T 54: Direkte Suche nach Dunkler Materie III

Zeit: Mittwoch 16:00–18:25 Raum: H09

Gruppenbericht T 54.1 Mi 16:00 H09

Direct Dark Matter Search with the CRESST-III Experiment — •Alexander Langenkämper for the CRESST-Collaboration — Physik-Department E15, Technische Universität München, D-85747 Garching, Germany

The detection of dark matter (DM) is one of the biggest challenges in modern astroparticle physics. The CRESST-III (Cryogenic Rare Event Search with Superconducting Thermometers) experiment aims at the direct detection of DM particles via their elastic scattering off nuclei. Each detector consists of a ∼25 g scintillating $CaWO_4$ single crystal operated as cryogenic detector at millikelvin temperatures. An interaction in the $CaWO_4$ target crystal leads to a phonon and a light signal which is detected by a separated cryogenic light detector. The read-out of phonon and light signals allows an event-by-event particle discrimination which is used for background suppression. The latest run of the experiment (CRESST-III Phase 1) started data taking in August 2016 and was successfully finished in 2018, reaching nuclear recoil thresholds of well below 100 eV. In this talk the latest results will be presented. Requirements and perspectives for the upcoming CRESST-III phase will be discussed.

Gruppenbericht T 54.2 Mi 16:20 H09

NaI-based direct search for dark matter with the COSINUS experiment — •Martin Stahlberg for the COSINUS-Collaboration — Institut für Hochenergiephysik der ÖAW, A-1050 Wien - Austria — Atominstitut, Technical University Vienna, A-1020 Wien - Austria

Presently, the search for dark matter is one of the most prominent fields in physics. Although the claim of an observation of a dark matter modulation signal has been made by the DAMA/LIBRA collaboration several years ago, this result is in tension with null results from several other experiments. As none of these experiments use sodium iodide (NaI), a target material dependency remains as one possible explanation of the signal. COSINUS (Cryogenic Observatory for Signals seen in Next-generation Underground Searches) employs scintillating cryogenic calorimeters operated at temperatures of a few mK to directly detect interactions of dark matter particles in a target NaI crystal. This well-tested detection technique comprises two readout channels, a phonon and a light channel, and thereby allows for discrimination of signal and background on an event-by-event basis, with the additional advantage of a low detection threshold for nuclear recoils in the order of several keV. Through the use of NaI as target, a model-independent direct comparison with the DAMA/LIBRA results will be possible. We will report the status of the COSINUS project, as well as first results obtained with prototypes. Finally, an outlook on the planned setup of the experiment will be given.

T 54.3 Mi 16:40 H09

Development of the First Prototype of an MMC-Based Detector for Light Dark Matter Direct Detection — •Arnulf Barth[1], Klaus Eitel[2], Christian Enss[1], Andreas Fleischmann[1], Loredana Gastaldo[1], Sebastian Kempf[1], Bernhard Siebenborn[2], and Marc Weber[2] — [1]Kirchhoff Institute for Physics, Heidelberg University. — [2]Institute for Nuclear Physics, Karlsruhe Institute of Technology.

The use of low temperature detectors in the search for the direct interaction of dark matter (DM) particles in a suitable target has opened the possibility to reach high sensitivities even at masses well below $1\,\mathrm{GeV}/c^2$. We present the design for a low-threshold detector optimized for the search of light DM particles based on metallic magnetic calorimeters (MMCs) with a germanium (Ge) crystal as a scattering target. The interaction of a DM particle in the Ge crystal would create two different kinds of excitations: phonons and electron-hole pairs. We discuss the design of a 3-fold MMC system for the measurement of the temperature increase of the Ge crystal, and how the temperature signal can be amplified via the Neganov-Trofimov-Luke effect to ensure a high sensitivity. A first detector prototype has already been developed. We describe the fabrication steps and a first characterization of the performance.

