T 77: Search for Dark Matter 4

Time: Wednesday 16:15–18:15 Location: T-H36

T 77.1 Wed 16:15 T-H36

Light dark matter search using SuperCDMS single-charge-sensitive devices and anticoincident tagging — •Alexander Zaytsev for the SuperCDMS-Collaboration — Karlsruher Institut für Technologie, Karlsruhe, Germany

As a part of its R&D program, the SuperCDMS collaboration has been developing cryogenic gram-scale eV-resolution (HVeV) detectors that utilize Neganov-Trofimov-Luke amplification by applying a voltage bias across the Si crystals. During the two previous above-ground dark matter (DM) searches, each collecting data with only one HVeV detector, competitive constraints were obtained for DM-electron scattering, as well as for dark photon and axion-like particle absorption. However during the second HVeV run, a background characterized by bursts of single electron-hole pair events was observed, which may originate from luminescence in SiO2 - the primary component of the detector holder material. Single-pulse events from the tails of such bursts degrade the sensitivity of the HVeV DM searches in the entire mass range of interest. In the latest underground HVeV DM search (Run 3), we have collected O(10) gram-days of exposure using three HVeV detectors, operated simultaneously within a shared housing. We present the current progress of the respective DM search analysis, which is expected to surpass the previous HVeV DM limits by utilizing an inter-detector anticoincidence event selection that considerably suppresses the rate of background events caused by bursts.

T 77.2 Wed 16:30 T-H36

Characterizing bursts of single-electron-hole-pair events using a SuperCDMS R&D device and a sodium-22 source — •Matthew Wilson for the SuperCDMS-Collaboration — Karlsruher Institut für Technologie

Recently, R&D facilities within the SuperCDMS collaboration have developed and employed cryogenic, high-voltage, eV-scale (HVeV) detectors that have single-charge sensitivity. When a bias voltage is applied across these gram-sized, silicon detectors, the charge signals are amplified in the form of phonons, making the detectors sensitive to low-energy electron interactions. HVeV detectors have been previously utilized for two separate above-ground dark matter (DM) searches to set competitive constraints on low-mass DM candidates. However, these constraints are limited by the presence of an unknown, low-energy background, a large component of which appears to be bursts of single-electron-hole-pair events. One hypothesis is that these events originate from the photoluminescence of SiO_2, a primary component of the detector holder material. A sodium-22 source has been placed near an HVeV detector to determine whether such burst events are induced by the high-energy gammas emitted by a radioactive source, which would support this hypothesis. This presentation shows the latest results of the investigation and characterization of this low-energy background.

T 77.3 Wed 16:45 T-H36

SuperCDMS detector testing at the Cryogenic Underground TEst (CUTE) facility — •Sukeerthi Dharani for the SuperCDMS-Collaboration — Universität Hamburg

SuperCDMS SNOLAB is an upcoming direct dark matter search experiment using silicon and germanium detectors operated at cryogenic temperatures. The experiment is planned to start data taking in 2023 at SNOLAB which is located 2 kilometers underground in the Creighton mine in Canada. With a low background from cosmic sources, SNOLAB is ideal for rare event searches. The Cryogenic Underground TEst (CUTE) is a well-shielded test facility operating at SNOLAB with a measured background rate of ~ 7 events/keV/kg/day. It acts as a testbed for the SuperCDMS detectors and facilitates performing early science runs. In this talk, an overview of the CUTE facility's features, ongoing activities, and applications for the SuperCDMS experiment will be presented.

T 77.4 Wed 17:00 T-H36

Current Status of the BRASS-P Experiment — •Fayez Bajjali[1], Le Hoang Nguyen[1], Dieter Horns[1], Andrei Lobanov[1,2], Artak Mkrtchyan[1], Sven Dornbusch[2], Christoph Kasemann[2], Martin Tluczykont[1], and Marko Ekmedžić[1] — [1]Institute of Experimental Physics - University of Hamburg — [2]Max-Planck-Institute for Radio Astronomy - Bonn

Axions and Hidden Photons (HPs) are among the best motivated candidates for explaining the enigmatic nature of the dark matter. These weakly interacting slim particles (WISPs) have a small mass and can be detected via electromagentic (EM) radiation arising from their interaction with normal matter, photons, and magnetic field. The concept for Broadband Radiometric Axion/ALP Searches (BRASS) provides a pioneering experimental setup for WISP searches in the range of 10-10000μeV. The prototype setup BRASS-P is currently being constructed at the University of Hamburg. It combines permanently magnetized conversion panels producing the EM signal from passages of WISPs, a parabolic mirror focusing the EM signal, a cryogenic 12-18 GHz heterodyne receiver, and a broadband digitizing backend DBBC3 for detecting and processing the signal.

