T 46: Neutrino Astronomy 2

Time: Tuesday 16:15–18:30 Location: T-H31

T 46.1 Tue 16:15 T-H31

Search for the Galactic Diffuse Neutrino Flux with IceCube — •Jonas Hellrung[1], Jakob Böttcher[1], Philipp Fürst[1], Erik Ganster[1], Philipp Mertsch[2], Georg Schwefer[1], Roman Suveyzdis[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]III. Physikalisches Institut B, RWTH Aachen University — [2]Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen University

A diffuse flux of high-energy astrophysical neutrinos has been detected with the IceCube Neutrino Observatory. This flux is dominated by neutrinos of extragalactic origin. However, a fraction of these neutrinos is expected to originate from cosmic rays interacting with the interstellar medium in our Galaxy. This flux has not been measured yet, but a detection could be within reach of IceCube's sensitivity. The signature of this flux with respect to the isotropic extragalactic flux is its close correlation with the galactic plane. The detection would contribute to the understanding of propagation and sources of galactic cosmic rays of typically PeV energies. In this talk the principle of an analysis using neutrino-induced through-going muons is presented and its sensitivity is discussed.

T 46.2 Tue 16:30 T-H31

The energy spectrum of the diffuse neutrino flux in a combined fit using 10 years of IceCube data — •Richard Naab[1], Erik Ganster[2], Markus Ackermann[1], and Christopher Wiebusch[2] for the IceCube-Collaboration — [1]DESY, Zeuthen, Germany — [2]Physics Institute III B, RWTH Aachen University, Germany

The IceCube Neutrino Observatory has discovered a diffuse astrophysical neutrino flux and measures the energy spectrum and flavor composition in different detection channels. With almost 10 years of data, we aim to combine different detection channels to constrain this energy spectrum and flavor composition with unprecedented precision. The increased statistics require rigorous treatment of systematic uncertainties, which we aim to achieve with the so-called SnowStorm method, recently developed within the IceCube collaboration. This technique involves a continuous variation of systematics parameters during the detector simulation and requires a dedicated analysis approach.

In this work, we present the validation of this method for the purpose of measuring the energy spectrum, using two distinct analysis approaches. Furthermore, we discuss the sensitivity of an upcoming analysis combining the detection channels of tracks and cascades.

T 46.3 Tue 16:45 T-H31

Impact of the Binning in the Likelihood-Analysis of the Diffuse Neutrino Flux in IceCube — •Roman Suveyzdis, Jakob Böttcher, Philipp Fürst, Erik Ganster, Jonas Hellrung, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen University, Aachen, Germany

The IceCube Neutrino Observatory is measuring a diffuse flux of astrophysical high-energy muon-neutrinos. For this measurement, events are binned in energy and zenith direction, and a flux model can be fitted to the resulting distributions with a likelihood. The current analysis is based on a binning scheme with equidistant bins in logarithmic energy and cosine zenith. Such a binning is suboptimal, because particularly for high energies, the event statistics in the experimental data as well as in the Monte-Carle prediction is low, leading to inherent uncertainties. Here, we explore the effects of non-equidistant and generalized binnings, and investigate how these binnings can improve the analysis.

T 46.4 Tue 17:00 T-H31

Studying the Energy Dependent Cosmic Ray Moon and Sun Shadow with IceCube Data. — •Johan Wulff and Julia Becker Tjus for the IceCube-Collaboration — Institute for theoretical physics IV, Ruhr-University Bochum, Germany

While the Cosmic Ray Moon shadow can be utilised to verify the pointing of detectors such as IceCube, the Sun shadow has proven to be a successful tool for the assessment of solar magnetic field models.

In a previous publication (Aartsen et al, Phys. Rev. D), the relationship between the solar activity and the strength of the Cosmic Ray Sun shadow was investigated by comparing seven years of IceCube data with the solar cycle and solar magnetic field models. By modelling the propagation of Cosmic Rays through the solar magnetic field, two models of the coronal magnetic field were tested by comparing the observed shadow to the predicted one.

For this analysis, an energy reconstruction of Cosmic Ray induced muon events was introduced, allowing for an investigation of the energy dependence of both shadows. Furthermore, magnetic field effects of the Sun shadow can be investigated at different energies and an energy- dependent pointing can be studied with the Cosmic Ray Moon shadow. In this talk, the performance of the machine-learning based energy reconstruction with respect to the IceCube Cosmic Ray Sun and Moon shadow dataset, as well as the extension of the Cosmic Ray Sun shadow analysis up to the minimum of the 24th Solar cycle will be discussed. This project is funded via BMBF Verbundforschung, Project 05A20PC2.

