T 81: Neutrino astronomy III

Time: Thursday 16:30–19:00 Location: H-1.004

T 81.1 Thu 16:30 H-1.004

Observations of the Moon Shadow in Cosmic-Ray-Induced Muons with the IceCube Neutrino Observatory — •Saskia Philippen, Johannes Merz, René Reimann, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B RWTH Aachen

Calibrating the directional reconstruction of neutrino-induced muons in IceCube is a challenging task. As no luminous neutrino source exists in the sky, pointing and resolution are often estimated by Monte-Carlo methods. Experimentally, IceCube uses cosmic-ray-induced atmospheric muons for various calibration purposes. Particularly useful is the effect that cosmic rays are absorbed by the moon, resulting in a deficit of cosmic-ray muons from the lunar direction. This "Moon Shadow" finds application in the verification of the angular resolution and pointing of the detector as well as for source analyses. In this talk, the improvements in the directional uncertainty estimation of events and in the background determination are presented. The point source hypothesis is extended to a disc source hypothesis, which allows a scan of the radius of the moon. These improvements are tested against the standard analysis methods using the Moon Shadow. Furthermore, ideas to measure the impact of Earth's magnetic field with the usage of the Moon Shadow analysis are discussed.

T 81.2 Thu 16:45 H-1.004

Improving IceCube low-energy event reconstruction — •Elisa Lohfink, Jan Weldert, and Sebastian Böser for the IceCube-Collaboration — Johannes Gutenberg-Universität Mainz

With the low-energy extension (DeepCore) of the IceCube Neutrino Observatory, neutrinos with energies down to the GeV range can be reconstructed individually. The reconstruction is based on minimizing an eight-dimensional likelihood, using tabulated charge expectation values at each optical module, for the entire range of possible light sources. Due to computational restrictions, this includes spline-interpolating between a finite number of possible sources as well as assuming symmetries of the light behavior in the ice, neglecting for instance the known ice anisotropy. Also, within reconstruction, particle track lengths are quantized and certain characteristics of the light emission are simplified. Motivated by the resolutions an ideal reconstruction would yield and by the improvements this implies for physics results, it is worthwhile to thoroughly understand the individual effects these simplifications have. Consequently, those having the largest impact are identified and the potential of using full available detail is evaluated.

T 81.3 Thu 17:00 H-1.004

Moon analysis to test the directional resolution of a segmented spline algorithm in IceCube — •Sebastian Schindler, Thorsten Glüsenkamp, and Gisela Anton for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), University Erlangen-Nürnberg, Germany

In IceCube arrival directions of muon neutrinos are determined from resulting muon tracks in the detector. As muons from cosmic rays produce the same signature in the detector they can be used to test reconstruction algorithms. A calibration source of cosmic ray muons is provided by the moon, which produces an easy to observe localized reduction of the mostly uniform cosmic ray flux.

The directional resolution of a new segmented spline algorithm for muon reconstructions is tested by using the abundant flux of cosmic rays in a moon analysis. The current work using both experimental data and Monte Carlo simulations will be presented.

T 81.4 Thu 17:15 H-1.004

Observation of the Shadow of the Moon in Cosmic rays with the IceCube Neutrino Obervatory — •Johannes Merz, Erik Ganster, Christian Haack, Saskia Philippen, René Reimann, Lisa Schumacher, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

When new processes to calculate trajectories of muons passing through the IceCube Observatory are developed, the need for a calibration method arises. Due to the lack of a reliable standard candle, other options are considered, particularly with an all too familiar one rising over the horizon. The moon casts an observable shadow in the muon flux originating from air showers due to cosmic rays. This talk presents advancements in using this moon shadow as a calibration method for IceCube's reconstruction algorithms.

T 81.5 Thu 17:30 H-1.004

Seasonal Variation of the Atmospheric Neutrino Flux measured by IceCube — •Simon Hauser, Jakob Böttcher, Philipp Fürst, Patrick Heix, René Reimann, Jöran Stettner, Christopher Wiebusch, and Marit Zöcklein for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Atmospheric muon neutrinos measured by the IceCube Neutrino Observatory originate from charged meson decays in cosmic-ray induced air showers. The meson production and decay depend on the local atmospheric conditions. Therefore, one expects a correlation between the atmospheric temperature and the observed atmospheric neutrino flux. For the analysis of this correlation, almost 10 years of IceCube neutrino data are analyzed in conjuction with atmospheric temperature profiles measured by the Atmospheric Infrared Sounder (AIRS). The observed seasonal variation allows for testing models of hadronic interaction in atmospheric air showers. In this talk, an unbinned likelihood analysis of the correlation will be presented.

