T 87: Neutrino physics 11

Time: Thursday 16:00–18:00 Location: Geb. 30.22: Gaede-HS

T 87.1 Thu 16:00 Geb. 30.22: Gaede-HS

Search for the leptonic CP violation with the ESSnuSB(+) project — •Tamer Tolba — Universität Hamburg, Hamburg, Germany

The measurement of the unexpectedly high value of the third neutrino mixing angle, θ_{13}, opened the possibility of measuring the Dirac leptonic CP violating angle, δ_{CP}, using intense neutrino beams. The European Spallation Source neutrino Super Beam (ESSνSB) is a long-baseline neutrino project that aims in measuring CPV in the leptonic sector at the second, rather than the first, of the ν_μ to ν_e oscillation maximum, where the sensitivity is ~ 3 times higher. The use of the 5 MW proton beam of the ESS linac combined to a $\sim$ cubic-km Water Cherenkov detector located at the second oscillation maximum paves the way to a precise measurement of δ_{CP}. The ESSνSB CDR showed that after 10 years of data taking, more than 70% of the δ_{CP} range will be covered with 5σ C.L. to reject the no-CP-violation hypothesis. The expected value of δ_{CP} precision is smaller than 8° for all δ_{CP} values, making it the most precise proposed experiment by a large margin. The next phase of the project, the ESSνSB+, which started in 2023, aims in using the intense muon flux produced together with neutrinos to measure the neutrino-nucleus cross-section (the dominant term of the systematic uncertainty) in the energy range of 0.2 to 0.6 GeV, using a LEnuSTORM and a LEMNB facilities.

In this talk, an overview of the concluded phase and an update on the first-year design-study of the current phase of the project will be presented.

T 87.2 Thu 16:15 Geb. 30.22: Gaede-HS

The Low Energy Excess in ANNIE — •Daniel Tobias Schmid, Johann Martyn, David Maksimović, Amala Augusthy, Noah Goehlke, Dorina Zundel, and Michael Wurm for the ANNIE-Collaboration — Johannes Gutenberg-Universität Mainz, Germany

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton Gadolinium-doped water Čerenkov detector located on the Booster Neutrino Beamline (BNB) at Fermilab. The scientific aim of ANNIE is the study of the cross-section and the neutron multiplicity of GeV neutrinos in the BNB.

The MiniBooNE experiment, a mineral oil Čerenkov detector that was also served by the BNB, previously measured an unexpected excess of $e^{\pm}$-type events at neutrino energies below 500 MeV. This is referred to as the Low Energy Excess (LEE). An excess solely due to ν_e interactions is disfavoured by findings of the MicroBooNE experiment within the same beamline. A yet unprobed explanation for the LEE in the BNB is that the excess could be constituted by an abundance of interacting $\bar{\nu}_e$.

The suppressed $\bar{\nu}_e$ interaction cross-section in Argon makes this measurement difficult within MicroBooNE and other LArTPC-based experiments. As a water Čerenkov detector with a high neutron detection efficiency, ANNIE is well-suited to directly measure and constrain the $\bar{\nu}_e$ flux via inverse-beta-decay (IBD) events.

In this talk, we inform about the ongoing efforts in measuring IBD-type events within ANNIE.

This work is supported by the DFG Project 490717455.

T 87.3 Thu 16:30 Geb. 30.22: Gaede-HS

Characterization and deployment of LAPPDs for ANNIE — •Noah Goehlke, Amala Augusthy, David Maksimovic, Johann Martyn, Daniel Tobias Schmid, Michael Wurm, and Dorina Zundel for the ANNIE-Collaboration — JGU Mainz, Institute of Physics and EC PRISMA+

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a neutrino detector at the Booster Neutrino Beam at Fermilab. It is designed for a measurement of the neutron multiplicity in neutrino-nucleus interactions, improving the systematics of neutrino detectors. In addition, ANNIE has a strong focus on testing new detector technologies, in specific Water-based liquid scintillators (WbLS) and Large Area Picosecond Photodetectors (LAPPD). WbLS is a novel detector medium, combining the low energy threshold of a scintillator with the good directional resolution of a Cherenkov detector. LAPPDs are micro channel plate-based photon detectors with an active area of 20×20 cm^2. Their high spacial (< 1 cm^2) and timing (< 60 ps) resolution promise a more precise reconstruction than conventional PMTs. In combination with WbLS, the high timing resolution can be used for a time separation of the Cherenkov and scintillation emission from WbLS. ANNIE aims to upgrade from three to five LAPPDs. In preparation, those LAPPDs have to be tested, characterized and assembled with their electronics in a waterproof housing. This talk presents ANNIE and the LAPPDs, as well as the recent progress towards the use of five LAPPDs. This work is supported by the DFG Project 490717455 and the DFG Graduate School GRK 2796: Particle Detectors.

