T 32: Neutrinophysik X

Zeit: Dienstag 16:30–19:05 Raum: Z6 - HS 0.002

Gruppenbericht T 32.1 Di 16:30 Z6 - HS 0.002

The Jiangmen Underground Neutrino Observatory — •Christoph Genster for the JUNO-Collaboration — IKP-2, Forschungszentrum Jülich

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator detector currently under construction near Kaiping in the province Guangdong in southern China. It will have an overburden of 1900 m.w.e. and will detect reactor antineutrinos from two nuclear power plants on a baseline of 53 km. Starting from 2020, JUNO plans to measure the neutrino mass ordering by probing the antineutrino energy spectrum. The energy resolution is designed to be better than 3% @ 1 MeV, in order to reach a significance of at least 3 sigma. In addition, JUNO can improve the precision on solar oscillation parameters below 1% and allows for the study of geoneutrinos and neutrinos from core-collapse supernovae. Furthermore, it has the potential to search for dark matter, sterile neutrinos, and non-standard interactions. This talk will give an overview on the physics potential and the current status of the project.

T 32.2 Di 16:50 Z6 - HS 0.002

Advances of the topological track reconstruction for large unsegmented liquid scintillator neutrino detectors. — •David Meyhöfer for the JUNO-Collaboration — University of Hamburg

The track reconstruction of charged particles in liquid scintillator (LS) detectors is of utmost importance for efficient cosmogenic background rejection and the analysis of multi-GeV neutrino interactions. A topological reconstruction of such events yields the possibility of gaining a 3D density distribution of the emitted scintillation and/or cherenkov photons. This reconstruction approach can in principle be used for any geometry of unsegmented LS detector and for MeV- up to several GeV-events. In association with the JUNO experiment in China, this topological reconstruction method is developed in Germany. With simulated muon events, this method has shown, that the particles differential energy loss dE/dx is obtainable. This talk will give an overview over the recent developments and the current status for this reconstruction approach.

T 32.3 Di 17:05 Z6 - HS 0.002

Topological Track Reconstruction in Liquid Scintillator Neutrino Detectors for MeV Events — •Henning Rebber[1], Björn Wonsak[1], Caren Hagner[1], Sebastian Lorenz[2], and David Meyhöfer[1] — [1]Universität Hamburg, Institut für Experimentalphysik — [2]Johannes Gutenberg-Universität Mainz, Institut für Physik

Neutrino detectors like the JUNO experiment in China demand for an unprecedented energy resolution while pushing the fiducial mass of liquid scintillator to ever higher dimensions. This complicates the tasks of event reconstruction and background reduction. For widespread events, like e.g. high energy ($\sim$GeV) muons, current developments in the topological track reconstruction provide a 3D light emission density distribution based on isotropically emitted, unscattered scintillation photons. The method gives access to a particle's differential energy loss $\mathrm{d}E/\mathrm{d}x$ and can help in the essential task of background rejection.

But also for low energy events in the signal range ($\sim$MeV) – although comparatively point-like – the topological features hold valuable information which can be used e.g. for particle discrimination. The current status of these low energy studies is presented. This work is supported by the DFG.

T 32.4 Di 17:20 Z6 - HS 0.002

Waveform Reconstruction for IBD and Muon Events in JUNO — •Michaela Schever[1,2], Yaping Cheng[1], Christoph Genster[1,2], Philipp Kampmann[1,2], Livia Ludhova[1,2], Rikhav Shah[1,2], Achim Stahl[2], Christopher Wiebusch[2], and Yu Xu[1,2] — [1]IKP-2 Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The JUNO 20 kton liquid-scintillator detector aims at achieving an outstanding energy resolution of $3\%/\sqrt{E(\mathrm{MeV})}$ of Inverse Beta Decay (IBD) events to determine the neutrino mass hierarchy at the desired statistical significance of $> 3\sigma$. Therefore, the charge and arrival times of individual photons detected by each single PMT have to be reconstructed with great precision. To ensure a low dead time for this large scale detector, the suppression of the cosmic muon background is performed by partial volume veto, which relies on the precise reconstruction of the first hit time and charge of the muon signals in each PMT.

The talk presents the current status of the waveform analysis for MeV neutrino and muon events in Germany. The IBD waveform study is based on the deconvolution method, which unfolds the photoelectron hit pattern and the single photo-electron response via transforms of the signal between the time and frequency domain. The results of IBD photo-electron reconstruction and several reconstruction methods for the first hit time of muons and the corresponding charge are presented.

T 32.5 Di 17:35 Z6 - HS 0.002

Determination of the Nonlinearity Parameter for LAB Based Liquid Scintillators for JUNO — •Konstantin Schweizer, Lothar Oberauer, and Julia Sawatzki — Technische Universität München

The organic liquid scintillator based JUNO experiment (Jiangmen Underground Neutrino Observatory) has the aim to determine the neutrino mass hierarchy. To achieve this goal an unprecedented energy resolution of 3% at 1 MeV is crucial. Therefore the energy dependent light yield for electrons depositing energy in the scintillator has to be known precisely. There was an experiment conducted to measure the nonlinearity of the light yield of low energy electron events with a low threshold of 5 keV. A photomultiplier tube (PMT) was used to detect the light produced by a Compton electron in a liquid scintillator sample. A High Purity Germanium Detector, operated in coincidence with the PMT, was used to determine the deposited energy in the scintillator by measuring the remaining energy of the Compton scattered gamma ray. The talk will present the current status of the experiment. This work is supported by the DFG Cluster of Excellence "Origin and Structure of the Universe", the DFG research unit "JUNO" and the SFB1258.

