T 42: Neutrino astronomy II

Time: Tuesday 16:00–18:30 Location: Tq

T 42.1 Tue 16:00 Tq

Muon Deflection Angle Study with IceCube — •Pascal Gutjahr, Mirco Hünnefeld, and Wolfgang Rhode — TU Dortmund, Experimentelle Physik Vb

Neutrino detectors, such as IceCube, utilize muons resulting from charged current muon-neutrino interactions to infer the direction of the primary neutrino. These muons may travel several kilometers before entering the detector. Along this track, the muon may be deflected though interactions with the surrounding medium. Due to their high energies of hundreds of GeV to PeV, the muons are highly Lorentz boosted, resulting in small deflection angles. The deflection along the track is therefore assumed to be negligible for IceCube. However, these small deflection angles may accumulate over long distances.

A study is presented that investigates the impact of accumulated deflections along the muon track by introducing a scaling factor for bremsstrahlung interactions. This study focuses on the one hand on the possibility to measure this scaling factor with IceCube. On the other hand, the opening angle between the incoming and outgoing muon is studied as a function of scaling factor, energy and propagated distance via Monte Carlo simulation.

T 42.2 Tue 16:15 Tq

Studies of systematic uncertainty effects on IceCube's real-time angular uncertainty — •Cristina Lagunas Gualda for the IceCube-Collaboration — DESY Zeuthen

Sources of astrophysical neutrinos can be potentially discovered through the detection of neutrinos in coincidence with electromagnetic or gravitational waves. Real-time alerts generated by IceCube play an important role in this search since they act as a trigger for follow-up observations with instruments sensitive to other wavelengths.

Once a high-energy event is detected by the IceCube real-time program, a sophisticated and time-consuming method is run in order to calculate an accurate localization. To investigate the effect of systematic uncertainties on the uncertainty estimate of the location, we simulate a set of high-energy events with a wide range of directions for different ice model realizations. This makes use of a novel simulation tool, which allows the treatment of systematic uncertainties with multiple and continuously varied nuisance parameters. Then those events are reconstructed using various reconstruction methods. The aim of this study is to include systematic uncertainties in a robust way in the real-time direction and error estimates.

T 42.3 Tue 16:30 Tq

Precision self-monitoring calibration module for the IceCube Upgrade — •Tobias Pertl and Felix Henningsen — Technische Universität München

The IceCube detector is a large-volume neutrino detector embedded in the Antarctic ice at the geographic South Pole. As the detector has been online for over a decade, advancements in hardware and an increased scientific focus on oscillation and high-energy physics as well as re-calibration of the detector have driven the IceCube Upgrade. This upgrade encompasses a detector expansion with seven new densely instrumented strings focussed on low-energy physics. A novel type of precision optical calibration module – or POCAM – for large-volume detectors has been developed and will be deployed throughout the instrumented volume of the IceCube Upgrade. We report on the design and extended performance of the POCAM instrument as well as calibration procedures.

T 42.4 Tue 16:45 Tq

Redesigning the IceCube processing pipeline with deep learning — •Christian Haack and Theo Glauch for the IceCube-Collaboration — TU München

The IceCube Neutrino Observatory is a cubic-kilometer sized neutrino detector located at the geographic South Pole. The main background for neutrino searches are atmospheric muons, induced by cosmic-ray air showers. IceCube employs multiple levels of software filters, involving various event reconstructions, to reduce the atmospheric muon background and classify the events based on their topology. While this pipeline has enabled many scientific breakthroughs, such as the measurement of the diffuse astrophysical neutrino flux and the detection of the first high-energy neutrino point source, many of its components have been in place for more than ten years. This makes the filtering pipepline increasingly challenging to maintain. Additionally, detector extensions, such as the IceCube Upgrade, are difficult to incorporate in the existing filtering systems. However, recent developments in deep-learning based filtering and reconstruction algorithms have the potential to drastically simplify the filtering pipeline. In this talk, we will outline how a deep-learning based filtering system for IceCube might look like.

T 42.5 Tue 17:00 Tq

Machine Learning-based Cascade Event Selection for IceCube — •Mirco Hünnefeld for the IceCube-Collaboration — TU Dortmund, Germany

IceCube is a neutrino detector located at the geographic South Pole, instrumenting a cubic kilometer of glacial ice. Neutrino interactions are detected via Cherenkov radiation of charged secondary particles. The two main detection channels consist of tracks, induced by charged current muon-neutrino interactions, and cascade events, which are almost spherical energy depositions. Although the selection and angular reconstruction of cascades is challenging, these events enhance IceCube's capabilities to probe the southern neutrino sky. In this talk, a machine learning-based cascade event selection is presented. The event selection utilizes a series of convolutional neural networks and boosted decision trees for classification and reconstruction tasks. In addition, a novel reconstruction method based on a hybrid approach of maximum-likelihood estimation and generative neural networks is employed. The presented event selection improves upon the performance of previous selections, while greatly reducing the necessary computation time, enabling the application in real-time.

