T 23: Searches/BSM II (Non-collider)

Time: Tuesday 16:15–18:00 Location: ZHG010

T 23.1 Tue 16:15 ZHG010

Stringent Constraints on Pseudoscalar Couplings from Precision Hyperfine Splitting Measurements — •Cedric Quint[1], Zoltán Harman[1], Joerg Jaeckel[2], Fabian Heisse[1], Lutz Leimenstoll[2], and Christoph H. Keitel[1] — [1]Max Planck Insitute for Nuclear Physics, Heidelberg, Germany — [2]Institute for Theoretical Physics, Heidelberg, Germany

Axion-like particles and similar new pseudoscalar bosons coupled to nucleons and electrons are known to lead to spin-dependent forces in atoms and ions. Hyperfine structure measurements are a sensitive probe to this effect. Specific differences, which are meant to reduce uncertainties due to nuclear effects in hyperfine structure calculations and measurements, yield stringent bounds on these couplings. We show that existing measurements on Be provide competitive limits in the region $m_\phi \gtrsim 100\,\mathrm{keV}$. We find that measurements on Cs and B have discovery potential. We also discuss various other candidate elements and evaluate their prospects.

T 23.2 Tue 16:30 ZHG010

Nonlinear calcium King plot constrains new bosons and nuclear properties — •Agnese Mariotti[1], Alexander Wilzewski[2], Lukas J. Spiess[2], Malte Wehrheim[2], Shuying Chen[2], Steven A. King[2], Peter Micke[2], Melina Filzinger[2], Martin R. Steinel[2], Nils Huntemann[2], Erik Benkler[2], Piet O. Schmidt[2,7], Luca I. Huber[3], Jeremy Flannery[3], Roland Matt[3], Martin Stadler[3], Robin Oswald[3], Fabian Schmid[3], Daniel Kienzle[3], Jonathan Home[3], Diana Prado Lopez Aude Craik[3], Menno Door[4], Sergey Eliseev[4], Pavel Filianin[4], Jost Herkenhof[4], Kathrin Kromer[4], Klaus Blaum[4], Vladimir A. Yerokhin[4], Igor A. Valuev[4], Natalia S. Oreshkina[4], Chunhai Lyu[4], Sreya Banerjee[4], Christoph H. Keitel[4], Zoltan Harman[4], Julian C. Berengut[6], Anna Viatkina[2,5], Jan Gilles[2,5], Andrey Surzhykov[2,5], Michael K. Rosner[4], Jose R. Crespo Lopez-Urrutia[4], Jan Richter[1,2], and Elina Fuchs[1,2] — [1]LUH-ITP — [2]PTB — [3]LUH-IQE — [4]MPI — [5]TUB-IMP — [6]UNSW — [7]LUH-IQ

The SM predicts isotope shifts (IS), i.e. differential measurements of the same electronic transition in different isotopes of an element, to follow a linear relation: the King plot (KP). Nonlinearities in KP set constraints on the existence of new interactions. We measure IS in Ca14+ and in Ca+, as well as isotope masses of calcium, observing for the first time a nonlinearity in this system. Combining these with the calculation of the next-to-leading SM term, we are able to improve the bounds on the existence of a new light boson coupling electrons and neutrons.

T 23.3 Tue 16:45 ZHG010

BDF/SHiP @CERN (NA67): Search for Hidden Particles at a Future Beam Dump Facility — •Annika Hollnagel for the SHiP-Collaboration — JGU Mainz (DE)

The Search for Hidden Particles (SHiP) experiment has been selected as the new flagship project of the CERN Physics Beyond Colliders intensity frontier, featuring a dedicated Beam Dump Facility (BDF) at CERN's North Area ECN3 to exploit the full potential of the 400GeV SPS proton beam.

The experiment will be realised by a two-fold detector setup enabling a diverse physics program: While the Hidden Sector (HS) detector is going to study the decay of Heavy Neutral Leptons (HNL), Axion-Like Particles (ALPs), and other Feebly-Interacting Particles (FIPs) in a broad range of masses and coupling inaccessible to colliders, the upstream Scattering and Neutrino Detector (SND) will enable a direct search for Light Dark Matter (LDM), as well as measurements in neutrino physics with unprecedented precision. With the detector located closely downstream of the dense proton target, a major challenge will be the reduction of beam-related backgrounds. Following the hadron stopper, a magnetic muon shield will deflect most of these particles from the detector acceptance, and the 50m-long HS decay volume will be enveloped by a Surrounding Background Tagger (SBT). This talk will give an overview of the detector technologies and physics capabilities of the proposed experiment.

Having recently been approved by the CERN Research Board, this is the ideal time for new groups to join the project.