T 87.4 Thu 16:45 Geb. 30.22: Gaede-HS

Deployment of water-based liquid scintillator in ANNIE — •Johann Martyn, Amala Augusthy, Noah Goehlke, David Maksimovic, Daniel Tobias Schmid, Michael Wurm, and Dorina Zundel for the ANNIE-Collaboration — JGU Mainz, Institute of Physics and EC PRISMA+

The Accelerator Neutrino Neutron Interaction Experiment (ANNIE) is a 26-ton water Cherenkov neutrino detector installed on the Booster Neutrino Beam (BNB) at Fermilab. As its main physics goals the experiments aims to perform a measurement of the neutron yield from neutrino-nucleus interactions, as well as a measurement of the charged-current cross section of muon neutrinos. Additionally, ANNIE has an equally important focus on the research and development of new detector technologies and target media. Here water-based liquid scintillator (WbLS) is of special interest, as it allows for the simultaneous detection of scintillation and Cherenkov light of the events. This talk presents the deployment and first data of a 366 L WbLS vessel in ANNIE in March 2023. The successful observation of both scintillation and Cherenkov light in ANNIE corresponds to a proof-of-concept for the hybrid event detection concept in ANNIE. This allows for the future development of reconstruction and particle identification algorithms, as well as dedicated analyses in ANNIE, that make use of both the Cherenkov and scintillation component. This work is supported by the DFG Project 490717455.

T 87.5 Thu 17:00 Geb. 30.22: Gaede-HS

Status of the KM3NeT experiment and contributions from ECAP — •Tamas Gal for the ANTARES-KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

The KM3NeT neutrino telescope is continuously growing at two detector sites. The ORCA detector designed to detect neutrinos with energies from a few GeV up to several tens of GeV located off the coast of France and the ARCA detector with a much larger instrumentation volume but the same technology optimised for the detection of high-energetic neutrino events above 100 GeV located off the shore of Sicily. Both detectors are installed in the deep seas of the Mediterranean. ORCA currently consists of more than 10000 photomultiplier tubes and already provides valuable data for roughly 1200 kt-years while ARCA operates with nearly 16000 photomultiplier tubes. Both detectors are continuously extended with additional detection units and presumably double their size by the end of 2024. We will report on the status of the KM3NeT experiments and the contributions from the ECAP team to these scientific endeavours.

T 87.6 Thu 17:15 Geb. 30.22: Gaede-HS

First measurement of tau appearance with KM3NeT/ORCA — •Nicole Geisselbrecht for the ANTARES-KM3NET-ERLANGEN-Collaboration — ECAP, FAU Erlangen-Nürnberg

KM3NeT/ORCA is a water Cherenkov detector currently under construction in the Mediterranean Sea, aiming for the determination of the neutrino mass ordering. It is optimised for the study of atmospheric neutrinos.

Upon production, the atmospheric neutrino flux at GeV energies is dominated by electron and muon neutrinos. However, the tau neutrino component of the atmospheric neutrino flux at the Earth is considerably increased due to neutrino oscillations. This phenomenon is also known as tau appearance and can, among other things, be used to probe neutrino oscillations and test the unitarity of the PMNS matrix. This is one of the main goals of the KM3NeT/ORCA detector that can already be addressed during the ongoing construction. A first measurement has been performed with an early sub-array of the final detector configuration. In this talk, the first results and prospects for the future will be presented.

T 87.7 Thu 17:30 Geb. 30.22: Gaede-HS

Neutrino Generator Comparisons GiBUU/GENIE in KM3NeT — •Johannes Schumann for the ANTARES-KM3NET-ERLANGEN-Collaboration — Friedrich-Alexander-Universität Erlangen-Nürnberg

KM3NeT/ORCA is currently under construction in the Mediterranean Sea. It has been designed to detect atmospheric neutrinos with energies lower than 100 GeV. For this, a three dimensional grid of photomultiplier tubes (PMTs) detects the Cherenkov radiation emitted by particles that result from neutrino interactions with matter. The assessment of the data recorded by the detector is performed by comparisons to Monte Carlo simulations, which include the state of the art knowledge about all the physical processes involved in the production of the detected signals. The so-called neutrino generators employ different approximations to simulate the distribution of final state particles produced in neutrino interactions. KM3BUU is an implementation of the GIBUU generator for the KM3NeT detector, which is currently under development. In this talk, the status of KM3BUU is presented, as well as a comparison to an implementation of the GENIE generator in KM3NeT.

T 87.8 Thu 17:45 Geb. 30.22: Gaede-HS

Measuring Cherenkov light in liquid scintillator neutrino detectors using Wavelength-Shifting Optical Modules — •Florian Rehbein[1], Thomas Hebbeker[1], Heiko Lacker[2], and Michael Wurm[3] — [1]Physics Institute III A, RWTH Aachen University — [2]Humboldt-Universität zu Berlin — [3]Johannes Gutenberg-Universität Mainz

Wavelength-Shifting Optical Modules (WOMs) are photo sensors consisting of a PMMA tube coated with wavelength-shifting paint. The coating absorbs photons and re-emits wavelength-shifted photons, which are guided toward the ends of the tube and are then detected using an array of attached SiPMs. This simple design of a WOM presents a novel optical sensor for various applications, as the size of the module and the type of coating can be adjusted to the specific requirements of the detector. One future application of WOMs will be the Surrounding Background Tagger (SBT) of the proposed SHiP (Search for Hidden Particles) experiment at the CERN facility.

This contribution will present the first study of WOMs in liquid scintillator-based low-energy neutrino detectors. Instrumenting such a detector with two types of WOMs with different wavelength-shifting coatings provides spectral sensitivity for the incident photons. Since the two WOM types are sensitive to different wavelength ranges, one can discriminate long-wavelength Cherenkov from short-wavelength scintillation photons. This hybrid detection technique is especially advantageous to achieve both low-energy threshold (scintillation) and directional reconstruction (Cherenkov) for background reduction.