T 7: Neutrino physics without accelerators II

Time: Monday 16:30–18:05 Location: H-HS V

Group Report T 7.1 Mon 16:30 H-HS V

Prospects, Design and Status of JUNO — •Hans Theodor Josef Steiger — Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton multi-purpose liquid scintillator detector currently being built in a dedicated underground laboratory in Jiangmen (PR China). Data taking is expected to start in 2021. JUNO's main physics goal is the determination of the neutrino mass ordering using electron antineutrinos from two nuclear power plants at a baseline of about 53 km. JUNO aims for an unprecedented energy resolution of 3% at 1 MeV for the central detector, to be able to determine the mass ordering with 3 - 4 σ significance within six years of operation. Besides this fundamental aim, JUNO will have a very rich physics program. It includes the measurement (at a sub-percent level) of the solar neutrino oscillation parameters, the detection of low-energy neutrinos coming from galactic core-collapse supernovae, the first measurement of the diffuse supernova neutrino background, the detection of neutrinos coming from the Sun, the Earth and the Earth's atmosphere. Moreover, JUNO will be sensitive to searches for nucleon decays and neutrinos resulting from dark matter annihilation in the Sun.
In this talk JUNO's design, physics prospects as well as the status of its construction will be presented, together with a short excursion into its rich R&D program.

T 7.2 Mon 16:50 H-HS V

JUNO Sensitivity in The Search for Proton Decay — •Yuhang Guo[1,2], Christoph Genster[2], Wanlei Guo[3], Alexandre Göttel[2,4], Philipp Kampmann[2,4], Runxuan Liu[2,4], Livia Ludhova[2,4], Giulio Settanta[2], and Yu Xu[2,4] — [1]School of Nuclear Science and Technology, Xi'an Jiaotong University, Xi'an, China — [2]IKP-2, Forschungszentrum Jülich, Jülich, Germany — [3]The Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China — [4]III. Physikalisches Institut B, RWTH Aachen University, Aachen, Germany

Many Grand Unified Theories have predicted that the Baryon number is unconservative, which is beyond the Standard Model physics. As a result, proton decay would be an obvious consequence and would become an explanation to the asymmetry of matter and anti-matter in the Universe. Many experiments have been designed and built in order to search for this key sign of a new physics. Among them, the SuperK has obtained the currently best lower limit to the proton life time, in spite of a low detection efficiency. Jiangmen Underground Neutrino Observatory (JUNO), which is a 20 kton liquid scintillator detector under construction in China, has a large sensitivity in these terms. This is, in addition to the detector's large mass, also thanks to a detection efficiency expected to be larger than in SuperK. The results of a preliminary study concerning JUNO potential in the search for proton decay will be presented.

T 7.3 Mon 17:05 H-HS V

Radon Monitoring in gaseous Nitrogen used for the Filling of the Central Detector of JUNO and OSIRIS — •Hans Theodor Josef Steiger, Lothar Oberauer, and Matthias Raphael Stock — Technische Universität München (TUM), Physik-Department, James-Franck-Straße 1, 85748 Garching bei München

The planned JUNO (Jiangmen Underground Neutrino Observatory) Detector will use 20 kt of liquid scintillator (LS) based on LAB (Linear AlkylBenzene) as neutrino target within an acrylic sphere with a diameter of 35.4 m. For the filling of this sphere as well as for the filling of OSIRIS (Online Scintillator Internal Radioactivity Investigation System) with LS pressurized nitrogen will be used. To avoid a contamination of the LS withradon, its content in the nitrogen gas will be monitored. In this talk the status of a prototype radon monitoring system based on a large volume (50 l) proportional chamber operated in pure nitrogen will be presented as well as pulse shape analysis techniques applied for efficient background reduction. This work is supported by the DFG Research Unit JUNO and the Maier-Leibnitz-Laboratorium (MLL).

