T 35: Searches/BSM II

Time: Tuesday 16:15–18:30 Location: KH 02.018

T 35.1 Tue 16:15 KH 02.018

The current status of the Mu2e experiment at Fermilab — •Stefan E. Müller, Anna Ferrari, Oliver Knodel, and Reuven Rachamin for the Mu2e-Collaboration — Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany

The Mu2e experiment, which is currently under construction at the Fermi National Accelerator Laboratory near Chicago, will search for the neutrinoless direct conversion of a muon to an electron in the field of an aluminum nucleus, aiming at a sensitivity four orders of magnitude better than previous experiments. The observation would imply the violation of charged lepton flavor, and hint at physics beyond the Standard Model.

With the arrival of the large superconducting solenoid magnets at Fermilab, and the installation of the main detector subsystems at their final locations inside the Mu2e hall, the experiment has entered an exciting phase of its construction towards data taking.

The design and status of the Mu2e experiment and its detector subsystems will be presented, highlighting the large progress made over the last year.

T 35.2 Tue 16:30 KH 02.018

Probing hidden sectors with the SHiP experiment at CERN — •James Webb for the SHiP-D-Collaboration — Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, 79104 Freiburg, Germany

SHiP (Search for Hidden Particles) is a general purpose fixed target experiment. Approved in 2024 by the CERN research board, SHiP will be CERNs flagship experiment in the search for GeV-scale Feebly Interacting Particles (FIPs) and accelerator neutrino physics.

A 400 GeV/c proton beam extracted from the Super Proton Synchrotron (SPS) will be dumped on a heavy target, producing an expected 6×10^{20} proton-target collisions over 15 years of operation. A dedicated detector, based on a long helium decay volume, surrounded by veto detectors, and then followed by a spectrometer and particle identification detectors, will allow for a variety of new physics models with light long-lived exotic particles to be probed in a near-zero background environment. This detector will increase the discovery sensitivity for many new physics models by orders of magnitude. A second detector dedicated to the study of neutrino cross-sections of all three flavours, will incorporate tracking and calorimetry detectors interwoven between five tonnes of tungsten and iron plates. The large neutrino flux produced during the beam dump coupled with the mass of the detector will yield a significant number of neutrino interactions that will become available for measurement.

In this talk a brief discussion on the physics potential and an overview of the detector layout, with an emphasis on the contributions from the German community, will be presented.

T 35.3 Tue 16:45 KH 02.018

Search for exotic particles at NA62 — •Daniel Grewe[1], Babette Döbrich[1], Otmar Biebel[3], Tommaso Spadaro[2], Jan Jerhot[1], Lo Chiatto Prisco[1], Jonathan Schubert[1], and Marczika András[1] — [1]Max-Planck-Institut für Physik, Munich, Germany — [2]INFN e Laboratori Nazionali di Frascati,Frascati,Italy — [3]LMU, Munich, Germany

The NA62 experiment at the CERN SPS primarily aims to measure rare kaon decays. In addition, the experiment has the capability to collect data in a beam dump mode, where the 400 GeV protons are dumped on an absorber. In this configuration, exotic particles might be produced and reach the fiducial volume. Previous searches have focused on exotic particles with charged particle final states. In this talk, the first steps toward an analysis of a $\gamma\ \gamma$ final state decay are presented, including the development of new methods for vertex reconstruction for such decays.

T 35.4 Tue 17:00 KH 02.018

Event Selection for the Search of Sub-Relativistic Magnetic Monopoles with the IceCube Neutrino Observatory — •Jonas Häussler[1], Bryndis Kern[1], Nick Schmeisser[2], and Christopher Wiebusch[1] — [1]RWTH Aachen, Aachen, Deutschland — [2]Bergische Universität Wuppertal, Wuppertal, Deutschland

Grand-Unified-Theories predict the existence of magnetic monopoles to be created during transitions from one gauge group to a smaller sub-group. For most GUTs, magnetic monopoles can reach masses above 10^{14} GeV resulting in sub-relativistic speeds. These magnetic monopoles can catalyze nucleon decays via the Rubakov-Callan effect, resulting in a unique signature of small particle cascades along the trajectory of a slow moving particle. To search for this signature, a dedicated slow particle trigger has been implemented in the IceCube Neutrino Observatory since 2012. The low, if existent, flux of magnetic monopoles requires an exceptional classification, with high background rejection and signal efficiency. In this talk, a multi-level boosted decision tree for the event selection and the sensitivity of IceCube for the detection of sub-relativistic magnetic monopoles, is shown. This talk presents an event selection using a multi-level boosted decision tree, the sensitivity for the detection of sub-relativistic magnetic monopoles, and potential applications to other slow exotic particle searches in IceCube.

