T 64: Neutrinos, Dunkle Materie und Luftschauer

Zeit: Dienstag 16:45–19:10 Raum: VMP9 SR 30

Gruppenbericht T 64.1 Di 16:45 VMP9 SR 30

Sterile neutrino search in the STEREO Experiment — Christian Buck, Manfred Lindner, and •Christian Roca — MPIK

In neutrino oscillations, a canonical understanding has been established during the last decades after the measurement of the mixing angles θ_{12}, θ_{23}, θ_{13} via solar, atmospheric and, most recently, reactor neutrinos. However, the re-evaluation of the reactor neutrino theoretical flux has forced a re-analysis of most reactor neutrino measurements at short distances. This has led to an unexpected experimental deficit of neutrinos with respect to the theory that needs to be accommodated, commonly known as the "reactor neutrino anomaly". This deficit can be interpreted as the existence of a light sterile neutrino state into which reactor neutrinos oscillate at very short distances. The STEREO experiment aims to find an evidence of such oscillations.

The ILL research reactor in Grenoble (France) operates at a power of 58MW and provides a large flux of electron antineutrinos with an energy range of a few MeV. These neutrinos will be detected in a 2000 liter organic liquid scintillator detector doped with Gadolinium and consisting of 6 cells stacked along the direction of the core. Given the proximity of the detector, neutrinos will only travel a few meters until they interact with the scintillator. The detector will be placed about 10 m from the reactor core, allowing STEREO to be sensitive to oscillations into the above mentioned neutrino sterile state. The project presents a high potential for a discovery that would impact deeply the paradigms of neutrino oscillations and in consequence the current understanding of particle physics and cosmology.

Gruppenbericht T 64.2 Di 17:05 VMP9 SR 30

The OPERA Experiment: Discovery of ν_τ Appearance in the CNGS ν_μ Beam — •Annika Hollnagel for the OPERA-Hamburg-Collaboration — Universität Hamburg, Institut für Experimentalphysik

The long-baseline neutrino oscillation experiment OPERA has been designed for the direct observation of ν_τ appearance in the CNGS ν_μ beam.

The OPERA detector is located at the LNGS underground laboratory, with a distance of 730 km from the neutrino source at CERN. It is a hybrid apparatus built of about 150000 Emulsion Cloud Chamber modules providing micrometric resolution and Electronic Detector elements for online readout, interaction location, and the measurement of particle charge and momentum.

While CNGS beam data taking lasted from 2008 to 2012, the neutrino oscillation analysis is still ongoing: With the observation of a 5th τ neutrino event in an enlarged data sample, the experiment was recently able to report the discovery of $\nu_\mu \rightarrow \nu_\tau$ oscillations at a significance larger than 5σ.

T 64.3 Di 17:25 VMP9 SR 30

Neutrino-argon interactions in the T2K near detector — •Lukas Koch, Thomas Radermacher, Stefan Roth, and Jochen Steinmann — III. Physikalisches Institut B, RWTH Aachen

The T2K near detector employs three large, argon-filled TPCs with a total fiducial volume of about $10\,\mathrm{m}^3$ at ambient pressure. These TPCs have been exposed to the intense T2K muon-neutrino beam since the start of the experiment. The beam has a mean neutrino energy of 600 MeV and so far, data corresponding to over $6 \cdot 10^{20}$ ($4 \cdot 10^{20}$) protons on target was recorded in neutrino (anti-neutrino) mode.

We expect about 600 charged current neutrino-argon interactions in the data. That enables us to do the world's first neutrino-Argon cross section measurement in gaseous argon, thus making an important contribution to constraining nuclear interaction models for future neutrino oscillation measurements. This talk will describe the physics goals and present the current status of the analysis.

T 64.4 Di 17:40 VMP9 SR 30

Calibration and neutron detection efficiency in Double Chooz — •Helena Almazan, Christian Buck, Julia Haser, and Manfred Lindner for the Double Chooz-Collaboration — MPIK, Heidelberg

As an intense and pure source of low energy electron antineutrinos, nuclear reactors are one of the most powerful tools to analyse the neutrino oscillations. The Double Chooz experiment aims for a precise determination of the neutrino mixing angle θ_{13} with the new data from the near detector. In order to reach this precision, a high and accurately known detection efficiency of the inverse beta decay (IBD) signal – the antineutrino interaction – is required.

Several methods are available for detector calibration. Cosmic muons and spallation neutron captures are some examples of natural sources that are used. Furthermore, signals created by artificial sources contribute to the calibration with well defined classes of events. LED Light Injection systems in the Inner Detector and the Inner Veto are used to measure PMT gains and time responses. Radioactive sources deployed inside the detector are used to determine the energy scale and the detector stability. The ^{252}Cf source plays an important role in the detector calibration. In the spontaneous fissions of this isotope neutrons are produced with high multiplicity. An analysis of the neutron interactions in the scintillator can be used to estimate the detection efficiency of the delayed coincidence signal of the IBD reaction. New results from recent calibration campaigns will be presented, providing a crucial input for reactor antineutrino analysis with two detectors.