The structure of the conversion panels and the measurement of the static magnetic field will be presented. The setup and calibration procedures employed for the 12-18 GHz receiver and the DBBC3 digitizer will be discussed. Finally, preliminary results from the first science run carried out for searching for HPs in the frequency range of 12-16 GHz will be presented.

T 77.5 Wed 17:15 T-H36

Axion simulation in various geometry — •Johannes Ulrichs[1], Le Hoang Nguyen[1], Dieter Horns[1], and Andrei Lobanov[1,2] — [1]Institut für Experimentalphysik, Universität Hamburg, Hamburg, Deutschland — [2]Max-Planck-Institut für Radioastronomie, Bonn, Deutschland

Using commercial FEM software (COMSOL TM), we solve the Axion-Maxwell equation in the geometrical context of experiments that search for axion and axion-like-particles (ALPs) dark matter. Firstly, the BRASS-p is the pilot experiment that search for axion/alps in the frequency range of 12 - 18 GHz (49.63 - 74.4 μeV). The multiphysics simulation (AC/DC and RF modules) is used to explore the realistic magnetic field of the magnet panels and the axion-induced radiation. Accompanied with further studies concerning the efficiency and coherence effect of the overall setup. Secondly, we consider the possibility of detecting the skin current induced by the low mass axion dark matter (few kHz to 3MHz, 4.14 peV - 12.4 neV) using a novel solenoid magnet. The theoretical foundation, simulation result is discussed. Followed by the proposed approaches to pickup the signal using High Impedance Amplifier (HIA) and SQUIDS receiver.

T 77.6 Wed 17:30 T-H36

Low Temperature MMC-based X-ray Detectors for IAXO — •Daniel Unger, Andreas Abeln, Daniel Behrend-Uriarte, Daniel Hengstler, Andreas Fleischmann, Christian Enss, and Loredana Gastaldo — Kirchhoff Institute for Physics, Heidelberg University

Axion helioscopes search for evidence of axion-like particles (ALPs) produced in the Sun. Via the generic ALP-photon coupling, a strong magnetic field would convert ALPs into photons which could then be detected by low background and high efficiency X-ray detectors. Having also detectors with good energy resolution and low energy threshold would in addition in case of discovery allow to investigate ALP properties and generation mechanisms in the Sun. We propose to use low temperature metallic magnetic calorimeters (MMCs) for the International Axion Observatory (IAXO). We present the current state of our detector system developed for IAXO containing a two-dimensional 64-pixel MMC array covering an active area of 16 mm^2 with a fill factor of 93 %. We achieve an average energy resolution of 6 eV FWHM allowing for energy thresholds well below 100 eV. The results obtained during experiments with different experimental configurations show a background reduction in the case of low-Z material directly surrounding the active part of the detector. In the future, active and passive shields will be used to reduce the background further. The obtained results highlight that MMC-based arrays are a suitable technology for helioscopes to discover and study ALPs.

T 77.7 Wed 17:45 T-H36

Indirect dark matter search with IceCube — •Li Ruohan, Stephan Meighen-Berger, and Anja Brenner — Technische Universität München, James-Franck-Straße 1, 85748, Garching, Germany

Dark Matter annihilation can generate standard particle pairs in primary and decay into neutrinos at the final state. Its spectrum can have a line shape in case of direct annihilation into neutrinos pair. IceCube neutrino observatory is a powerful instrument for indirect dark matter search because of its sensitivity to neutrinos energy of TeV to PeV. Its planned Upgrade can improve the dark matter nucleons interaction cross-section limits of one magnitude at lower energy. This talk will show a potential approach to test IceCube's line-spectrum detection ability and estimate the conservative cross-section using both spin-independent and -dependent effective fields theory.

T 77.8 Wed 18:00 T-H36

EXCESS workshop: a collaborative investigation of the sub-keV backgrounds observed in various rare event search experiments — •Margarita Kaznacheeva[1], Alexander Fuss[2,3], Florian Reindl[2,3], and Felix Wagner[2] — [1]Physik-Department E15, Technische Universität München, D-85748 Garching, Germany — [2]Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Austria — [3]Atominstitut, Technische Universität Wien, 1020 Wien, Austria

After having lowered the energy thresholds down to O(10eV), various dark matter and coherent elastic neutrino-nucleus scattering experiments observe an unexpected exponential rise of the event rate towards low energies. This excess signal caused by an as yet unknown origin currently provides the main limitation for further sensitivity improvement. A collective initiative to share experimental observations and compare the measured excess signals was started. I will report the outcomes of the dedicated EXCESS workshop that took place in June 2021 as a joint effort of 10 collaborations and lead to an in-depth discussion within the community. Presented measurements were taken by cryogenic, CCD, and gaseous ionization detectors, under and above ground, with different levels of shielding and a wide range of operating temperatures. In the scope of the workshop, a publicly accessible data repository was created that allows studying the sub-keV excess signals measured by the participating collaborations. A summary paper of the workshop is expected to be published in early 2022 and further meetings are already planned.