T 23.4 Tue 17:00 ZHG010

Background suppression in the SHiP experiment with the Surround Background Tagger — •Katharina Albrecht for the SHiP-SBT-Collaboration — Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Germany

SHiP (Search for Hidden Particles) is an experiment that will be installed in a dedicated beam-dump facility in the ECN3 cavern, located in the CERN north area. SHiP will search for feebly interacting particles (FIPs) produced by 400 GeV/c protons from the SPS impinging on a heavy-metal target. Over a 15-year span, the objective is to accumulate 6×10^{20} protons on target with a detector setup that allows suppression of possible background to a negligible level. The experiment focuses on optimizing the sensitivity for models featuring long-lived FIPs below 10 GeV/c^2 by minimizing backgrounds induced by the huge flux of neutrinos and muons emerging from the beam-dump target. The Surround Background Tagger (SBT) is a critical component surrounding the 50 m long helium-filled decay volume. The SBT is instrumental to detect charged particles entering the decay volume from the sides as well as inelastic interactions of neutrinos and muons taking place inside the helium-filled decay volume, but also in the SBT itself. The presentation will discuss simulation studies on the background suppression strategies with focusing on role of the SBT.

T 23.5 Tue 17:15 ZHG010

Search for Sub-Relativistic Magnetic Monopoles with the IceCube Neutrino Observatory — •Jonas Häussler, Jakob Böttcher, Christopher Wiebusch, and Peter-John Cusack — RWTH Aachen University, Aachen, Germany

Magnetic monopoles are Beyond-Standard-Model particles, predicted by Grand Unified Theories (GUTs) to be created during their freeze-out in the early universe. At typical masses of the GUT-scale - above 10^{14} GeV - these particles would move at sub-relativistic speeds. The Rubakov-Callan effect predicts that magnetic monopoles can catalyze proton decays. This results in a unique signature of small particle cascades along the trajectory of the slow-moving particle. Since 2012, a dedicated Slow-Particle Filter has been implemented in the IceCube Neutrino Observatory for the detection of magnetic monopoles. The low, if existent, flux of the monopoles requires exceptional background rejection and signal efficiency. This is accomplished using machine learning methods. For this analysis we use a multi-level Boosted-Decision-Tree classifier. We present the strategy behind the background and signal simulation, the classification efficiency, and the projected sensitivity of IceCube for the detection of sub-relativistic magnetic monopoles.

T 23.6 Tue 17:30 ZHG010

Faint non-standard model particles in IceCube — •Nick Jannis Schmeisser, Timo Stürwald, and Christian Locatelli for the IceCube-Collaboration — Bergische Universität Wuppertal

Fractionally Charged Particles (FCPs) are particles that carry a fraction of the elementary charge e, which are predicted by multiple extensions of the standard model of particle physics. Relativistic FCPs produce Cherenkov light in the IceCube Neutrino Observatory. Due to the charge dependence of the Cherenkov light yield, the particles produce faint tracks in the detector. To increase the sensitivity for these faint signatures, the Faint Particle Trigger (FPT) was developed and deployed in 2023.

This presentation shows simulation studies optimizing the reconstruction of events triggered by the FPT. Different timing-based reconstruction techniques are compared based on their performance in reconstructing simulated FCP events. The reconstruction performance especially depends on the reduction of noise hits in the detector, which are dominant in comparison to the number of signal hits produced by FCPs. First efforts towards a Machine-Learning based analysis searching for FCPs using events triggered by the FPT are shown. A first reduction of background events includes the Faint Particle Filter utilizing results from the optimized event reconstruction.

T 23.7 Tue 17:45 ZHG010

Exploring beta decay with light boson emission in the KATRIN experiment — •Joscha Lauer for the KATRIN-Collaboration — Karlsruhe Institute of Technology (KIT)

The Karlsruhe Tritium Neutrino (KATRIN) experiment is designed to measure the effective electron antineutrino mass with a sensitivity better than $m_\nu c^2 = 0.3\,\mathrm{eV}$ (90% C.L.) in a kinematic approach by applying precision electron spectroscopy to the beta decay of molecular tritium. The measurement focuses on the spectral endpoint (E_0) region, extending up to tens of eV below $E_0 \approx 18.6\,\mathrm{keV}$.

Light neutral pseudoscalars and vector bosons are predicted in many theories beyond the Standard Model (BSM). Constraints on the couplings of such particles to neutrinos or electrons can be derived from cosmological, astrophysical and laboratory observations. With high-statistics beta spectroscopy, KATRIN complements these approaches, as the emission of an additional light state in tritium beta decay introduces characteristic modifications to the observed electron spectrum. We present the computation of these spectra, based on JHEP 01 (2019) 206. Preliminary analysis of the second KATRIN measurement campaign explores the parameter space of boson couplings, offering perspectives for BSM physics.

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