T 42: Neutrino astronomy 2

Time: Tuesday 16:00–18:00 Location: Geb. 30.23: 6/1

T 42.1 Tue 16:00 Geb. 30.23: 6/1

Dissecting and Improving the High-Energy Muon Neutrino Track Selection of the IceCube Neutrino Observatory — •Johanna Hermannsgabner, Jakob Böttcher, Philipp Fürst, Erik Ganster, Michael Handt, Philipp Soldin, and Christopher Wiebusch for the IceCube-Collaboration — RWTH Aachen, Aachen, Germany

The IceCube Neutrino Observatory observes high-energy neutrinos from the atmosphere as well as from astrophysical sources. One important detection channel is up-going muon tracks from charged-current muon-neutrino interactions, called Northern Tracks. This channel includes a Boosted Decision Tree (BDT)-based selection to remove down-going atmospheric muons and other event signatures. By retraining the BDT with updated simulation data and improved input variables, we achieve an increased efficiency. In this talk, we introduce IceCube's Northern Tracks event selection, point out challenges, and present the most recent results.

T 42.2 Tue 16:15 Geb. 30.23: 6/1

Binning Optimization of the Likelihood Analysis of Astrophysical Muon Neutrinos with IceCube using an Evolutionary Algorithm — •Matthias Thiesmeyer, Jakob Böttcher, Shuyang Deng, Philipp Fürst, Erik Ganster, Sharif El Mentawi, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Insitut b, RWTH Aachen University

One important detection channel for astrophysical neutrinos in the IceCube Neutrino Observatory is neutrino-induced muon tracks. The astrophysical flux parameters are estimated using a profile likelihood fit of the measured neutrino data. The binned 2D distribution of reconstructed zenith and energy is compared to the number of expected events from atmospheric and astrophysical neutrino fluxes. To maximize the sensitivity to the astrophysical neutrino flux properties, we optimize the choice of binning. First, we extend the simple Poissonian likelihood to an effective likelihood that includes the uncertainties of the bin predictions caused by limited Monte-Carlo statistics. Then, using the effective likelihood, we apply an evolutionary algorithm for binning optimization. Iteratively, the algorithm creates different candidate binnings, compares them, and selects the best performing binning to create new candidates from. This talk highlights the different properties of both likelihoods for binning optimization, describes the evolutionary algorithm, and discusses the result.

T 42.3 Tue 16:30 Geb. 30.23: 6/1

Energy-dependent measurement of seasonal variations in the atmospheric muon neutrino spectrum — •Karolin Hymon, Tim Ruhe, and Lucas Witthaus for the IceCube-Collaboration — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

A large number of atmospheric neutrinos are detected in ground-based neutrino telescopes, such as the IceCube Neutrino Observatory. These neutrinos are generated in extensive air showers initiated by a cosmic rays interacting with air nuclei in the atmosphere. Conventional atmospheric neutrinos originate mostly from kaons and pions that decay into neutrinos. The production of atmospheric neutrinos varies seasonally due to temperature variations in the atmosphere during the year. As the temperature increases, the atmosphere expands and the atmospheric density decreases. The seasonal variation increases with energy, as parent particles interact at higher altitudes in the atmosphere and the interaction cross section increases with energy. Consequently, the probability of decay for the parent mesons increases, leading to a subsequent increase in the neutrino flux. This talk presents the measurement of seasonal variations in the muon neutrino energy spectrum between 125 GeV and 10 TeV. The determination of the neutrino energy presents an ill-conditioned inverse problem, requiring to infer the energy from measured detector quantities. This challenge is addressed by the Dortmund Spectrum Estimation Algorithm (DSEA+), which uses machine learning methods to unfold the neutrino energy using 11.5 years of IceCube data.

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T 42.4 Tue 16:45 Geb. 30.23: 6/1

Prompt neutrino flux with atmospheric neutrinos in IceCube — •Lars Bollmann, Mirco Hünnefeld, and Pascal Gutjahr for the IceCube-Collaboration — TU Dortmund University, AG Rhode, Dortmund, Germany

One of the main goals of the IceCube neutrino detector, located at the geographic South Pole, is the identification and characterization of the high-energy astrophysical neutrino flux. However, the majority of neutrinos detected by IceCube are atmospheric neutrinos from cosmic ray interactions in the atmosphere. The atmospheric neutrino flux consists of two components: conventional neutrinos from pion and kaon decays, and prompt neutrinos from the decay of charmed or heavier mesons. The precise shape of the prompt neutrino flux is not yet fully understood. A better understanding of this flux could improve measurements of astrophysical neutrinos, as prompt atmospheric neutrinos are their main background at high energies. By looking only for neutrino events with coinciding muons from the same air shower a purely atmospheric neutrino sample can be created. The removed astrophysical component allows for a better characterization of the prompt atmospheric neutrino flux. In this talk first steps toward a measurement of the prompt atmospheric neutrino flux using this approach will be presented.

