T 62: Search for New Particles V

Time: Wednesday 16:00–17:45 Location: Tl

T 62.1 Wed 16:00 Tl

Development of a new trigger for exotic particle searches with IceCube — •Timo Stürwald for the IceCube-Collaboration — Bergische Universität Wuppertal, Deutschland

The IceCube Neutrino Observatory is a km^3 scale Cherenkov light detector that also searches for signatures of particles beyond the standard model. The upcoming IceCube-Gen2 will improve the sensitivity for these searches due to an increased detection volume. The better sensitivity allows for the detection of faint signatures of exotic particles including Magnetic Monopoles, Q-Balls and Nuclearites which directly or indirectly produce light. In this talk we present the development of a new trigger that combines and improves searches for exotic particles from sub-relativistic to relativistic speeds. This new trigger includes the analysis of isolated single hits that so far are not included in any IceCube trigger.

T 62.2 Wed 16:15 Tl

Search for Sub-Relativistic Magnetic Monopoles in IceCube — •Christian Dappen, Jakob Böttcher, Sukeerthi Dharani, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen University - Physics Institute III B, Aachen, Germany

The IceCube Neutrino Observatory detects high energy atmospheric neutrinos through their interaction in the Antarctic ice while also searching for more exotic particles such as magnetic monopoles. These hypothetical particles are predicted by Grand Unified Theories to originate from the very early universe. For masses on the GUT-scale (10^{14} - 10^{17} GeV) those monopoles would move at subrelativistic speeds ($\beta < 10^{-2}$) through IceCube. A subrelativistic monopole in matter may catalyze nucleon decays via the Rubakov-Callan effect. This results in Cherenkov light from small particle showers along the trajectory of the monopole separated by centimeters to meters. This pattern is recognised by a dedicated Slow Particle Trigger in the detector. Simulated monopole signal and a data-driven background simulation are used to train a multivariate machine learning algorithm separating signal from background events. A first level Boosted Decision Tree is used to reject most of the background and further levels can perform a finer separation on the remaining events to achieve a final selection.

T 62.3 Wed 16:30 Tl

Sterile neutrino and exotics searches with the KATRIN experiment — Wonqook Choi, Stephanie Hickford, Leonard Köllenberger, and •Marco Wetter for the KATRIN-Collaboration — Institute for Astroparticle Physics and Institute of Experimental Particle Physics, Karlsruhe Institute of Technology

The KATRIN collaboration aims to determine the neutrino mass with a sensitivity of $0.2\,eV/c^2$ (90 % CL). This will be achieved by measuring the endpoint region of the tritium β-electron spectrum. Using this same measurement data searches for physics beyond the standard model, including eV-scale sterile neutrinos, right handed currents, and other exotic particles, can be performed.

The second KATRIN science run was taken in Autumn 2019. A sensitivity study for eV-scale sterile neutrinos using Monte Carlo equivalent to this high-statistics data set will be presented. Furthermore, an outlook will be given on analyses searching for physics beyond the standard model in the KATRIN data. This includes a search for right-handed currents and possible non V-A modifications to weak interactions.

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T 62.4 Wed 16:45 Tl

Search for new physics at NA62: beam line simulation for background studies — •Simone Schuchmann — Johannes Gutenberg University Mainz

The NA62 experiment challenges the Standard Model with measurements of rare charged kaon decays from a secondary charged kaon beam. In addition, searches for dark matter and exotic particles as well as high precision measurements of various kaon decays are performed. Not only the standard proton-on-target technique for secondary beam particle production is employed but also dumping of the proton beam upstream the detector region. Especially for these additional research targets the precise knowledge of the beam induced background is essential.

The background is produced by the decay of secondary beam particles and by beam interactions with material before reaching the detector. It is dominated by muons though careful measures to sweep them out of the detector acceptance were taken by the beam line design. In beam dump mode, the proton-on-material interaction is the main source for possible dark matter particle production as well as for secondary particle background. A simulation framework was developed which incorporates the detailed description of the NA62 detector using the GEANT4 software and the full secondary beam line employing the BDSIM software. In this contribution, the results of background simulation studies will be presented and an outlook for further possible measurements will be given.