T 7.4 Mon 17:20 H-HS V

Towards a Measurement of the CNO cycle in the Sun with Borexino — •Ömer Penek[1,2], Zara Bagdasarian[1], Alexandre Goettel[1,2], Sindhujha Kumaran[1,2], Livia Ludhova[1,2], Mariia Redchuk[1,2], Giulio Settanta[1], and Apeksha Singhal[1,2] for the Borexino-Collaboration — [1]Institut für Kernphysik, Forschungszentrum Jülich — [2]III. Physikalisches Institut B, RWTH Aachen University

The Borexino detector, located at the Laboratori Nazionali del Gran Sasso in Italy, is a liquid scintillator detector with a primary goal to measure solar neutrinos. The *pp* fusion chain has been measured in Borexino with an outstanding precision through the detection of *pp*, *pep*, ^{7}Be, and ^{8}B neutrinos. It is well motivated by standard solar models that less than 1% of the solar energy is fueled by the so-called Carbon-Nitrogen-Oxygen (CNO) cycle which is assumed to be the main energy production mechanism in heavier stars. However, a direct measurement of solar neutrinos from the CNO cycle is difficult due to the high correlation with the ^{210}Bi isotope present in the liquid scintillator. In the so-called Borexino Phase 3, namely the data-taking period after July 2016, the upper limit on the ^{210}Bi rate can be inferred through the α-decay of its decay daughter ^{210}Po. In this talk the Borexino strategy towards the first observation of the CNO neutrinos will be presented. This group report is presented in the name of the Borexino Collaboration.

T 7.5 Mon 17:35 H-HS V

Experimental Comparison of Empirical Ionization-Quenching Models for Plastic Scintillators — •Thomas Pöschl, Martin J. Losekamm, Daniel Greenwald, and Stephan Paul — Technische Universität München

Plastic scintillators have a long tradition as radiation detectors in high-energy physics and are widely used in calorimetry. For high-ionizing radiation, however, their light output is not linearly dependent on the particle's energy deposition. To correctly reconstruct the deposited energy, the scintillator's response including this saturation effect—commonly called ionization quenching—must be known. Several empirical models have been developed in the last decades, each giving a different functional form to the ionization-density dependence of the magnitude of quenching — the so-called quenching function.

We measured the response of two commonly used plastic scintillators to protons and validated the compliance of several quenching models with our data using a Bayesian approach. We calculated the evidences of the models and compared them using Bayes factors. The required posterior-probability distribution for each model was evaluated using a Markov-Chain Monte-Carlo algorithm. To further examine the functional form of the quenching function, we performed a model-independent fit to the data for both scintillators. We found that none of the investigated empirical models can describe the functional form of the quenching function for both scintillators within the explored range of ionization densities.

T 7.6 Mon 17:50 H-HS V

Event Discrimination with Topological 3D Reconstruction at MeV Energies in the JUNO Experiment — •Henning Rebber, Malte Stender, David Meyhöfer, Björn Wonsak, and Caren Hagner — Universität Hamburg

The JUNO experiment will use an unsegmented tank filled with 20 kton liquid scintillator to detect neutrinos and antineutrinos, starting from 2021. An important goal is to answer the open question of neutrino mass ordering by measuring electron-antineutrinos from two nuclear power plants in ~ 53 km distance. A further goal is to measure solar ^{7}Be and ^{8}B neutrinos at high rates. The reactor antineutrinos are identified by means of inverse beta decay (IBD) which leads to a prompt positron and a delayed neutron signal. However, β^{-}-decays of cosmogenic ^{8}He and ^{9}Li can be accompanied by neutron emission and thus mimic the IBD signature. Solar neutrinos are detected via elastic scattering off electrons. The cosmogenic β^{+}-emitters ^{10}C and ^{11}C are a major background here. In any case, a discrimination between electron and positron events would mean a background reduction.

The event discrimination is based on topological differences between the energy deposition of MeV electrons and positrons. The electron events are more point-like than positron events due to the latter emitting two annihilation gammas. A topological 3D reconstruction was applied to Geant4-simulated data in order to visualise the resulting fine differences in the time spectrum of PMT hits. The potential towards a discrimination between electrons and positrons, gammas, and ^{10}C decays, respectively, will be presented.