T 46.5 Tue 17:15 T-H31

Seasonal Variations of the Atmospheric Neutrino Flux determined from 10 years of IceCube Data with DSEA+ — •Karolin Hymon and Tim Ruhe for the IceCube-Collaboration — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

The IceCube Neutrino Observatory is a cubic-kilometer detector array at the South Pole. Beyond the detection of astrophysical neutrinos, the detector measures atmospheric neutrinos at a high rate. These atmospheric neutrinos originate from cosmic ray interactions in the upper atmosphere, mainly from the decay of pions and kaons. The rate of the measured neutrinos, however, is affected by seasonal temperature variations in the Stratosphere, and the variations are expected to increase with the particle's energy. The Dortmund Spectrum Estimation Algorithm (DSEA+) is a novel approach to spectrum unfolding. The ill-posed problem is transferred to a multinomial classification task, in which the energy distribution is estimated from measured quantities by machine learning algorithms. In this talk, the analysis approach to measure the spectral dependence of the seasonal neutrino flux will be presented. Seasonal neutrino energy spectra are determined by DSEA+, utilizing 10 years of IceCube's atmospheric muon neutrino data. The differences of the unfolded seasonal spectra will be compared to the unfolded annual mean flux.

T 46.6 Tue 17:30 T-H31

NN-based parametrization of muon deflections simulated by PROPOSAL — •Pascal Gutjahr and Mirco Hünnefeld — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

Neutrinos are fundamental particles that are nearly massless and not charged. This allows them to traverse the universe along a straight line without deflection. It makes them an excellent candidate for the search of astrophysical neutrino sources. This is achieved using detectors such as the IceCube Neutrino Observatory, which is located at the geographic South Pole. In the ice at a depth of 1450 m, Cherenkov radiation from the secondary particles of neutrino interactions is measured. Reconstruction of the daughter particles can then be used to infer the direction of the original neutrino. Due to the high energies in the GeV to PeV range, the deflection of the particles due to stochastic energy losses and multiple scattering is assumed to be negligible compared to the directional resolution of IceCube. This assumption may begins to be inaccurate as resolution increases and low energy muons are studied especially with respect to the IceCube upgrade. A study with the lepton propagator PROPOSAL is done to present expected deflections of muons for different energy ranges. The result is parametrized by a neural network.

T 46.7 Tue 17:45 T-H31

Improving Astrophysical Muon-Neutrino Measurements with New Energy Estimators in IceCube — •Philipp Fürst, Jakob Böttcher, Erik Ganster, Jonas Hellrung, Georg Schwefer, Roman Suveyzdis, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen University - Physics Institute III B, Aachen, Germany

The IceCube Neutrino Observatory is measuring a diffuse astrophysical neutrino flux with a spectral shape compatible with a single power law at Tev to PeV energies. With neutrinos conveying information directly from their source, their spectral shape is closely connected to open questions about the acceleration and propagation of the hadronic component of cosmic rays. While hints for spectral features beyond a single power law exist, spectral resolution in the muon-neutrino detection channel is strongly tied to the achievable energy resolution. We present new methods of energy estimation based on machine learning methods and estimate the expected sensitivity gain for model hypotheses beyond the single power law, exploring the possibility to distinguish different spectral shapes in the future.

T 46.8 Tue 18:00 T-H31

The Pacific Ocean Neutrino Experiment: prototype line development — •Martin Dinkel, Elisa Resconi, and Christian Spannfellner for the P-ONE-Collaboration — Technische Universität München

The Pacific Ocean Neutrino Experiment (P-ONE) is a planned large-scale neutrino telescope in the Northeast Pacific Ocean, near the coast of Vancouver Island, British Columbia. The P-ONE collaboration, founded by an initiative of Canadian and German institutes, successfully deployed two pathfinder experiments to probe the site for P-ONE. The next milestone is the construction and deployment of the first line of the Pacific Ocean Neutrino Experiment. This so-called prototype line will comprise optical and calibration modules and follow a novel design approach to minimize interface gaps and allow a scalable deployment approach. We will present the optical and calibration module development status and introduce the overall line design and deployment approach.

T 46.9 Tue 18:15 T-H31

Machine-learning aided experimental design for P-ONE — •Janik Prottung, Christian Haack, and Arturo Llorente Anaya — Technical University Munich, Germany

The Pacific Ocean Neutrino Experiment (P-ONE) is a collaboration of Ocean Networks Canada (ONC) and Universities from Germany, Canada, and the USA to build a large volume neutrino telescope in the Pacific Ocean. Similar to other neutrino telescopes, P-ONE wants to instrument the ocean with photosensors deployed on vertical cables (lines) to detect high-energy neutrino interactions by the Cherenkov light emitted from secondary particles. The design of such telescopes has a variety of free parameters, such as the sensor spacing and sensor density, trigger algorithms and thresholds, or hardware used for signal digitization. These parameters directly impact the physics potential of the telescope and need to be optimized under external constraints (cost, bandwidth, site limitations). These optimization studies typically require expensive Monte-Carlo simulations that limit the explorable parameter phase space. This talk presents a framework that uses graph-neural networks and multi-parameter optimization to comprehensively explore the parameter phase space while reducing the simulation time. The framework facilitates data-driven decisions for the P-ONE design, maximizing the physics potential while minimizing the expenses.