T 19: Search for Dark Matter I

Time: Monday 16:45–18:45 Location: VG 4.102

T 19.1 Mon 16:45 VG 4.102

The Direct search Experiment for Light Dark Matter (DELight): Overview and Perspectives — •Eleanor Fascione for the DELight-Collaboration — Heidelberg University

There is vast unexplored parameter space for dark matter masses below a few GeV, and the field of direct dark matter detection is constantly expanding to new frontiers. In particular, low mass dark matter candidates necessitate novel detector designs with lower thresholds and alternative target materials compared to e.g. the xenon-based experiments currently providing the strongest overall constraints on many dark matter models.

The Direct search Experiment for Light dark matter (DELight) will deploy a target of superfluid ^{4}He instrumented with large area microcalorimeters (LAMCALs) based on magnetic microcalorimeter (MMC) technology in a setup optimized for low mass dark matter searches. In this talk an overview of this novel upcoming experiment will be presented, including preliminary background models and sensitivity projections.

T 19.2 Mon 17:00 VG 4.102

Signal partitioning in superfluid ^{4}He: A Monte Carlo approach — •Francesco Toschi for the DELight-Collaboration — Karlsruhe Institute of Technology, Institute for Astroparticle Physics — Heidelberg University, Kirchhoff-Institute for Physics

Superfluid ^{4}He presents a compelling target for direct detection of light dark matter (LDM), offering both a low nuclear mass and a low energy detection threshold through quasiparticle generation. This talk will discuss the physical processes involved in the deposition of energy in superfluid ^{4}He, focusing on the response to nuclear and electronic recoils, which are crucial for the detection of LDM. A Monte Carlo simulation framework has been developed to model the distribution of deposited energy across distinct signal channels for various recoil types. This work is essential for optimizing the design and performance of next-generation detectors such as the DELight experiment.

T 19.3 Mon 17:15 VG 4.102

Simulation of Particle Induced Damage Tracks in Crystal Detectors — •Lukas Scherne and Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

A new approach to detecting Dark Matter (DM) involves so-called "Paleo Detectors" (PD)-minerals that may have accumulated DM-induced damage tracks over billions of years. These damage tracks could potentially form when a DM interaction leads to a nuclear recoil in the mineral's lattice. Modern microscopy techniques could have the potential to image these nanometer-sized features. Additionally, PDs could be used as a new way for the detection and study of neutrinos.
However, there are many research and development challenges to face, before PDs can be realized. A pilot project at the KIT's Institute for Astroparticle Physics, in collaboration with geologists from Heidelberg University and microscopy experts from KIT's Laboratory for Electron Microscopy and Institute of Nanotechnology, aims to address several key challenges. In the scope of this project, we aim to perform a series of calibration studies, irradiating a range of mineral samples with ions and neutrons of known energy. These samples will then be imaged and analyzed for the presence of particle-induced damage tracks.
To support these studies, we perform a series of simulations to study track formation and morphology in specific minerals. Ultimately, we seek to establish a clear correlation between the deposited energy and the resulting track morphology.
In this talk, I will report on the current state of these simulation studies and their implications for PDs.

T 19.4 Mon 17:30 VG 4.102

INCIDENCE - Impact of Crystal Effects on Cryogenic Detectors for Dark Matter Searches — •Holger Kluck[1], Jens Burkhart[1], Miroslav Macko[2], and Veronika Palušová[2,3] — [1]Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich — [2]Institute of Experimental and Applied Physics, Czech Technical University in Prague, 110 00 Prague 1, Czech Republic — [3]Johannes Gutenberg-Universität Mainz, Institut für Physik, 55128 Mainz, Germany

Nuclear recoils in cryogenic detectors are used to search for Dark Matter (DM) and for the prospective measurement of Coherent Elastic Neutrino-Nucleus Scattering (CEνNS). Experiments like CRESST or NUCLEUS reached detection thresholds for nuclear recoils in $CaWO_4$ and Al_2O_3 at the 20 eV-scale.

At this scale, solid-state effects can no longer be neglect, as they affect the observable energy. Once a DM particle or a neutrino induced a Primary Knock-On Atom in the detector crystal, the resulting displacement cascade can produce crystal defects that reduce the observable energy. Together with the ELOISE project, INCIDENCE aims to use Molecular Dynamics simulation to study this effect in $CaWO_4$ and Al_2O_3 at energies which are relevant for DM and CEνNS experiments.

