T 45: Search for Dark Matter 2

Time: Tuesday 16:00–18:00 Location: Geb. 30.35: HSI

T 45.1 Tue 16:00 Geb. 30.35: HSI

Crystal-based Detectors for Dark Matter & Neutrinos — •Alexey Elykov — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

With dark matter (DM) still eluding detection by large-scale experiments, and in light of the technical difficulties and expenses that are associated with constructing such detectors, a window has opened for new and daring ideas in the field. One such idea is to utilize the advent of modern microscopy and computational techniques to read out and reconstruct nanometer and micrometer-sized damage tracks produced by interactions of DM and neutrinos with nuclei of ancient natural crystals. Residing in the depths of the Earth for millions of years, certain minerals should have accumulated these minute tracks, allowing us to use such minerals as "paleo-detectors". Despite their small size the Myr-scale lifetime of paleo-detectors provides them with enormous exposure. Uniquely, if realized, such detectors can also probe the distribution of DM in our Galaxy and the evolution of neutrino fluxes over our Galaxy's lifetime. In this talk, I will report on the latest research and developments towards the realization of mineral-based paleo-detectors.

This work is supported in part through the Helmholtz Initiative and Networking Fund (grant agreement no. W2/W3-118). We also gratefully acknowledge the support by the KIT Center Elementary Particle and Astroparticle Physics (KCETA) for this project.

T 45.2 Tue 16:15 Geb. 30.35: HSI

Current Status of the Direct Search Experiment for Light Dark Matter (DELight) — •Eleanor Fascione for the DELight-Collaboration — Heidelberg University

Despite the lack of discovery of one of the favoured dark matter candidates, the Weakly Interacting Massive Particle, there is vast parameter space to explore 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 magnetic microcalorimeter (MMC) based wafer calorimeters in a setup optimized for low mass dark matter searches. In this talk the motivation, setup, and current status of this novel upcoming experiment will be presented.

T 45.3 Tue 16:30 Geb. 30.35: HSI

Search for Dark Matter with the Relic Axion Dark-Matter Exploratory Setup (RADES) — Saiyd Ahyoune[1], Alejandro Álvarez Melcón[2], Sergio Arguedas Cuendis[1], Sergio Calatroni[3], Cristian Cogollos[4], Alejandro Díaz-Morcillo[2], Babette Döbrich[4], Juan Daniel Gallego[5], José María García-Barceló[4], Benito Gimeno[6], Jessica Golm[3,7], Xavier Granados[8], Joffre Gutierrez[8], •Louis Herwig[4,9], Igor García Irastorza[10], Neil Lamas[8], Antonio Lozano-Guerrero[2], William L. Millar[3], Chloé Malbrunot[11], Jordi Miralda-Escudé[1,12], Pablo Navarro[2], Jose R. Navarro-Madrid[2], Teresa Puig[8], Marc Siodlaczek[13], Guilherme Telles[8], and Walter Wuensch[3] — [1]Institut de Ciències del Cosmos, Universitat de Barcelona — [2]Department of Information and Communications Technologies, Technical University of Cartagena — [3]CERN - European Organization for Nuclear Research — [4]Max-Planck-Institut für Physik — [5]Yebes Observatory (IGN) — [6]Instituto de Física Corpuscular (IFIC), CSIC-University of Valencia — [7]Institute for Optics and Quantum Electronics, Friedrich Schiller University Jena — [8]Institut de Ciència de Materials de Barcelona, CSIC — [9]Technical University of Munich — [10]Center for Astroparticles and High Energy Physics (CAPA), Universidad de Zaragoza — [11]TRIUMF — [12]Institució Catalana de Recerca i Estudis Avançats — [13]Technical University of Darmstadt, Institute for Energy Systems and Technology

The axion is a pseudoscalar particle, proposed as an extension to the Standard Model of particle physics, that is theorized to solve the strong CP problem in quantum chromodynamics by introducing a new symmetry that prevents CP violations in strong interactions. Additionally, it is considered a potential candidate for dark matter, offering a solution beyond the existing framework of the Standard Model. The RADES haloscope targets cosmic axions originating from the dark matter halo that surrounds our galaxy like a sphere. In the following, we describe the result of a haloscope axion search performed with an 11.7 T dipole magnet at CERN. We also reinterpreted our findings for dark photon limits, noting that the dark photon, a vector particle, is distinct due to its polarization. The search used a custom-made radio-frequency cavity coated with high-temperature superconducting tape. A set of several hours of data at a resonant frequency of around 8.84 GHz was analysed. In the currently unexplored axion mass range of around 36 μeV, we present the results of our search. Correspondingly, in this mass range, we also set a limit on the axion to photon coupling strength.

T 45.4 Tue 16:45 Geb. 30.35: HSI

snax: supernova analysis in xenon — •Melih Kara — Karlsruhe Institute of Technology, Institute for Astroparticle Physics

During the demise of a massive star, 99% of its energy is emitted as neutrinos, preceding any optical signals. Detection of these neutrinos offers crucial insights into the core collapse and associated mechanisms.