T 35.5 Tue 17:15 KH 02.018

Luminescence Simulation for the Search of Sub-Relativistic Magnetic Monopoles in IceCube — •Bryndis Kern, Jonas Häussler, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Magnetic monopoles are hypothetical particles predicted by various Grand Unified Theories, typically expected to have masses exceeding 10^{14} GeV. Such monopoles, as relics from the Big Bang, would propagate with sub-relativistic velocities, characterized by $\beta < 10^{-2}$. In ice they can emit light through two mechanisms: the catalyzation of nucleon decays via the Rubakov-Callan effect and luminescence. This results in a distinct signature of a slow light-emitting track in the IceCube Neutrino Observatory. Dedicated simulations of sub-relativistic monopole propagation and detector response are employed to model these signatures and to provide training data for Boosted Decision Trees (BDTs) used in event selection. This talk shows results from the inclusion of a new luminescence model into the monopole simulation framework.

T 35.6 Tue 17:30 KH 02.018

Search for Nuclearites with IceCube — •Nick Jannis Schmeisser[1] and Jonas Häussler[2] for the IceCube-Collaboration — [1]Bergische Universität Wuppertal — [2]RWTH Aachen

Nuclearites are lumps of strange quark matter that were first proposed in the 1980s. Strange quark matter consists of roughly equal amounts of up-, down-, and strange-quarks and could appear in the Standard model at high densities as well as in BSM theories. They are candidates for the cold dark matter observed in the Universe. We are presenting the first search for nuclearites with IceCube. The IceCube Neutrino Observatory is expected to have the best sensitivity to nuclearites due to its size and lower noise rate in comparison to other neutrino telescopes.

This presentation gives a short motivation for nuclearites and discusses their properties and the signature they are expected to produce in the IceCube detector, which are thermal shocks produced by atomic collisions in the Antarctic ice. The analysis chain used to search for nuclearites is discussed, leading to the first sensitivities of the IceCube detector for different nuclearite masses.

T 35.7 Tue 17:45 KH 02.018

Design Studies and Detector Simulation for the proposed Dark Photon Search Experiment Lohengrin — •Cedric Breuning for the Lohengrin-Collaboration — Physikalisches Institut, University of Bonn, Bonn, Germany

The proposed Lohengrin experiment will search for light dark matter at the Electron Stretcher Accelerator (ELSA) in Bonn. It employs the fixed-target missing momentum based technique for searching for dark-sector particles. A beam of electrons is extracted from ELSA and is shot onto a thin target to produce mainly Standard Model bremsstrahlung and – in rare occasions – possibly new particles, like the dark photon, coupling feebly to the electron. In the current phase, detector layouts and designs are studied and optimized to reach the highest sensitivity. This requires an accurate simulation of the interactions in the target and the detector response. In this talk, we present one of the ongoing design studies for the target and electromagnetic calorimeter of the experiment, including a full detector simulation in the DD4hep framework.

T 35.8 Tue 18:00 KH 02.018

Light Dark Matter simulation studies with GEANT4 for the DarkMESA experiment — •Saskia Plura for the MAGIX-Collaboration — Institute for Nuclear Physics, Johannes Gutenberg University Mainz, Germany

Dark Matter searches are an integral part of physics beyond the Standard Model. However, Dark Matter has yet to be observed directly. Theoretical models provide a large parameter space for Dark Matter and allow for different particle properties. Models incorporating so-called portal interactions, which allow Dark Matter to interact with Standard Model matter, are of special interest. Examples for these are Dark Photons and Axion-like particles (ALPs), which can be studied at low energy accelerator facilities.

The DarkMESA experiment is a beam dump experiment located at the upcoming accelerator MESA at the JGU Mainz, set to start operation in 2026. The accelerator provides an electron beam of 155 MeV and 150 μA in extracted beam mode, which, alongside the beam dump of the P2 experiment, provides an ideal environment for Light Dark Matter (LDM) searches.

To predict the potential signal yield of the separate phases of the DarkMESA experiment in relation to different Dark Matter models, a GEANT4 simulation is used. The simulation incorporates different production channels for Dark Matter through Dark Photons, ALPs, pseudoscalar or scalar mediators and offers both invisible (e.g. DM decays) or visible (e.g. SM decays) decay options. Here, the current status of the simulations is discussed.

T 35.9 Tue 18:15 KH 02.018

Search for Dark Matter with metastable nuclear isomer ^{180m}Ta — •Jannis Ender, Björn Lehnert, and Kai Zuber — IKTP TU Dresden

Due to extremely suppressed transitions, the nuclear isomer ^{180m}Ta is stable on cosmological time scales. It is the longest lived isomer and its decay has not yet been observed with half-live limits at $T_{1/2} > 0.29 \times 10^{18} y$ over all decay channels. Recently it has been proposed to use such isomers as detectors for Dark Matter particles, in which the DM particles would deexcite the isomer by scattering with the nucleus. A measurable signal could then be obtained through the decay chain of the isomer or the exited DM particle rescattering in a conventional DM detector setup. In this talk, different methods of implementing these possibilities into DM detectors are discussed to further probe the parameter space of various DM models currently unavailable.