In this contribution we will motivate the impact on the field, summarize the physics of the displacement cascade, present first results of defect creation in Al_2O_3 and give an outlook on the ongoing work for $CaWO_4$.

T 19.5 Mon 17:45 VG 4.102

New results from the SuperCDMS-HVeV program — •Emanuele Michielin for the SuperCDMS-Collaboration — Karlsruher Institut für Technologie, Institut für Astroteilchenphysik, 76344, Eggenstein-Leopoldshafen, Germany

SuperCDMS SNOLAB is a direct detection dark matter (DM) experiment currently under construction two kilometers underground at the SNOLAB laboratory near Sudbury, Canada. Its goal is to achieve world-leading sensitivity to DM-nucleus scattering within a mass range of 0.5 to 5 GeV. In parallel, gram-scale prototype detectors, known as HVeV devices, have been developed. These detectors achieve energy resolutions at the eV scale, enabling the detection of single electron-hole pairs when operated under high-voltage bias. HVeV devices present a unique opportunity to probe low-mass dark matter, study charge propagation, and refine calibration techniques that will also be implemented in SuperCDMS SNOLAB operations.

In this talk the latest results from the fourth data taking campaign with HVeV detectors in the NEXUS underground facility at Fermilab will be presented. A recent search for electron recoil DM candidates will be highlighted, which takes advantage of a new detector holder designed to eliminate luminescence-induced background from printed circuit boards. Additionally, a novel calibration method using Compton step spectral features in the low-energy region will be discussed. Finally, updates from the latest HVeV data-taking campaign at the SNOLAB laboratory will be introduced.

T 19.6 Mon 18:00 VG 4.102

The SuperCDMS HVeV run at CUTE — •Julius Viol for the SuperCDMS-Collaboration — Kirchhoff-Institut für Physik, Uni Heidelberg

The SuperCDMS HVeV detectors are gram-scale cryogenic semiconductor devices used for the direct search of dark matter. They have achieved eV-scale energy resolution through the application of an electric field, enabling the amplification of the phonon signal of ionizing particle interactions via the Neganov-Trofimov-Luke effect, resulting in great sensitivity to low-mass dark matter candidates. The energy resolution of these detectors also allows the investigation of the excess of low-energy events that has been systematically observed by cryogenic low-threshold experiments. In this talk I will present details of a recent run of HVeV detectors that was conducted at CUTE (Cryogenic Underground TEst facility), a test facility at the SNOLAB underground laboratory near Sudbury, Canada. This was the first time in which such sensitive detectors were operated deep underground in a low-background environment. I will describe the goals of this run, the payload, as well as provide a first peek into the results of the ongoing data analysis.

T 19.7 Mon 18:15 VG 4.102

Study of Low Energy Excess in the CRESST experiment — •Eleonora Rebecca Cipelli — Max Planck Institute für Physik

The CRESST (Cryogenic Rare Event Search with Superconducting Thermometers) experiment operates Transition Edge Sensors (TESs) at millikelvin temperatures to directly search for dark matter, with a focus on the sub-GeV mass range. Located in the ultra-low-background environment of the Laboratori Nazionali del Gran Sasso (LNGS) in Italy, CRESST is one of the leading experiments in the field thanks to

its extremely low energy threshold. However, its sensitivity is affected by an increasing event rate at low energies (below ~200eV), known as the Low Energy Excess, whose origin remains unclear. While several potential causes have been ruled out, ongoing measurements and efforts to develop new detector designs aim to provide deeper insights into these observations. In this talk, the studies and latest results of Low Energy Excess performed by CRESST are presented.

T 19.8 Mon 18:30 VG 4.102

Results of the double-TES in the CRESST experiment — •Felix Dominsky — Max-Planck-Institut für Physik

CRESST is a leading direct dark matter search experiment that employs transition edge sensors (TES) to detect energy depositions in cryogenic target crystals. Like many experiments in this field, CRESST observes an excess of events near the detector threshold, commonly referred to as the low-energy excess (LEE). This phenomenon poses a significant challenge to the sensitivity of the experiment, particularly for light dark matter detection. To investigate the origin of the LEE, CRESST has developed the double-TES module, featuring two identical TESs on a single target crystal. A particle interaction in the bulk of the crystal is sensed in both TES, whereas events detected in only one TES can be excluded as valid particle interactions. This presentation will detail the operating principle of the double-TES and highlight new insights into the LEE derived from this technology.