T 32: Neutrino Astronomy II

Time: Tuesday 16:15–18:00 Location: VG 1.105

T 32.1 Tue 16:15 VG 1.105

Design and Production of the first P-ONE detector line — •Ben Nührenbörger for the P-ONE-Collaboration — Department of Physics, Technical University of Munich, Germany

Astrophysical neutrinos at the TeV scale would open a new observational window into currently obscured and inaccessible extreme environments. Detecting them poses significant challenges due to their low rate and weak interactions with matter. The Pacific Ocean Neutrino Experiment (P-ONE) addresses this problem by instrumenting a large volume of water at a depth of 2.6 km in the Northeast Pacific Ocean, piggybacking on a large oceanographic infrastructure maintained by Ocean Networks Canada. The ocean water will be used as a detection medium for the Cherenkov light emitted by the charged secondary particles produced by a neutrino interaction at TeV and above. This is done using an array of photomultiplier tubes encapsulated in glass hemispheres. A total of 20 hemispheres are mounted on a kilometer-high mooring line and read out by a newly designed data acquisition system that ensures sub-nanosecond timing, which is critical for correlating and reconstructing signals across the detector array. This talk will provide an overview of the design and integration of the first mooring line, focusing on the construction and operation of the optical modules, the measures taken to achieve precise timing, and the data acquisition processes.

T 32.2 Tue 16:30 VG 1.105

Status and results of the KM3NeT neutrino telescope — •Thomas Eberl for the KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

KM3NeT is the next-generation underwater Cherenkov neutrino detector operational and under construction in the Mediterranean Sea at two different locations. The ORCA detector, close to Toulon, features a dense configuration of optical modules, optimised for the study of interactions of neutrinos with energies down to a few GeV. The same technology, albeit in a sparser configuration, is used for high-energy (TeV-PeV) neutrino astronomy with the ARCA neutrino telescope off the coast of Sicily. Both instruments are operational, take data since several years, and have been completed to more than 20% of their expected final volume. In this talk the construction plans and status will be reviewed and an overview of recent results on particle physics and neutrino astronomy will be given. The recent discovery of an extreme-energy neutrino will be discussed.

T 32.3 Tue 16:45 VG 1.105

Neutrino Event Generator Studies with NEUT — •Frederik Andersen, Thomas Eberl, and Rodrigo Gracia Ruiz for the KM3NET-ERLANGEN-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg, Nikolaus-Fiebiger-Str. 2, 91058 Erlangen, Germany

The KM3NeT/ORCA neutrino telescope is currently under construction in the Mediterranean Sea. It is optimized to detect atmospheric neutrinos with energies up to 100 GeV. To this end a three dimensional grid of photomultiplier tubes detects Cherenkov radiation induced by particles that result from neutrino interactions with seawater. The data recorded by the experiment is analysed by comparing to detailed Monte-Carlo simulations which implement state-of-the-art knowledge on secondary particle production and detection processes. As a first step, so-called neutrino event generator codes employ different approximations to simulate the distribution of final-state particles produced in neutrino interactions. Differences in neutrino generators can introduce biases in the interpretation of the experimental data, and lead to tensions in measurements performed by different experiments. In this talk we will present our strategy to study how using different neutrino event generators impacts KM3NeT/ORCA's scientific results. We implement an alternative simulation pipeline using NEUT, the neutrino event generator developed by Super-Kamiokande, and compare its results to the default KM3NeT pipeline employing GENIE as event generator.

T 32.4 Tue 17:00 VG 1.105

Prospects for a combined measurement of the galactic neutrino flux with KM3NeT and IceCube — •Anke Mosbrugger and Oliver Janik — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Observing the Galactic Plane with muon neutrinos relies on precise muon track reconstruction for accurate pointing and high detection efficiency. To suppress the dominant background from atmospheric muons, the Earth itself is used as a natural filter. This effectively yields a pure neutrino data set on the Hemisphere below the local horizon. Hence, combining data from a neutrino telescope in the Southern Hemisphere (IceCube) and the Northern Hemisphere (KM3NeT) increases the sensitivity to the astrophysical neutrino flux, especially for observations of the Galactic plane. The diffuse astrophysical neutrino flux is analyzed using a binned forward-folding likelihood approach. All statistical modeling in this work is handled by the framework NNMFit. This talk will outline the implementation of KM3NeT data in this framework and the prospects of combining data of the KM3NeT and IceCube neutrino telescopes for a measurement of the galactic neutrino flux.

T 32.5 Tue 17:15 VG 1.105

The Galactic Diffuse Neutrino Emission in a combined fit of Muon Tracks and Cascades with IceCube* — •Jonas Hellrung[1,2], Niclas Krieger[1,2], and Julia Tjus[1,2,3] for the IceCube-Collaboration — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

Although cosmic rays (CRs) were discovered more than a hundred years ago, their origin is not yet understood. One problem is that the cosmic-ray spectrum can only be measured close to Earth. However, there is a way to indirectly study the distribution of CRs in the Galaxy: When CRs interact with the interstellar medium, they produce gamma rays and neutrinos. The first observation of this neutrino flux was published in 2023 by IceCube. Here I present plans for a new analysis combining different event topologies. IceCube measures events in two main topologies: Tracks, originating in charged current ν_μ interactions, provide a better angular resolution. In contrast cascades, from most other possible interactions, provide a better energy resolution and are able to observe the Southern sky (and therefore the Galactic Center) despite the huge background of atmospheric muons. Combining both event topologies in one analysis exploits all these advantages. Sensitivities and model discrimination power of such a measurement are discussed here. *Supported by BMBF and SFB 1491

T 32.6 Tue 17:30 VG 1.105

Unfolding the Electron Neutrino Diffuse Spectrum — •Lene van Rootselaar, Lucas Witthaus, and Pascal Gutjahr for the IceCube-Collaboration — Technische Universität Dortmund

The IceCube Neutrino Observatory, located at the geographic South Pole, is a cubic-kilometre detector designed to identify neutrinos across a wide energy range. It distinguishes between two main types of neutrino signatures: track events, caused by muons traversing the detector, and cascade events, primarily produced by Charged-Current (CC) interactions of electron neutrinos and Neutral-Current (NC) interactions of all neutrino flavours. By analysing cascade events, it becomes possible to assess a diffuse electron neutrino spectrum, provided the background from Neutral-Current tau and muon neutrino interactions is properly accounted for.

Current progress on the production of this electron neutrino spectrum will be presented. The method used for this analysis is unfolding. The analysis is based on a Monte Carlo cascade sample. Preliminary flux results will be shown and compared to theoretical models, alongside an overview of the preparatory steps leading to this approach.

T 32.7 Tue 17:45 VG 1.105

Sensitivity of IceCube Upgrade to neutrinos from the Galactic Plane — •Berit Schlüter and Alexander Kappes for the IceCube-Collaboration — Universität Münster, Institut für Kernphysik

As part of the IceCube Upgrade, the IceCube neutrino observatory will be instrumented with seven additional strings during the Antarctic summer of 2025/26 to improve sensitivity in the low-energy range from 10 GeV to 1 GeV and to achieve a significant improvement in the detector's calibration. New optical modules and calibration devices have been developed for this purpose. To evaluate the impact of the IceCube Upgrade on low-energy sensitivity, analyses are being performed on two IceCube data sets and one MC data set for the IceCube Upgrade, focusing on neutrinos from the Galactic plane. In this talk, the procedure for this analysis will be presented, and preliminary results will be shown.