T 54.4 Mi 16:55 H09

Modelling backgrounds for the CRESST experiment — •Holger Kluck for the CRESST-Collaboration — Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, 1050 Wien, Österreich — Atominstitut, Technische Universität Wien, 1020 Wien, Österreich

CRESST searches directly for dark matter (DM) with $CaWO_4$ crystals operated as cryogenic calorimeters. It established leading limits for the spin-independent DM-nucleon scattering cross-section down to DM-particle masses of $350\,\mathrm{MeV}/c^2$. At this mass regime, the rejection power against electromagnetic background starts to degrade. The background in the region of interest is mainly caused by β and γ decays of radioactive contaminations in the $CaWO_4$ crystals and their Cu surrounding. To gain a reliable understanding of these background components a detailed Geant4 simulation code was developed.

In this contribution we present the final model of electromagnetic backgrounds for CRESST-II phase 2. We discuss ongoing modifications to adapt this model for the current CRESST-III phase 1 and to improve its accuracy. Finally, we show preliminary simulations of the cosmic activation of $CaWO_4$.

T 54.5 Mi 17:10 H09

DELight: A new detection concept to search for light Dark Matter — •Klaus Eitel[1], Arnulf Barth[2], Christian Enss[2], Andreas Fleischmann[2], Loredana Gastaldo[2], Sebastian Kempf[2], Bernhard Siebenborn[1], and Marc Weber[3] — [1]Karlsruher Institut für Technologie, Institut für Kernphysik — [2]Kirchhoff-Institut für Physik, Universität Heidelberg — [3]Karlsruher Institut für Technologie, Institut für Prozessdatenverarbeitung und Elektronik

Recently, there has been increased interest in investigating Dark Matter particle candidates in the MeV mass range. Such light DM particles could be detected via DM-electron scattering with energy transfers in the eV range. An excellent target material is Ge with an efficient band gap of only 3eV. Amplifying the phonon signal in a mK-cold Ge crystal via the Neganov-Luke effect and reading out this signal via a metallic magnetic calorimeter (MMC) has the potential to detect single electron-hole pairs and thus test a yet unexplored parameter range for DM.

We present the physical motivation, the general detection scheme and first R&D tests performed in the last months.

T 54.6 Mi 17:25 H09

Investigation of Production Techniques for Sputtered Tungsten Thin Films — •Tobias Ortmann, Angelina Kinast, Alexander Langenkämper, Elizabeth Mondragon, Andrea Münster, Luca Pattavina, Walter Potzel, Stefan Schönert, Raimund Strauss, and Michael Willers for the CRESST-Collaboration — Technische Universität München, Physik Department, Lehrstuhl E15, James-Franck-Str. 1, D-85748 Garching

The CRESST experiment (Cryogenic Rare Event Search with Superconducting Thermometers) searches for nuclear recoils events induced by elastic scattering of dark matter particles off the target nuclei within CaWO4 target crystals. The detectors are operated at a temperature of (10 mK) and consist of the target crystal and a separate cryogenic detector. Both heat (phonon) and light signals are read out via a tungsten TES (Transition Edge Sensor) utilizing the superconducting phase transition of tungsten to measure the energy deposited in the absorbers. Until now the TES are produced via electron beam physical vapor deposition. For future large scale production the application of magnetron sputtering is investigated in terms of film quality and reproducibility. Several sputtering techniques were examined and the results are presented. This work was supported by the DFG Excellenzcluster Origin and Structure of the Universe, the SFB 1258 and the Maier-Leibnitz- Laboratory (Garching).