T 62.5 Wed 17:00 Tl

Prospects for a Dark Photon Search Expermiment at the ELSA Electron Accelerator — Philip Bechtle, Klaus Desch, Oliver Freyermuth, Matthias Hamer, •Jan-Eric Heinrichs, and Martin Schürmann — Rheinische Friedrich-Wilhemls-Universität Bonn

The true nature of Dark Matter (DM) has long been of interest for scientists worldwide. Previous searches have so far been unsuccessful in finding proposed DM particles. A promising and not well explored parameter space of light DM particles up to 1 GeV remains to be subjected to intense experimental testing. Mainly two approaches are investigated by the community: Beam dump and single particle-tracking fixed-target experiments, respectively. In the latter case, single electrons with a narrow energy spectrum are extracted from a storage ring or linear accelerator and tracked individually in front and behind a target, yielding sensitivity to Bremsstrahlung of invisible particles

This talks highlights the future prospects of a fixed target experiment aimed at detecting particles from one of the simplest light DM models - Dark Photons. The underlying theory and the resulting experimental challenges and strategy will be explained. The possibility of building a corresponding experiment at the ELSA electron accelerator in Bonn is highlighted. First steps towards a Geant4 simulation, including pixel based tracking with a Kalman Filter, have been taken and will be presented.

T 62.6 Wed 17:15 Tl

Including heavy spin effects in the investigation of $\bar{b}\bar{b}ud$ tetraquark candidates with lattice QCD static potentials — •Andre C. Zimermmane-Santos[1,2], Jakob Hoffmann[2], and Marc Wagner[2] — [1]Deutsches Elektronen-Synchrotron - DESY, Hamburg, Germany — [2]Institut für Theoretische Physik, Goethe Universität, Frankfurt am Main, Germany

The study of exotic hadrons composed of four or more valence quarks is very challenging, both from theoretical and experimental perspectives. In this context, the particular class of states composed of two heavy antiquarks, $\bar{b}\bar{b}$, and two light quarks, ud is a promising system in the search for tetraquark candidates.

In this talk, I present an approach to investigate such a system in the Born-Oppenheimer approximation using lattice-QCD static potentials. In the static limit, spins of the heavy particles are irrelevant. To go beyond that limit, we have developed a formalism to include $\bar{b}\bar{b}$-spin corrections for arbitrary angular momentum. I will discuss and apply it in the context of a possibly existing $\bar{b}\bar{b}ud$ resonance with quantum numbers $I(J^P) = 0(1^-)$.

T 62.7 Wed 17:30 Tl

Study of the X(3915) at Belle — •Yaroslav Kulii[1], Thomas Kuhr[1], and Boris Grube[2] — [1]Ludwig-Maximilians-Universität München — [2]Technische Universität München

Many of the charmonium states, which consist of a charm and anti-charm quark, have been found and studied experimentally. Detailed theoretical predictions of the charmonium excitation spectrum agree well with the experimental data.

However, in recent years experiments discovered a growing number of charmonium-like states that do not fit into the predicted charmanticharm excitation spectrum. One such state is X(3915). It has been discovered by the BaBaR and Belle collaborations in the reaction $e^+e^- \to e^+e^- X(3915) \to e^+e^- J/\psi\omega$, where the final-state electron and positron were not detected. The analysis of projections of angular distributions preferred the $J^{PC} = 0^{++}$ hypothesis, but other quantum numbers, in particular $J^{PC} = 2^{++}$, could not be excluded.

Because of this the $X(3915)$ was initially identified as the $\chi_{c0}(2P)$ charmonium state, although its mass and decay width were not in good agreement with the theory predictions. Following the Belle discovery of the $X^*(3860)$, which agrees much better with the $\chi_{c0}(2P)$ hypothesis, opinions shifted towards interpreting the X(3915) as an exotic state. It could be, for example, a meson molecule or a so-called hybrid meson.

We will present the current state of affairs as well as the research prospects of studying the X(3915) in its $J/\psi\omega$ decay using Belle and, in the future, Belle II data.