T 42.6 Tue 17:15 Tq

Unfolding the neutrino energy spectrum from three years of IceCube data — •Leonora Kardum — Technische Universität Dortmund

Precise unfolding techniques are crucial for determining the diffuse astrophysical neutrino flux from the low statistic data of the higher energy region. Here presented is a rigorous approach to muon neutrino sample cleaning achieving higher purity than previous methods, combined with a novel approach to rebin the observable space with the goal of attaining substantial statistics in all regions. A comprehensive unfolding approach is presented for the purpose of determining the neutrino distribution in the whole zenith area of interest aimed at analyzing three years of IceCube IC86 data.

T 42.7 Tue 17:30 Tq

Perspectives of a Global Fit of IceCube's Astrophysical Neutrino Data — •Erik Ganster[1], Jakob Böttcher[1], Philipp Fürst[1], Christian Haack[2], Jöran Stettner[1], and Christopher Wiebusch[1] for the IceCube-Collaboration — [1]RWTH Aachen University - Physics Institute III B, Aachen, Germany — [2]TU München - Experimental Physics with Cosmic Particles

The IceCube Neutrino Observatory has observed a flux of high-energy astrophysical neutrinos since 2013. This observation has been confirmed in multiple complementary detection channels such as high-energy starting events (HESE), cascades, and through-going muon tracks. This diffuse flux is typically modelled by power-law energy spectra. However, the measured flux properties differ between these different observations. We report on the status of a combined global analysis of all high-energy neutrino data from IceCube which is currently being prepared. Studies of the sensitivity of this 'global fit' for measuring the flux properties will be shown.

T 42.8 Tue 17:45 Tq

Neutrino-blazar correlations: Striving for the big picture — •Martina Karl[1,2] and Matthias Huber[2] for the IceCube-Collaboration — [1]Max-Planck-Institut für Physik, Föhringer Ring 6, 80805München, Deutschland — [2]Technische Universität München, Fakultät für Physik, James-Franck-Str. 1, 85748 Garching, Deutschland

The IceCube neutrino observatory experienced remarkable success in the field of neutrino astronomy since its completion. Besides the discovery of a diffuse astrophysical high-energy neutrino flux, IceCube

found evidence for a correlation between high-energy neutrinos and the blazar TXS 0506+056 in 2018. Blazars, being a subclass of active galactic nuclei and consequently one of the most powerful objects in the universe are one of the most promising source candidates of high-energy neutrinos.

In this talk, we will present a correlation study between high-energy neutrinos measured with the IceCube neutrino detector and different classes of blazars. This study aims to provide the deepest understanding of the neutrino-blazar correlation that is accessible by means of current measurements.

T 42.9 Tue 18:00 Tq

The followup of IceCube alerts: Search for high-energetic neutrino sources — •Anna Schubert[1] and Martina Karl[1,2] for the IceCube-Collaboration — [1]Technische Universität München, Fakultät für Physik, James-Franck-Str. 1, 85748 Garching, Deutschland — [2]Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Deutschland

IceCube is a cubic-kilometer scale neutrino detector instrumenting a gigaton of ice at the geographic South Pole in Antarctica. On average, 8 track-like high energetic neutrino events with a high probability of being of astrophysical origin are detected per year. The bright appearance of these events in the detector allows for a good pointing to their origin. In this talk we present a search for the production sites of these cosmic neutrinos and hence also of the closely connected high-energy cosmic-rays. We use IceCube's high-statistics, neutrino-induced through-going muon samples to search for sources specifically in the vicinity of the arrival directions of the single most high-energetic events. The analysis searches for both, steady sources as well as for sources that only temporarily produce neutrinos.

T 42.10 Tue 18:15 Tq

Stacking Point Source Search for a Neutrino Contribution at HESE and EHE Positions with IceCube Data — •Johannes Kollek[1], Jan Soedingrekso[1], and Alexander Sandrock[1,2] for the IceCube-Collaboration — [1]TU Dortmund, Dortmund, Germany — [2]Now at National Research Nuclear University MEPhI, 115409 Moscow, Russia

Neutrino point source searches could help understanding cosmic ray acceleration. With past all-sky searches in IceCube not revealing any point sources so far, a higher sensitivity can be achieved with time-dependent stacking searches on predefined source positions. A previous analysis on high energy starting event (HESE) positions with different non-overlapping time windows issued no significant lower-energy excess. The analysis is repeated also using the positions of extremely high energy events (EHE) and extended to additionally test overlapping time windows. This talk covers the early stage of the analysis and gives an overview over the analysis methods and goals.