T 54.7 Mi 17:40 H09

Production and investigation of radiopure $CaWO_4$ crystals for the CRESST experiment — •Angelina Kinast[1], Andreas Erb[1,2], Andreas Erhart[1], Alexander Langenkämper[1], Elizabeth Mondragón[1], Andrea Münster[1], Tobias Ortmann[1], Luca Pattavina[1], Walter Potzel[1], Stefan Schönert[1], Raimund Strauss[1], and Michael Willers[1] — [1]Physik-Department E15, Technische Universität München, D-85747 Garching, Germany — [2]Walther-Meißner-Institut für Tieftemperaturforschung, D-85748

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The direct dark matter search experiment CRESST (Cryogenic Rare Event Search with Superconducting Thermometers) uses scintillating $CaWO_4$ single crystals as targets for potential recoils of dark matter particles. For several years these $CaWO_4$ crystals have been produced in-house at Technische Universität München (TUM) via Czochralski growth from the raw materials $CaCO_3$ and WO_3. Thereby, extensive powder purification procedures have been applied. In a next step, TUM aims for minimizing the internal stresses of the $CaWO_4$ crystals. For this a COMSOL-simulation of the growth process was developed. In this talk the results of this simulation will be presented. In addition, the status of the alpha screening measurements planned at TUM, which are an important tool for characterization of TUM-grown crystals, will be presented. This research was supported by the DFG cluster of excellence "Origin and Structure of the Universe", by the BMBF Verbundprojekt 05A2017 CRESST-XENON and by the SFB1258.

T 54.8 Mi 17:55 H09

Erster Vergleich von Oberflächenereignissen eines Germaniumdetektors mit einer neuen 3d Simulationssoftware — •Lukas Hauertmann für die LEGEND-Kollaboration — Max-Planck-Institut für Physik

Germaniumdetektoren kommen in Experimenten mit niedrigem Untergrund zum Einsatz. So, z.B. in den beiden Experimenten GERDA und MAJORANA, die nach neutrinolosem doppelten Betazerfall suchen. In der nächsten Generation dieser Experimente soll die Anzahl der Detektoren erhöht und der Untergrund noch weiter reduziert werden. Um dazu beizutragen, wurde in der GeDet (Germaniumdetektor Entwicklung) Gruppe am MPI für Physik eine neue Software, „SolidStateDetectors.jl“ , zur 3d Simulation solcher Detektoren entwickelt. Diese hilft Germaniumdetektoren besser zu verstehen und mehr Untergrundereignisse als solche zu identifizieren. Die GeDet Gruppe besitzt auch mehrere Teststände um Germaniumdetektoren experimentell zu untersuchen. Einer davon ist der Teststand GALATEA, der besonders geeignet ist um die Oberflächeneffekte bei Germaniumdetektoren mit Alpha- und Beta-Teilchen zu studieren. In diesem Vortrag werden erste Vergleiche zwischen mittels der neuen Software simulierten und in GALATEA experimentell aufgenommenen Pulsformen gezeigt.

T 54.9 Mi 18:10 H09

Eine neue Software zur 3d Simulation von Solid-State Detektoren — •Martin Schuster für die LEGEND-Kollaboration — Max-Planck Institut für Physik, München

Germanium- und Siliziumdetektoren kommen in einer Vielzahl von Experimenten weltweit zum Einsatz und haben einen festen Platz in zahlreichen Industriefeldern. In der GeDet (Ger- maniumDetektor Entwicklung) Gruppe am MPI für Physik werden Germaniumdetektoren genau untersucht. Dabei spielt der Vergleich von im Experiment aufgenommenen und simulierten Daten eine entscheidende Rolle. In der Gruppe wurde eine neue schnelle "Open Source" Software in der jungen Programmiersprache Julia geschrieben, mit der das Verhal- ten aller auf Dioden basierenden Halbleiterdetektoren simuliert werden kann. Das Paket dient der Berechnung der elektrischen Potentiale und Felder und bietet die Möglichkeit der Pulsformsimulation basierend auf der Drift der Ladungsträger. Das Einlesen von GEANT4-generierten Ereignissen ist möglich. In diesem Vortrag wird die Funktionsweise der Software Schritt für Schritt erläutert. Als Beispiel dient ein vierfach segmentierter n-Typ Punktkontakt - Germaniumdetektor.