Unlike typical neutrino detectors focusing on single flavors, large dark matter detectors such as XENONnT, LZ, and future models like DARWIN utilize coherent elastic neutrino-nucleus scattering (CEνNS) in the low-energy range to detect interactions from neutrinos of all flavors.

This presentation outlines how XENONnT and similar dark matter detectors can establish a robust analysis framework for the prompt identification and analysis of galactic supernovae through the CEνNS channel. Specifically, we look into signal simulation, identification in the data stream, and the implementation of an active software trigger for seamless communication with the Supernova Early Warning System (SNEWS). Probing inverse beta decay from the same flux using the water shield that is usually employed as an ancillary veto system could also enhance the detection significance. We conclude that dark matter detectors can play an important role in the analysis of the next galactic supernova.

This work is supported in part through the Helmholtz Initiative and Networking Fund (grant no. W2/W3-118). Support by the graduate school KSETA at KIT is gratefully acknowledged.

T 45.5 Tue 17:00 Geb. 30.35: HSI

Direct search for modulated Dark Matter signals with XENON1T — •Lutz Althueser for the XENON-Collaboration — Institute for Nuclear Physics, University of Münster, Germany

The XENON Dark Matter Project uses a dual-phase xenon time projection chamber (TPC) to directly search for Dark Matter (DM), such as weakly interacting massive particles (WIMPs). DM particles are expected to scatter off xenon nuclei in the active detector region, leading to nuclear and electronic recoils. The measured DM count rate is expected to modulate with a certain amplitude and phase.

The concept of annual modulation assumes that DM exists as a spherical and non-rotating halo in which the Earth and Sun are contained. Given the relative movement of the Sun, Earth and galactic center, one would expect a time-dependent DM interaction rate. Using this time dependent signature of the count rate provides an additional handle for the background discrimination, one of the biggest challenges of any direct detection DM experiment.

The talk will give an introduction to the characteristics of the event rate modulation under the Standard Halo Model and dives into the search for modulations over the runtime of the XENON1T experiment.

The work of the author is supported by Deutsche Forschungsgemeinschaft (DFG) through the Research Training Group "GRK 2149: Strong and Weak Interactions - from Hadrons to Dark Matter".

T 45.6 Tue 17:15 Geb. 30.35: HSI

A first dark photon search with 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 aims to detect axions or dark photons in the mass range of 40-400 μeV that remains inaccessible to the traditional cavity approach. The key component

of MADMAX is the booster: a stack of dielectric disks that forms an open resonator whose volume can scale independently of the resonance frequency. To demonstrate the feasibility of this concept, the MADMAX prototype is currently under construction. Even before operation at cryogenic temperatures and magnetic field, a simple receiver chain and small booster is capable of exploring new dark photon parameter space.

In this talk I will present the results of a first dark photon search with the MADMAX prototype including the characterization and calibration of the receiver system and booster. Using a novel approach, the sensitivity to dark photons is obtained in a model-independent way and cross-checked against simulations.

T 45.7 Tue 17:30 Geb. 30.35: HSI

Extending light dark matter searches to the neutrino floor with spherical proportional counters — •Ioannis Manthos — University of Hamburg, Hamburg, Germany

The NEWS-G collaboration is searching for light dark matter candidates using spherical proportional counters (SPC). Access to the mass range from 0.05 to 10 GeV is enabled with the combination of low energy threshold, light gaseous targets (H, Ne, C), and highly radio-pure detector construction. To-date NEWS-G has placed world-leading constraints in both spin-independent and spin-dependent DM-nucleon cross sections. The current status of the experiment will be presented, along with the latest advances in spherical proportional counter instrumentation. The conceptual design and physics potential of DarkSPHERE, a 3m in diameter SPC fully electroformed underground in Boulby Underground Laboratory (UK), will be also presented.

T 45.8 Tue 17:45 Geb. 30.35: HSI

Illuminating the Invisible: Deep underground dark matter search with COSINUS — •Mukund Raghunath Bharadwaj for the COSINUS-Collaboration — Max Planck Institute for Physics

The COSINUS experiment (Cryogenic Observatory for SIgnatures seen in Next generation Underground Searches) is a cryogenic, low-background experiment being set up at Laboratori Nazionali del Gran Sasso, Italy. It aims to provide a model independent cross-check of the DAMA/LIBRA findings of a potential dark matter-like modulation signal. COSINUS utilizes a two-channel readout system based on transition edge sensors (TESs) that allows for particle discrimination. It consists of ultrapure scintillating sodium iodide (NaI) crystals read out using a novel remoTES scheme to measure the phonon signal of a particle interaction. A silicon beaker surrounding the crystal is used to measure the light signal from the same particle interaction. Results from the latest prototypes and updates on the setup will be presented in this contribution.