T 62: Neutrino-Astronomie II

Zeit: Mittwoch 16:00–18:35 Raum: S14

Gruppenbericht T 62.1 Mi 16:00 S14

High-energy neutrino astronomy with IceCube: recent results and new perspectives — •Kai Krings for the IceCube-Collaboration — Technische Universität München, Physik-Department, James-Franck-Str. 1, 85748 Garching

Building a neutrino telescope at the Geographic South Pole was envisioned in the end of the 80s. After the first in-ice detection of neutrinos from the Earth's atmosphere with its predecessor AMANDA in the year 2000, the IceCube Neutrino Observatory was completed in 2011. IceCube is a one cubic kilometer sized deep in-ice Cherenkov telescope. It is composed by 5160 digital optical modules that record the Cherenkov light emitted along secondary charged particles, which are produced in neutrino interactions with the Antarctic ice. First high-energy neutrino events of astrophysical origin were discovered in 2013. A new phase of neutrino astronomy in Antarctica was initiated with the first evidence for a non-stellar neutrino point source in 2018: a high-energy neutrino-induced muon track was observed from the direction of the blazar TXS0506+056 and in coincidence with very high-energy gamma rays from the same direction. Moreover, a follow-up search found in the archival IceCube data evidence for a neutrino flare from the direction of TXS0506+056. In this group talk, we will report on recent IceCube results connected to high-energy neutrino astronomy and introduce a possible path towards the future of this new field.

T 62.2 Mi 16:20 S14

Self-triggered point source search with IceCube — •Martina Karl for the IceCube-Collaboration — Max-Planck-Institut für Physik, München, Deutschland — Technische Universität München, Deutschland

IceCube is a cubic-kilometer scale neutrino detector instrumenting a gigaton of ice at the geographic South Pole in Antarctica. On average, about 6-8 track-like high energetic neutrino events with energies ranging from 70 TeV to few PeV are detected per year. These muon tracks allow for a pointing to the origin of the muon neutrino in the sky as precise as 0.2°. This work presents a search for cosmic neutrino sources by looking for an excess of neutrino events with energies >= 100 GeV at the source positions of these track-like events. The analysis is applicable to both, a continuous neutrino flux from the source position, meaning a time integrated search over the entire live time of IceCube; as well as to neutrino flares from that source position, comprising an analysis of a time-dependent source. This search will be applied to all presently measured track-like events and additionally will be implemented as an automatic procedure that will be started as soon as a new track-like high energy event is detected.

T 62.3 Mi 16:35 S14

Improving the description of the astrophysical muon-neutrino spectrum with 9 years of IceCube data — •Joeran Stettner, Christian Haack, René Reimann, and Christopher Wiebusch for the IceCube-Collaboration — Otto-Blumenthal Strasse, 52074 Aachen

The IceCube Neutrino Observatory has observed a flux of high-energy astrophysical neutrinos, typically modeled as unbroken powerlaw energy spectrum. This observation has been confirmed in independent channels, i.e. different event selections and event topologies. However, the best-fitting description of the astrophysical astrophysical component differs between these analyses and it is an unsolved question where the difference comes from. Here, we present an update of the analysis of through-going muon-neutrinos from the Northern Hemisphere. It was extended to nine years of data and models beyond the unbroken powerlaw are explored to describe the astrophysical component. Additionally, an approach is presented to extract the flux-normalization in bins of true neutrino energy to enable an easy comparison to other measurements and theoretical predictions.

T 62.4 Mi 16:50 S14

Studying the temporal variation of the cosmic-ray Sun shadow – comparison of IceCube data with theoretical models of the solar magnetic field — •Frederik Tenholt and Julia Becker Tjus for the IceCube-Collaboration — Ruhr-Universität Bochum

The shadowing effect of the Moon and Sun in TeV cosmic rays has been measured with high statistical significance by several experiments. Unlike particles from directions close to the Moon, however, charged particles passing the Sun are deflected not only by the geomagnetic but also by the solar magnetic field. Since the latter undergoes a well-known 11-year cycle – during which it can become highly disordered – changes in the cosmic-ray Sun shadow measured at Earth are expected over time. We present a comparison of simulations that were developed in order to predict the cosmic-ray shadows of Moon and Sun and seven years of data taken with the IceCube Neutrino Observatory. While the results for the Moon shadow verify a stable detector, the results for the Sun shadow exhibit a clear variation. The observed variation in the data is used to compare two potential field models of the coronal magnetic field.

