T 7: Neutrino physics 1

Time: Monday 16:00–18:00 Location: Geb. 30.21: Gerthsen-HS

T 7.1 Mon 16:00 Geb. 30.21: Gerthsen-HS

Quantum gravity inspired decoherence models in the context of neutrino oscillations — •Alba Domi, Thomas Eberl, Max Joseph Fahn, Kristina Giesel, Lukas Hennig, Ulrich Katz, Roman Kemper, and Michael Kobler — Friedrich-Alexander Universität Erlangen-Nürnberg, Germany

We discuss the theoretical background for recent decoherence models inspired by quantum gravity and their application in the context of neutrino oscillations. We compare the properties and predictions of these models with existing models and discuss their similarities and differences. Finally, the effects of different quantisation methods and their impact on the final models are briefly discussed.

T 7.2 Mon 16:15 Geb. 30.21: Gerthsen-HS

A Look at General Neutrino Interactions with KATRIN — •Caroline Fengler for the KATRIN-Collaboration — Karlsruhe Institute of Technology, Karlsruhe, Germany

The KATRIN experiment aims to measure the neutrino mass by precision spectroscopy of tritium β-decay. Recently, KATRIN has improved the upper bound on the effective electron-neutrino mass to $0.8\,\mathrm{eV/c^2}$ at 90 % CL [1] and is continuing to take data for a target sensitivity of better than $0.3\,\mathrm{eV/c^2}$. In addition to the search for the neutrino mass, the ultra-precise measurement of the β-spectrum can be used to probe physics beyond the Standard Model. In particular, general neutrino interactions (GNI) [2] can be investigated through a search for potential shape variations of the β-spectrum. For this purpose, all theoretically allowed interaction terms for neutrinos are combined in one effective field theory. This enables a model-independent description of novel interactions, which could provide small contributions to the weak interaction. Such potential modifications can then be identified in the KATRIN β-spectrum by means of energy-dependent contributions to the rate. The talk will introduce the theoretical background of the general neutrino interactions, give an overview of the analysis method and present recent sensitivity studies.

[1] Nat. Phys. 18 (2022) 160-166 [2] Nucl. Phys. B947 (2019) 114746

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T 7.3 Mon 16:30 Geb. 30.21: Gerthsen-HS

Neutrino directionality with the reaction of inverse beta decay in Double Chooz — •Yaroslav Nikitenko, Philipp Soldin, Achim Stahl, and Christopher Wiebusch — III. Physikalisches Institut B, RWTH Aachen University

Reconstructing the direction of neutrinos is important for observations of supernovae and geoneutrinos. In liquid scintillator detectors the reaction of inverse beta decay is the main channel for detecting neutrinos from those sources. While the experimental spatial resolution does not allow reconstructing antineutrino direction for a single event, a large sample of prompt (positrons) and delayed (neutrons) events makes that possible on a statistical basis.

The Double Chooz reactor neutrino experiment allows studying neutrino directionality with the reaction of inverse beta decay. Its advantage is the neutrino source of a known direction and almost point-like structure, as well as good spatial resolution compared to other reactor experiments. We present the latest experimental results from Double Chooz, which for the first time in the world is measuring neutrino directionality using total neutron capture on both Gd and H nuclei in the detector.

T 7.4 Mon 16:45 Geb. 30.21: Gerthsen-HS

Design and first tests of the MANGO scattering setup for characterization of liquid scintillators — •Daniela Fetzer[1,2], Michael Wurm[1,2], Manuel Böhles[1,2], Hans Steiger[2,3], Arshak Jafar[1,2], and Kai Loo[4] — [1]JGU Mainz, Institute for Physics — [2]EC PRISMA+ — [3]Technical University of Munich, Physics Department — [4]University of Jyväskylä, Department of Physics

Detectors for low-energy particles (MeV) are often calibrated using gamma rays to induce electron-like signals. Yet the energies of standard calibration sources are often not sufficient. For instance, the JUNO reactor neutrino experiment requires excellent understanding of the energy response to energies of 8 MeV and higher. The MANGO experiment will use 9 MeV gamma rays from neutron capture on nickel to characterize scintillator samples. Neutrons are produced by a DD108 fusion generator, which creates mono-energetic neutrons of 2.45 MeV that can also be directly used for neutron irradiation of the detector. Using a secondary detector array of neutron and gamma detectors, the energy and momentum direction of the scattered particles can be determined. This additional information can help to relate the visible scintillation signal to the deposited energy and thus to investigate non-linearity or quenching of the scintillator response. This contribution presents the setup as well as first tests of the experimental components. Once MANGO is fully constructed and understood, it will be used for the characterization of the liquid scintillator of the JUNO neutrino detector. This work is supported by the DFG Graduate School GRK 2796: Particle Detectors and the Cluster of Excellence PRISMA+.

