T 102: Niederenergie-Neutrinophysik III

Zeit: Donnerstag 16:45–19:05 Raum: VMP9 SR 07

Gruppenbericht T 102.1 Do 16:45 VMP9 SR 07

Latest results from the Double Chooz experiment — •Marianne Göger-Neff for the Double Chooz-Collaboration — Physik Department E15, Technische Universität München

Double Chooz aims at a precise measurement of the neutrino mixing angle θ_{13} through the disappearance of reactor electron antineutrinos. The experiment relies on the measurement of neutrino flux and spectrum with two identical detectors at 400 m and 1000 m from the reactor cores of two nuclear power reactors. $\bar{\nu}_e$ are detected by inverse beta decay on free protons in 8.3 tons of Gd-loaded liquid scintillator, providing a unique delayed coincidence signature. Double Chooz has been running since 2011 with the far detector only, providing the first indication for non-zero θ_{13} with reactor antineutrinos. With a rate+shape analysis of 467.90 live days from 2011 - 2013 we obtain a value of $\sin^2 2\theta_{13} = 0.090^{+0.032}_{-0.029}$. Data taking with the near detector has started beginning of 2015, allowing a significant reduction of both reactor and detector related systematic uncertainties. The talk will review the most recent results obtained with the far detector only and discuss first data from the near detector.

This work was supported by the DFG (GO 1729/1-1).

T 102.2 Do 17:05 VMP9 SR 07

Sterile Neutrino Search with the Double Chooz Experiment — •Denise Hellwig, Ilja Bekman, Philipp Kampmann, Stefan Schoppmann, Michael Soiron, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B - RWTH Aachen

The Double Chooz experiment is a reactor neutrino disappearance experiment located at the Chooz nuclear power plant, France. It measures the electron-antineutrino flux of the two nuclear reactors with two detectors of identical design. A far detector at a distance of about 1 km is operating since 2011; a near detector at a distance of about 400 m is operating since the end of 2014. The combination of the two detectors offers sensitivity to sterile neutrino mixing parameters. Sterile neutrinos are neutrino mass states not taking part in weak interactions, but may mix with known neutrino states. This induces additional mixing angles and mass differences. This talk describes the search for sterile neutrinos and the sensitivity of Double Chooz to the mixing angle θ_{14}.

T 102.3 Do 17:20 VMP9 SR 07

Measurements of the Proton Quenching Effect in Various Organic Liquid Scintillators — •Vincenz Zimmer, Dominikus Hellgartner, Lothar Oberauer, and Stefan Schönert — Physik-Department and Excellence Cluster Universe, Technische Universität München, D-85747 Garching

Understanding the quenching effect for protons in organic liquid scintillators is important for both signal and background detection in present and future neutrino experiments, like Double Chooz, Borexino, LENA and JUNO. This effect defines the energy scale for proton recoil events in the scintillator, which is of particular importance for the detection of neutrinos from a galactic core collapse supernova by elastic ν-p-scattering.

A time-of-flight based experiment has been established at the Maier-Leibnitz-Laboratorium in Garching. Using a pulsed ^{11}B-beam and a fixed H_2-target, monoenergetic neutrons with different energies between ~ 4.7 and ~ 11.2 MeV were produced to induce proton recoils in the scintillator samples. To quantify the quenching effect for protons the semi-empiric Birks quenching model was utilized. The final results on the Birks quenching factors kB, obtained from the performed measurements for various scintillator samples, including the Borexino and Double Chooz scintillators and different LAB-based mixtures, will be presented.

This research was supported by the DFG cluster of excellence 'Origin and structure of the Universe' and the Maier-Leibnitz-Laboratorium (MLL), Garching.

T 102.4 Do 17:35 VMP9 SR 07

The Reactor Antineutrino Anomalies — •Julia Haser, Christian Buck, and Manfred Lindner — Max-Planck-Institut für Kernphysik, Heidelberg

Major discoveries were made in the past few years in the field of neutrino flavour oscillation. Nuclear reactors produce a clean and intense flux of electron antineutrinos and are thus an essential neutrino source for the determination of oscillation parameters. Most currently the reactor antineutrino experiments Double Chooz, Daya Bay and RENO have accomplished to measure θ_{13}, the smallest of the three-flavour mixing angles. In the course of these experiments two anomalies emerged: 1) the reanalysis of the reactor predictions revealed a deficit in experimentally observed antineutrino flux, known as the "reactor antineutrino anomaly". 2) The high precision of the latest generation of neutrino experiments resolved a spectral shape distortion relative to the expected energy spectra. Both puzzles are yet to be solved and triggered new experimental as well as theoretical studies, with the search for light sterile neutrinos as most popular explanation for the flux anomaly.

This talk will outline the two reactor antineutrino anomalies. Discussing possible explanations for their occurrence, recent and upcoming efforts to solve the reactor puzzles will be highlighted.