T 62.5 Mi 17:05 S14

First Double Cascade Tau Neutrino Candidates in IceCube — •Juliana Stachurska for the IceCube-Collaboration — DESY Zeuthen

The IceCube Neutrino Observatory at the South Pole detects Cherenkov light from charged particles produced in neutrino interactions. At the highest energies, the neutrino flux is of cosmic origin, with an expected flavor ratio of ν_e:ν_μ:ν_τ of about 1:1:1. A measurement of the flavor ratio on Earth can provide important information to constrain sources and production mechanisms. We have performed a flavor composition measurement of astrophysical neutrinos using 7.5 years of HESE data, distinguishing between three topologies: single cascades, double cascades and tracks. In IceCube, ν_τ -CC interactions above $\sim$ 100 TeV can produce resolvable double cascades, breaking the degeneracy between ν_e and ν_τ present at lower energies. I will present IceCube's first two identified double cascades and discuss these two ν_τ candidates.

T 62.6 Mi 17:20 S14

Observation of the cosmic-ray moon shadow using the IceCube Neutrino Observatory — •Saskia Philippen, Christian Haack, René Reimann, Marius Wallraff, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, Physikzentrum RWTH Aachen, Otto-Blumenthal-Straße, 52074 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. By combining multiple years of observation a high-statistics data sample is obtained. In addition to the verification of existing reconstruction methods, the contrast of the shadow will be employed to optimize the reconstructions.

T 62.7 Mi 17:35 S14

Seasonal variations of the atmospheric neutrino flux — •Marit Zöcklein, Pascal Backes, Jakob Böttcher, Philipp Fürst, Christian Haack, Patrick Heix, Jöran Stettner, and Christopher Wiebusch for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen University

Most neutrinos detected by the IceCube Neutrino Observatory emanate from pion and kaon decays in the Earth's atmosphere. Their flux correlates with the density of the atmosphere and thus with its temperature. Consequently, variations of the atmospheric neutrino flux caused by seasonal temperature variations are observable. The measured correlation can be used to test hadronic interaction models of air shower simulations and improve modeling of the atmospheric neutrino background for the search of cosmic neutrinos. This talk will present a measurement of these seasonal variations. Furthermore, it focuses on the development of a generalized analysis method of the neutrino rate correlation with the atmospheric temperature.

T 62.8 Mi 17:50 S14

Light diffusion in birefringent polycrystals and the IceCube ice anisotropy — •Martin Rongen for the IceCube-Collaboration

— III. Physikalisches Institut B, RWTH Aachen University

The IceCube Neutrino Observatory instruments about $1\,\mathrm{km}^3$ of deep, glacial ice at the geographic South Pole with 5160 photomultipliers to detect Cherenkov light of charged relativistic particles. The experiment pursues a wide range of scientific questions ranging from particle physics such as neutrino oscillations to astronomy with the search for sources of astrophysical neutrinos. Most of these efforts rely heavily on an ever more precise understanding of the optical properties of the instrumented ice. A largely unexplained light propagation effect is an anisotropic attenuation, which is aligned with the local flow of the ice. In this talk, the micro-structure of ice as a birefringent polycrystal is explored as the cause for this anisotropy.

T 62.9 Mi 18:05 S14

Study of seasonal variations of the atmospheric neutrino flux with MCEq — •Patrick Heix, Pascal Backes, Jakob Böttcher, Philipp Fürst, Christian Haack, Jöran Stettner, Christopher Wiebusch, and Marit Zöcklein for the IceCube-Collaboration — III. Physikalisches Institut B, RWTH Aachen

Atmospheric muon neutrinos originate mostly from the decay of pions and kaons in atmospheric showers initiated by cosmic rays. The production rate of these neutrinos depends on the profiles of density and temperature of the atmosphere. Using the Matrix Cascade Equation (MCEq) code, we calculate the neutrino flux for different atmospheric profiles, varying hadronic interaction and cosmic ray models. In particular we study the impact of these parameters on the seasonal variation of the atmospheric neutrino flux.

T 62.10 Mi 18:20 S14

Predictions for the flux of high-energy cosmogenic neutrinos* — •David Wittkowski and Karl-Heinz Kampert — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal

The origin and properties of the sources of ultra-high energy cosmic rays (UHECR, charged nuclei with energies $E > 1\,\mathrm{EeV}$) are still among the most important issues in astroparticle physics. A promising way to solve these issues is offered by multi-messenger approaches. When they propagate through the universe, UHECR interact with cosmic background photons generating the so-called „cosmogenic neutrinos“. Since they are not affected by cosmic magnetic fields or energy losses due to interactions with the cosmic background photons, cosmogenic neutrinos can provide additional and independent information about the sources of UHECR. In this talk, we present predictions for the so far unmeasured flux of high-energy cosmogenic neutrinos. These predictions are consistent with recent upper limits for the neutrino flux from large-scale cosmic-ray experiments and based on four-dimensional simulations that take the extragalactic magnetic field into account. The corresponding simulation results for the flux of UHECR are in good agreement with data from the Pierre Auger Observatory. Our predictions are important for the design of future neutrino observatories, since they allow to assess what detector volume and detection time are needed to measure the flux of high-energy cosmogenic neutrinos.

**Gefördert durch die BMBF Verbundforschung Astroteilchenphysik (Vorhaben 05A17PX1).*