T 32.6 Di 17:50 Z6 - HS 0.002

Impact of energy response of liquid scintillator detector on JUNO Mass Hierarchy sensitivity — •Yaping Cheng[1], Christoph Genster[1,2], Philipp Kampmann[1,2], Livia Ludhova[1], Michaela Schever[1,2], Rikhav Shah[1], Achim Stahl[2], Christopher Wiebusch[2], and Yu Xu[1,2] — [1]IKP-2 Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator detector that will be located at Kaiping, Jiangmen city in South China. An energy resolution of 3% at 1 MeV is required to determine the neutrino mass hierarchy by spectral analysis. In this largest liquid scintillator detector, a good understanding of the position-dependence of the energy response is essential. The intrinsic non-linearity response of liquid scintillator, mainly originating from the quenching effect and Cherenkov light contribution, will cause distortion to the observed spectra. In this presentation, I will report my studies of non-linearity and non-uniformity's impact on neutrino mass hierarchy sensitivity.

T 32.7 Di 18:05 Z6 - HS 0.002

Reduction of the ^{14}C background for the neutrino mass-hierarchy measurement of the JUNO experiment — •Philipp Kampmann[1,2], Yaping Cheng[1], Christoph Genster[1,2], Livia Ludhova[1,2], Michaela Schever[1,2], Rikhav Shah[1,2], Achim Stahl[2], Christopher Wiebusch[2], and Yu Xu[1,2] — [1]IKP-2 Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (JUNO) will be a 20 kt liquid scintillator neutrino detector. Its main goal is the determination of the neutrino mass hierarchy from a precise measurement of the energy spectrum of anti-electron-neutrinos 53 km away from the reactor. To precisely measure the oscillation pattern of the reactor spectrum an unpredecent energy resolution for this kind of detector of 3% at 1 MeV is needed. Pile-up events with background from radioactive decays such as those from ^{14}C can spoil the reconstruction of the neutrino energy. In this talk a clusterization method for detecting spoiled pile-up events is presented. It is optimized to give the best sensitivty on the neutrino mass-hierarchy. Furthermore the suppression of dark-noise using this method is presented.

T 32.8 Di 18:20 Z6 - HS 0.002

Positron and Electron Discrimination with Deep Neural Network Image Recognition with JUNO — •Thilo Birkenfeld[1], Christoph Genster[2], Florian Kiel[1], Achim Stahl[1], and Christopher Wiebusch[1] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Institut für Kernphysik Jülich

The JUNO detector is going to be a 20kt liquid scintillator neutrino observatory, currently under construction near Kaiping, China, with a baseline of about 50km to two reactor plants. With its excellent energy resolution and large fiducial volume, it will be able to determine the neutrino mass hierarchy from the energy spectrum. The neutrinos are detected by measuring the signature of the inverse beta decay (IBD), which consists of a prompt positron- and a delayed neutron capture signal. The coincidence of an electron and a neutron, caused by nuclear decay, can mimic such an IBD signature. Those differ by the additional positron annihilation. New developments in deep learning techniques give the possibility to distinguish the different event shapes. In this talk the method to discriminate positrons and electrons via image recognition neural networks is presented.

T 32.9 Di 18:35 Z6 - HS 0.002

Thermonuclear Supernova Neutrino Signals in JUNO — Max Büsken[1], Florian Kiel[1], Livia Ludhova[2], •Josina Schulte[1], Achim Stahl[1], Jochen Steinmann[1], and Christopher Wiebusch[1] — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Institut für Kernphysik, Forschungszentrum Jülich

JUNO (**J**iangmen **U**nderground **N**eutrino **O**bservatory) is a 20kt liquid scintillator-based detector currently under construction in China. The main goal is the determination of the neutrino mass hierarchy, but the large mass and the good energy resolution make it possible to also investigate astrophysical processes - such as supernovae. Neutrino models of core-collapse supernovae have been investigated thoroughly though the exact mechanism of thermonuclear supernovae is still a mystery. The neutrino signal of a type Ia supernova could help in the understanding of the explosion mechanism at the end of a white dwarfs' life. The prominent neutrino interactions in JUNO and the final rates will be discussed.

T 32.10 Di 18:50 Z6 - HS 0.002

Detection Potential for the Diffuse Supernova Neutrino Background in the Large Liquid Scintillator Detector JUNO — •Julia Sawatzki and Lothar Oberauer — Technical University of Munich, Chair for Experimental Astroparticle Physics E15, James-Franck-Str. 1, 85748 Garching b. München

The planned 20 kt liquid scintillator detector JUNO (Jiangmen Underground Neutrino Observatory) will offer the possibility of a diffuse supernova neutrino background (DSNB) measurement. Although the cosmic background of neutrinos generated by core collapse supernova explosions throughout the universe is present in all flavors, the study will focus on the measurement of electron antineutrinos via the inverse beta decay, as this coincidence reaction provide powerful background suppression. This is of particular importance, as the relic neutrino signal rate in JUNO is, with few events per year, quite low. Therefore good background knowledge as well as powerful background suppression techniques are required. Neutrinos produced in nuclear reactors, the atmosphere, and cosmic muons, which can induce cosmogenic isotopes or fast neutrons, are the main background sources.
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