T 102.5 Do 17:50 VMP9 SR 07

Correlated background induced by radioimpurities in Double Chooz — •Michael Franke for the Double Chooz-Collaboration — Physik Department E15, Technische Universität München

The Double Chooz reactor antineutrino experiment, located at the Chooz nuclear power plant in France, provides a precise measurement of the θ_{13} parameter. After data taking with the far detector since April 2011, the near detector was finished in October 2014 and data taking started within this year. Although this enables a significant reduction of both reactor and detector related systematics uncertainties, several sources of background have to be taken into account to allow a measurement of the neutrino mixing angle θ_{13} with the desired precision. The talk will focus on the background induced by radioactivity in the near detector. Events coming from the decay of ^{214}Bi and ^{212}Bi followed by the α-decay of ^{214}Po and ^{212}Po, referred to as BiPo coincidences, provide a fast coincidence signal between β^- and α signal, which is also spatially correlated. It can be easily distinguished from other background. Therefore it provides tagging of the number of decays within the U decay chain and the Th decay chain. This provides a tool to prove the radiopurity of the Double Chooz Detector. It shows that the radiopurity in Double Chooz is well within the specifications of less than $10^{-13}\,\frac{g}{g}$ of U and Th in all parts of the inner detector. However, these events cannot be neglected for a measurement of θ_{13} and have to be addressed in further ongoing studies.

This work has been supported by the DFG (GO 1729/1-1).

T 102.6 Do 18:05 VMP9 SR 07

Meeting the future of coherent neutrino scattering - A feasibility study for upcoming reactor experiments — Marco Salathe and •Thomas Rink — Max-Planck-Institut für Kernphysik, Heidelberg, Deutschland

Due to ongoing progress in detector development and background suppression techniques first evidence of neutrino coherent scattering seems reachable in future experiments. In recent years efforts have been enhanced to detect this effect with germanium detectors. This work aims at summarizing and improving past studies on the potential of an experiment at a reactor site to a new level of accuracy by using the most recent neutrino spectra, knowledge gained in recent detector developments and in contrast to prior studies an energy-dependent quenching factor. The influence of the main parameters (background suppression, detector resolution and threshold, reactor spectra, different isotopes) of a germanium detector experiment is presented and the sensitivities regarding the main reaction channels are calculated. The results were obtained through two independent methods; an algebraic computation and a numerical simulation. Both methods reveal the most important experimental parameters and clarify the state of the art challenges that research has to meet in such an experiment.

T 102.7 Do 18:20 VMP9 SR 07

Results of the Nucifer reactor neutrino experiment — •Christian Buck and Manfred Lindner — MPIK Heidelberg

Nuclear reactors are a strong and pure source of electron antineutrinos. With neutrino experiments close to compact reactor cores new insights into neutrino properties and reactor physics can be obtained. The Nucifer experiment is one of the pioneers in this class of very short baseline projects. Its detector to reactor distance is only about 7m. The data obtained in the last years allowed to estimate the plutonium concentration in the reactor core by the neutrino flux measurement. This is of interest for safeguard applications and non proliferation efforts.

The antineutrinos in Nucifer are detected via the inverse beta decay on free protons. Those Hydrogen nuclei are provided by 850 liters of organic liquid scintillator. For higher detection efficiency and background reduction the liquid is loaded with Gadolinium. Despite all shielding efforts and veto systems the background induced by the reactor activity and cosmogenic particles is still the main challenge in the experiment.

The principle of the Nucifer detector is similar to the needs of upcoming experiments searching for sterile neutrinos. Therefore, the Nucifer results are also valuable input for the understanding and optimization of those next generation projects. The observation of sterile neutrinos would imply new physics beyond the standard model.

T 102.8 Do 18:35 VMP9 SR 07

Measurement of Reactor Neutrino Oscillations with Double Chooz — •Stefan Schoppmann, Ilja Bekman, Denise Hellwig, Philipp Kampmann, Michael Soiron, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B - RWTH Aachen University

The Double Chooz experiment is a reactor neutrino disappearance experiment located at the nuclear power plant in Chooz, France. The aim of the Double Chooz experiment is the precise measurement of the neutrino mixing angle θ_{13}, a neutrino oscillation parameter. The experiment consists of two identical liquid scintillator detectors and measures the electron-antineutrino flux of the two nuclear reactors. The 1 km distant far detector started operation in 2011. The 400 m distant near detector started operation in 2015. The reactor neutrinos are detected by the signature of an inverse beta decay (IBD). The neutrino energy spectrum is extracted from the spectrum of the IBD-produced positrons. The IBD-produced neutrons can be captured by Gadolinium or Hydrogen, which provides two independent data samples. Both samples allow the utilisation of the neutrino rate and energy spectral shape information in a combined fit. This contribution presents the first oscillation results derived from the full two-detector setup.

T 102.9 Do 18:50 VMP9 SR 07

Reactor Neutrino Oscillation Measurement with Double Chooz Hydrogen Data — •Philipp Kampmann, Ilja Bekman, Denise Hellwig, Stefan Schoppmann, Michael Soiron, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B - RWTH Aachen

The Double Chooz experiment is a reactor neutrino experiment with the purpose of a precise measurement of the neutrino mixing angle θ_{13}. The setup consists of two identical liquid scintillator detectors at an average baseline of 400m and 1km to two nuclear reactor cores in Chooz, France. The neutrinos are detected by the signature of the inverse beta decay, which consists of a positron signal and a delayed neutron capture signal. From the positron measurement the neutrino energy is extracted. Neutrons are captured either by gadolinium or hydrogen in the scintillator. Due to different capture energies, two independent data samples are obtained. This presentation describes the determination of the neutrino mixing angle θ_{13} using a likelihood fit approach of hydrogen capture data.