T 100: Cosmic Rays V

Time: Friday 9:00–10:15 Location: VG 3.102

T 100.1 Fri 9:00 VG 3.102

Exploring High-Energy Atmospheric Muons with IceCube: Unfolding the Muon Flux — •Pascal Gutjahr — TU Dortmund University, Dortmund, Germany

Atmospheric muons, produced in cosmic ray air showers, can be divided into two components: conventional muons from pion and kaon decays, and prompt muons from heavy meson decays. While conventional muons dominate at TeV energies, the prompt component becomes increasingly relevant at PeV energies. Studying these muons is essential for understanding cosmic rays, refining hadronic interaction models, and reducing neutrino background in neutrino telescopes like IceCube.

This talk will present recent air shower simulations performed with CORSIKA, validated against numerical predictions from MCEq. A key focus will be on a method to unfold the atmospheric muon flux at the surface, leveraging machine learning for event reconstruction in IceCube.

T 100.2 Fri 9:15 VG 3.102

Unfolding the Atmospheric Muon Spectrum Using Stopping Muons in IceCube — •Lucas Witthaus for the IceCube-Collaboration — TU Dortmund University

The IceCube Neutrino Observatory is a neutrino detector embedded within the Antarctic ice sheet near the South Pole. Although its primary goal is the neutrino observation, the majority of detected events are attributed to atmospheric muons generated by cosmic-ray-induced air showers in the upper atmosphere. As muons enter the ice, they lose significant energy through interactions with the surrounding matter, which limits their propagation length depending on their initial energy. This talk presents the unfolding of the muon surface energy spectrum and the stopping muon depth intensity, providing information about the abundance of atmospheric muons in the South Pole ice. The study targets a specific subset of events comprising single muons that stop within the IceCube detector. The event classification as well as the reconstruction of the muon tracks are performed using deep neural networks.

T 100.3 Fri 9:30 VG 3.102

Studies of primary mass sensitivity of muons of the IceCube surface array IceTop — •Donghwa Kang for the IceCube-Collaboration — Karlsruhe Institute of Technology

The surface component of the IceCube Neutrino Observatory at the geographical South Pole, IceTop, is designed to measure the air showers of cosmic ray with energies from PeV to EeV. Based on the charge signal distribution only with IceTop, a mass-sensitive parameter was defined and estimated event by event, which is the sum of the charge signals divided by the effective area at a fixed distance from the shower core. In this contribution the estimated mass-sensitive parameter and its dependencies on the hadronic interaction models will be discussed.

T 100.4 Fri 9:45 VG 3.102

Detection of Ultra-High-Energy Cosmic Rays using the Next-Generation Prototypes of the Fluorescence-Detector Array of Single-Pixel Telescopes (FAST) — •Marcus Niechciol for the FAST-Collaboration — Experimentelle Astroteilchenphysik, Center for Particle Physics Siegen, Universität Siegen

Understanding the nature and origin of ultra-high-energy cosmic rays (UHECRs) remains one of the key goals in astroparticle physics. The Fluorescence-detector Array of Single-pixel Telescopes (FAST) is a proposed next-generation cosmic-ray observatory, aimed at observing UHECRs with energies above 10^{19} eV with unprecedented statistics. To achieve this, FAST will employ cost-effective, easily deployable, autonomous fluorescence telescopes, each equipped with four photomultiplier tubes with a diameter of 200 mm positioned at the focal plane of a segmented mirror with a diameter of 1.6 m. Currently, there are three prototypes in operation at the Telescope Array Experiment in the Northern hemisphere (Utah, USA) and one in the Southern hemisphere at the Pierre Auger Observatory (Malargüe, Argentina). Together, they enable observations of UHECRs in both hemispheres using the same technology. In the contribution, the current status of observations of UHECRs using the FAST prototypes is summarized. Preliminary results from the data analysis are presented, as well as recent developments towards a mini array of FAST telescopes, to be installed at the Pierre Auger Observatory.

T 100.5 Fri 10:00 VG 3.102

Diffuse emissions with stochastic cosmic ray sources — •Anton Stall and Philipp Mertsch — Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Aachen, Germany

Diffuse emission in gamma-rays and neutrinos are produced by the interaction of cosmic rays with the interstellar medium. Below some hundreds of TeV, the sources of theses cosmic rays are most likely Galactic. Hence, observations of high-energy gamma-rays and neutrinos can be used to probe the flux of cosmic rays in other parts of the Galaxy. Supernova remnants are usually considered as the prime candidate for the acceleration of Galactic cosmic rays. They inject cosmic rays in a point-like and specific time-dependent manner. As the precise positions and ages of the sources are not known, predictions must be obtained in a stochastic model. At GeV energies, the distribution of sources can be approximated with a smoothly varying spatial and temporal source density. At hundreds of TeV, however, the point-like nature matters as less sources contribute effectively due to shorter escape times. We have modelled diffuse emissions at hundreds of TeV, relevant for measurements by LHAASO, Tibet AS-gamma, IceCube, and the upcoming SWGO. In general, we have found its morphology to be very different from those at GeV energies, as measured by Fermi-LAT. Those differences can potentially be used to constrain source models and locate cosmic ray sources.