T 81.6 Thu 17:45 H-1.004

Seasonal Variations of the unfolded Atmospheric Neutrino Energy Spectrum with IceCube — •Karolin Hymon[1,2], Tim Ruhe[1], and Julia Tjus[2] for the IceCube-Collaboration — [1]TU Dortmund — [2]Ruhr-Universität Bochum

The IceCube Neutrino Observatory is a detector array at the South Pole with the central aim of studying high energy neutrinos of astrophysical origin. The majority of the detected neutrinos, however, are atmospheric neutrinos, caused by cosmic ray interactions in the atmosphere. The rate of atmospheric neutrinos undergoes a seasonal variation with indications that the rate changes with the temperature in the stratosphere. Possible implication of this variation on the shape of the atmospheric neutrino spectrum have not been studied so far. This talk will focus on the investigation of possible shape changes of the atmospheric neutrino spectrum, which will be analyzed using the Dortmund Spectrum Estimation Algorithm (DSEA).

T 81.7 Thu 18:00 H-1.004

Event Selection of Muons with Recurrent Neural Networks in IceCube — •Gerrit Wrede, Thorsten Glüsenkamp, and Gisela Anton for the IceCube-Collaboration — Erlangen Centre for Astroparticle Physics (ECAP), University Erlangen-Nürnberg, Germany

Relativistic muons created by muon neutrinos offer a good angular resolution and are thus an ideal channel for the detection of point sources. However, IceCube also measures a major background of muons from cosmic rays. This background can be avoided by selecting upgoing events from the northern hemisphere, where the earth shields cosmic rays. It is essential to reject misreconstructed cosmic-ray events in the upgoing region while preserving as much signal as possible. We trained a recurrent neural network to reconstruct muon tracks with high accuracy. In this talk, the neural-network-based reconstruction will be presented and its ability to reject cosmic-ray muons will be compared with standard reconstructions.

T 81.8 Thu 18:15 H-1.004

Development of the comprehensive analysis tools for the Supernova neutrino detectors — •Vsevolod Orekhov and Michael Wurm — Institute of Physics, Johannes Gutenberg Universität, Mainz

A galactic Supernova explosion is a unique neutrino source: detecting the neutrinos from deep inside the star will help us understand both the physics of the core collapse and properties of the neutrino themselves. If a SN neutrino burst arrived at Earth today, it would be detected by a variety of ton to kiloton scale neutrino detectors based on different technologies and target media. A full understanding of the observed signals can only be obtained by a combined analysis of the different interaction channels. This contribution presents an analysis framework developed to combine and fit the neutrino spectra from different detectors assuming a common flavour-dependent neutrino signal. We start the development from the six channels available on hydrogen, carbon and electrons that are available in large liquid scintillator detectors like JUNO. From there, the framework will be extended to include other detector media.

T 81.9 Thu 18:30 H-1.004

Unfolding of Supernova Neutrino Spectra in JUNO — •Max Büsken, Thilo Birkenfeld, Achim Stahl, Sivaram Yogathasan, and Shivani Ramachandran — III. Physikalisches Institut B, RWTH Aachen University

The Jiangmen Underground Neutrino Observatory (short: JUNO) currently under construction in southern China, is a 20 kt liquid scintillator neutrino detector. Its main physics goal will be to determine the neutrino mass hierarchy by measuring reactor neutrinos from two nuclear power plants at a baseline of 53 km. Apart from that JUNO will also be a great detector for neutrinos emerging from core-collapse supernovae. Recording such a signal would give a lot of insight into the physics of the collapse. Comprehensive simulations allow studying JUNO's potential detector response to the energy spectrum of supernova neutrinos. In this talk such simulations together with an identification of neutrino reaction channels are presented and a first approach to spectrum unfolding is shown.

T 81.10 Thu 18:45 H-1.004

P-ONE and prospects towards a global neutrino telescope network — •Matthias Huber — Technische Universität München, Deutschland

The origin of cosmic rays, the highest-energy particles ever observed is one of the greatest scientific mysteries that captures the interest of scientist for more than 100 years. High energy neutrinos, arriving from the farthest reaches of the cosmos, could hold the key to resolving this cosmic ray riddle. In 2018 first evidence for high-energy neutrino emission from the blazar TXS 0506+056 was announced by the IceCube collaboration as a result of a multi-messenger campaign. Despite this evidence no sources of high-energy neutrinos have been detected yet. The Pacific Ocean Neutrino Explorer (P-ONE) located in Canada at Cascadia Basin is designed to identify the origin of these high-energy neutrinos by covering a detector volume of $3km^3$ at a depth of 2660m after its completion. In order to reach maximal sensitivity to high-energy neutrino sources we furthermore propose a Planetary Neutrino Monitoring System (PLEnuM) realised by the integration of all existing neutrino telescopes in progress (KM3NeT, GVD, P-ONE and IceCube). In the first part of this presentation we will give a brief overview of the idea, the current status and the future plans of P-ONE. In the second part we will concentrate on a sensitivity study showing the enormous potential of the collaborative PLEnuM project in order to observe the sources of high-energy neutrinos.