T 64.5 Di 17:55 VMP9 SR 30

ν_τ-physics with the SHiP experiment — •Daniel Bick, Stefan Bieschke, Joachim Ebert, Caren Hagner, and Walter Schmidt-Parzefall — Universität Hamburg, Institut für Experimentalphysik, Luruper Chaussee 149, 22761 Hamburg

SHiP stands for Search for Hidden Particles and is a recently proposed new general-purpose fixed target facility at the SPS at CERN. The main aim is the search for hidden particles predicted by different models capable of explaining dark matter, neutrino masses or the origin of baryon asymmetry in the Universe. Furthermore, a huge number of (τ-)neutrinos will be produced at such a facility making it an ideal place for ν_τ-physics and thus giving the opportunity for a measurement of the τ-neutrino cross-sections or a first-time experimental evidence of the anti-τ-neutrino.

This talk will give an overview of the neutrino experiment at the SHiP experiment. An emphasis is given to the reconstruction of muons from interactions in the neutrino target using a magnetic spectrometer.

T 64.6 Di 18:10 VMP9 SR 30

Study of the optical properties of the DF2000MA daylight film used in the XENON1T muon veto water tank — •Diego Ramírez — Institut für Physik, Johannes Gutenberg-Universität Mainz

XENON1T is the 3rd stage of a series of experiments performed by the XENON collaboration for the direct detection of dark matter candidates, such as WIMPs. Its projected spin-independent WIMP-nucleon elastic scattering cross-section entails an improvement of two orders of magnitude with respect to Xenon100 and requires, for a fiducial mass of the detector of about 1 ton liquid xenon, a similar reduction in background. In order to minimize the neutron background induced by cosmic ray muons, the XENON1T TPC is placed in the center of a 750 m^3 water tank acting as an active Cherenkov muon veto, the walls of which are clad with the high reflective DF2000MA foil by 3M.

The improved setup and results of a dedicated study of the reflective properties of the foil is presented, as well as a measurement of its possible wavelength shifting (WLS) properties. The analysis yields a specular reflectance of $\approx$ 100% for wavelengths larger than 400 nm, while $\approx$ 90% of the incoming light with wavelengths smaller than 370 nm is absorbed by the foil. The emission spectra of the WLS are dependent on the absorbed wavelength and show Gaussian shapes, with highest intensities at mean values of $\approx$ 450 nm emission wavelength.

T 64.7 Di 18:25 VMP9 SR 30

Status of the 2D Bayesian analysis of XENON100 data — •Stefan Schindler for the XENON-Collaboration — JGU, Staudingerweg 7, 55128 Mainz

The XENON100 experiment is located in the underground laboratory at LNGS in Italy. Since Dark Matter particles will only interact very rare with normal matter, an environment with ultra low background, which is shielded from cosmic radiation is needed. The analysis for XENON100 data was performed with the profile likelihood method (a frequentist approach) and still provides one of the most sensitive exclusion limits to WIMP Dark Matter.

Bayesian inference takes a different approach towards probability. Here, probability is interpreted as a degree of believe. In the Bayesian approach a prior probability density function (pdf) is defined, which represents the state of knowledge in a parameter of interest. After looking at the data, the knowledge is updated, which results in a posterior pdf. All inferences of the problem are obtained following Bayes'theorem. We present the status of an unbinned 2D approach, using Bayesian inference. Going away from a spatial averaged treatment of the signal in the detector, postion dependence is introduced. The progress to reconstruct mass and cross-section of an interacting WMIP for a given set of mock-data is shown and compared to the spatial averaged case.

T 64.8 Di 18:40 VMP9 SR 30

Mounic Footprint of Simulated Extensive Air Showers — •Mona Erfani[1,2], Markus Risse[1,2], and Alexey Yushkov[1,2] — [1]University of Siegen — [2]for the Pierre Auger Observatory

The muon component of extensive air showers produced by the ultra-high energy cosmic rays (E$\sim 10^{18}$ eV) is a subject of numerous studies related to the determination of the primary mass composition or to the properties of the hadronic interactions at the energies beyond the reach of LHC. In our work we investigate the nature of the fluctuations of the muon density at the ground and consider other characteristics of the muon footprint using CORSIKA simulations with no thinning applied to the muon component.

This work was supported by the BMBF Verbundforschung Astroteilchenphysik.

T 64.9 Di 18:55 VMP9 SR 30

Geant4-Simulationen des SLAC T-510-Experiments zur Messung elektromagnetischer Strahlung von Teilchenschauern — •Anne Zilles für die SLAC T-510-Kollaboration — Institut für Experimentelle Kernphysik, Karlsruher Institut für Technologie, Deutschland

In den letzten Jahrzehnten hat sich die Radiodetektion von ausgedehnten Luftschauern als Methode zur Messung von ultrahochenergetischer kosmischer Strahlen etabliert. Die Analyse der gemessenen Daten baut dabei auf der zugrunde liegenden Theorie der Radiostrahlung auf. Im Jahr 2014 führten wir ein Experiment unter kontrollierten Laborbedingungen am SLAC durch, mit dem wir die Strahlung im MHz-Bereich einer geladenen Teilchenkaskade gemessen haben. Dabei wurde ein Magnetfeld mit einer Stärke von bis zu 1000 G induziert. Parallel entwickelten wir eine detaillierte Simulation des Experiments, um das Radiosignal unter Verwendung von zwei modernen Formalismen für die Berechnung der elektromagnetischen Strahlung von Teilchenkaskaden vorherzusagen. Der Vortrag gibt Einblick in die Details der Simulation und präsentiert einen Vergleich der Simulationsergebnisse der beiden Formalismen mit den Messdaten. Dieser zeigt, dass die Simulationen quantitativ mit den Messungen innerhalb der Systematik übereinstimmen und eine qualitativ sehr gute Beschreibung geben.