielectric discs in the experiment.

T 38.7 Tue 17:45 T-H23

Axion dark matter searches using superconducting radio frequency cavities — •Tom Krokotsch[1], Robin Löwenberg[1], Daniel Klein[1], Gudrid Moortgat-Pick[1,2], and Krisztian Peters[2] — [1]Universität Hamburg, Hamburg, Germany — [2]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

Recent proposals of employing superconducting radio frequency (SRF) cavities to detect axions suggest promising sensitivities in previously unexplored parameter space. This includes QCD axions and axion-like dark matter with masses in a range of about eight orders of magnitude.

The setup aims to detect photons generated through the predicted interaction of axions with electromagnetic fields. An advantage of this design is that it allows scanning over a range of axion masses by slightly altering the cavity. Such a detector benefits from the high quality factors achieved in modern SRF technology.

In the talk we discuss the general idea behind the detector, it's most significant parameters to achieve a high signal power and evaluate which cavity geometries and transitions are the most promising. Particular attention must be paid to minimise various noise sources which limit the sensitivity of the setup.