T 42.5 Tue 17:00 Geb. 30.23: 6/1

Detector Response Parametrization with Symbolic Regression for Next-Generation Neutrino Telescopes — •Arsenije Arsenić and Christian Haack — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Symbolic regression is a machine learning-based tool used to find mathematical expressions which describe a set of datapoints. It differs from normal regression methods in that it does not require a predefined form of the expression, but rather explores the space of various different mathematical expressions.

Neutrino telescopes are observatories for the detection of high-energy neutrinos. These telescopes are typically placed in cubic-kilometer-scale volumes of transparent material (such as ice or water) where sensors capture photons produced by neutrino interactions.

We aim to utilize symbolic regression for the geometry optimization of next-generation neutrino telescopes. As end-to-end Monte Carlo simulations are computationally expensive, symbolic regression offers an alternative by parameterizing the detector response as a function of detector layout. This helps with optimization of the detector configuration, enhances computational efficiency, and thus allows for rapid exploration of new designs.

T 42.6 Tue 17:15 Geb. 30.23: 6/1

Studying neutrino emission from the galactic plane with PLEnuM — •Anke Mosbrugger, Lisa Schumacher, and Christian Haack — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

Diffuse neutrino emission from the galactic plane has long been expected given the observed gamma ray flux. One of the recent successes of the IceCube Neutrino Observatory was the observation of high-energy neutrinos from the galactic plane. This observation will give us further insight into cosmic ray propagation and galactic sources. However, due to its location at the geographic South Pole, IceCube's effective area in the direction of the galactic center region is limited. This limitation can be overcome by combining data from multiple neutrino telescopes with different fields of view, thereby increasing the analysis sensitivity. This concept is implemented in the Planetary Neutrino Monitoring System (PLEnuM). The PLEnuM software uses parametrized instrument response functions to facilitate the combination of datasets from multiple detectors. In this talk I will present the implementation of a galactic plane analysis in PLEnuM and show first results from the application of this method to public IceCube data. This work will enable projections and combined analyses for existing and future experiments such as IceCube-Gen2, KM3NeT, and P-ONE.

T 42.7 Tue 17:30 Geb. 30.23: 6/1

Enhancing neutrino detection efficiency with new triggers at the Pierre Auger Observatory * — •Srijan Sehgal for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

Besides detecting ultra-high-energy cosmic rays, the Pierre Auger Observatory with its large Surface Detector (SD) array offers a remarkable exposure to neutrinos above 10^{17}eV. Two new SD triggers, Time-over-Threshold-deconvolved (ToTd) and Multiplicity-of-Positive Steps (MoPS), were implemented in 2014 to further increase the detection capability for low energy neutrino-induced air showers.

This contribution aims to present the impact of the new triggers in the context of neutrino search for the zenith angle range of $60° < \theta < 75°$. An optimised neutrino selection, which includes the MoPS and ToTd, is devised and evaluated on simulated neutrino showers. This selection is then further applied to the data sample, and the results are compared to previous neutrino searches performed at the Pierre Auger Observatory.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A23PX1)*

T 42.8 Tue 17:45 Geb. 30.23: 6/1

Constraints on UHE fluxes of ν_τ, τ, and τ-like particles generated from BSM particles with the Pierre Auger Observatory — •Baobiao Yue for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Wuppertal, Germany

The Fluorescence Detector (FD) of the Pierre Auger Observatory offers a large exposure for Ultra-High Energy (UHE) Upward-Going Showers (UGS) like the ones reported by ANITA. Recently, strong limits on UGS were obtained using 14 years of FD data, which are in tension with the observations made by ANITA-I and III. Furthermore, ANITA-IV has reported new UGS candidates. Both of these observations motivate the exploration of Beyond Standard Model (BSM) scenarios.

In this work, we explore the parameter space to test three classes of BSM models. These unknown BSM particles can interact inside the Earth and produce ν_τ, τ, and τ-like particles, which can further interact or decay. Subsequently, some of the final products may escape the Earth and induce a UGS in the atmosphere. Due to the non-observation of the UGS by the FD, the upper flux limits of these UHE BSM particles are obtained as a function of their possible cross-sections with matter. In addition, stronger constraints are achieved by combining the Surface Detector and FD data of the Pierre Auger Observatory.

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