T 7.5 Mon 17:00 Geb. 30.21: Gerthsen-HS

Investigation of background processes for proton decay search in the JUNO experiment — •Korbinian Stangler[1], Carsten Dittrich[1], Ulrike Fahrendholz[1], Meishu Lu[1], Sarah Braun[1], Lothar Oberauer[1], Hans Steiger[2], and Matthias Raphael Stock[1] — [1]E15, Physik-Dep., Technische Universität München, James-Franck-Str. 1, 85748 Garching — [2]Cluster of Excellence PRISMA$^+$, Staudingerweg 9, 55128 Mainz

The Jiangmen Underground Neutrino Observatory (JUNO) is a large liquid scintillator detector, capable to search for the hypothetical proton decay $p \to K^+ + \bar{\nu}$, which is predicted by supersymmetric Grand Unified Theories (GUTs). As the momentum of the daughter kaon is below the Cherenkov threshold in water, JUNO will quickly be able to provide competitive results in comparison to the current lifetime limit of $\tau > 5.9 \cdot 10^{33}$ years by the Super-Kamiokande collaboration. The three-fold coincidence signature generated by the kaon and its daughter particles will be crucial to discriminate proton decay events from possible backgrounds produced by atmospheric neutrinos. This talk will present a brief overview on the proton decay search in JUNO, the different background processes and possible identification criteria to discriminate between the two.

This work is supported by the Clusters of Excellence Origins and PRISMA$^+$.

T 7.6 Mon 17:15 Geb. 30.21: Gerthsen-HS

JUNO's sensitivity to geoneutrinos — •Cristobal Morales Reveco — GSI Helmholtzzentrum für Schwerionenforschung, 64291 Darmstadt, Germany — III. Physikalisches Institut B, RWTH Aachen University, 52062 Aachen, Germany — Institut für Kernphysik, Forschungszentrum Jülich, 52425 Jülich, Germany

The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kt liquid scintillator detector experiment being built in China. Its main objective is to determine the neutrino mass ordering by measuring reactor anti-neutrinos at 52.5 km baseline. JUNO is also expected to have a high sensitivity to geoneutrinos, electron antineutrinos from natural radioactivity decays from 238-Uranium and 232-Thorium inside the Earth. The radiogenic heat released in these decays is in a well established relationship with the abundances of Uranium and Thorium. Thus, the measurement of geoneutrino flux can provide an insight on the Earth's energy budget. Even more, distinguishing the signal coming from the Earth's mantle is a key feature, which can unveil its convection scheme and contribution to the total radiogenic heat. Thanks to its large mass, JUNO will be able to measure Uranium and Thorium fluxes individually and to establish their ratio, yet another important parameter for geoscience, giving insights about the Earth's formation process. The talk will report the latest geoneutrino's sensitivity study of JUNO. In just one year, it will be able to collect more geoneutrinos events than KamLAND and Borexino experiments in their more than 10 years of data taking. JUNO will provide the third unique geographical and geological point of geoneutrino measurement.

T 7.7 Mon 17:30 Geb. 30.21: Gerthsen-HS

Time Reversal Symmetry Violation study in neutrino oscillations — •Kiran Sharma[1,2], Sabya Sachi Chatterjee[1], and Thomas Schwetz[1] — [1]Institut für Astroteilchenphysik, Karlsruher Institut für Technologie (KIT), 76131 Karlsruhe, Germany — [2]Department of Physics, Indian Institute of Technology (IIT) Bhilai,

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Time reversal symmetry violation is connected to the creation of matter in the early moments of the universe following the Big Bang.The current and upcoming neutrino oscillation experiments will address the δ_{13} value but also its impact on discrete symmetries such as CP and T. In this work, we extend the idea of the model for T violations that covers a wide range of non-standard scenarios independent of the specific parameterizations adopted for fitting the experimental data. We perform extensive numerical simulations on the complex coefficients and oscillation frequencies in the parameterized transition probabilities. We find that the study hints at the feasibility of T-violation signatures in the proposed experiments.

T 7.8 Mon 17:45 Geb. 30.21: Gerthsen-HS

Lorentz invariance violation searches with the ANTARES and KM3NeT/ORCA neutrino telescopes — •Lukas Hennig for the ANTARES-KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Lorentz invariance is a fundamental symmetry in physics that ensures that the same equations can be used to describe experiments in any inertial laboratory. Many proposed quantum gravity theories predict Lorentz invariance violation (LIV). The "Standard-Model extension" parametrizes physically valid ways of including LIV into the Standard Model of particle physics by introducing a set of operators coupled with coefficients that can be experimentally constrained with neutrino telescopes. The "Quantum GRavity seArches with Neutrino Telescopes" (QGRANT) project aims at performing the first combined fit of these coefficients using data from the three neutrino telescopes ANTARES, IceCube, and KM3NeT, which is expected to give an unprecedented sensitivity for constraining the LIV coefficients. This contribution discusses the current progress in the analysis of the ANTARES and KM3NeT/ORCA data and outlines the next steps that will be taken in the QGRANT analysis.