T 107: Cosmic rays 7

Time: Friday 9:00–10:30 Location: Geb. 20.30: 2.059

T 107.1 Fri 9:00 Geb. 20.30: 2.059

Towards the measurement of seasonal variations in the atmospheric muon spectrum — •Samuel Haefs and Karolin Hymon for the IceCube-Collaboration — Astroparticle Physics WG Rhode, TU Dortmund University, Germany

Atmospheric muons are produced when cosmic rays interact with nuclei in the Earth's atmosphere. These interactions produce secondary particles, mainly pions and kaons. These secondary particles either interact with other nuclei or decay into muons and neutrinos, forming an air shower. The muons can be detected by the IceCube Neutrino Observatory. This observatory is located at the South Pole, 1450m to 2450m deep in the Antarctic ice. High-energy muons passing through the ice produce Cherenkov light, which is then detected by the optical modules of the detector. Seasonal variations in atmospheric muon flux are influenced by changes in atmospheric temperature and pressure. This work addresses these fluctuations using a deconvolution technique called funfolding, which employs Markov Chain Monte Carlo (MCMC) methods for unfolding.

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T 107.2 Fri 9:15 Geb. 20.30: 2.059

Enhanced photon triggers using the underground muon detector of AugerPrime — Linda Hofmann and •David Schmidt for the Pierre-Auger-Collaboration — Institute for Astroparticle Physics (IAP), Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

We present a method for increasing the aperture of the Pierre Auger Observatory for ultra-high-energy photons with energies exceeding a couple dozen PeV. The method involves lowering the trigger thresholds of individual water-Cherenkov detector stations when their partner underground muon detectors measure below a certain number of muons. This increases the detection efficiency for muon-poor photon primaries while mitigating otherwise significant increases in the total rate of event-level triggers due to the steep fall off of the cosmic ray energy spectrum. A detailed evaluation of the method is presented for the $23.5\,\mathrm{km}^2$ dense sector of the observatory's surface detector array, where the spacing between individual 12-ton water-Cherenkov detectors is 750 m, and where each detector position is currently also being equipped with a $30\,\mathrm{m}^2$ buried muon counter.

T 107.3 Fri 9:30 Geb. 20.30: 2.059

Adding interferometric lightning detection to the Pierre Auger Observatory — •Melanie Joan Weitz for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

The Pierre Auger Observatory has detected high-energy events with its Surface Detector in times of thunderstorms. The observed events indicate a connection to terrestrial gamma ray flashes (TGFs). A key to understanding this high-energy radiation in thunderstorms is to combine such measurements with measurements of lightning processes in their earliest stages. With small modifications of Auger Engineering Radio Array (AERA) stations we can build an interferometric detector to precisely measure the lightning stepped leaders in 3D. This will allow us to decipher atmospheric high-energy models and clarify the reason for the observed high-energy particles in thunderstorms. We will demonstrate the capabilities of the current stations for lightning measurements and show the status of the current detection plans.

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T 107.4 Fri 9:45 Geb. 20.30: 2.059

Measurement of the composition of cosmic rays and proton-proton interaction cross section at ultrahigh energies with the Pierre Auger Observatory — •Olena Tkachenko for the Pierre-Auger-Collaboration — Karlsruhe Institute of Technology, Karlsruhe, Germany

We present a combined estimate of the cosmic-ray mass composition and particle interaction cross sections from the distributions of shower maximum ($X_{\max}$), measured with the fluorescence detector of the Pierre Auger Observatory. For this purpose, we adjust fractions of cosmic-ray mass groups to fit the data with $X_{\max}$-distributions from air shower simulations. In addition to the fractions, we fit for the proton-proton cross section at ultrahigh energies, from which simulations with modified nucleus-air cross sections are obtained via Glauber theory. Whereas previous analyses either fit the composition assuming the validity of hadronic interaction models or derived the cross sections assuming a particular composition, the combined fit presented in this contribution is the first self-consistent analysis of both quantities. We will present the resulting energy-dependent composition fractions and the ultrahigh-energy proton-proton interaction cross section and compare them to previous analyses and model extrapolations of low-energy accelerator data.

T 107.5 Fri 10:00 Geb. 20.30: 2.059

The paleo-detectors technique applied to cosmic rays — •Lorenzo Apollonio[1], Lorenzo Caccianiga[2], Claudio Galelli[3], Alessandro Veutro[4], and Paolo Magnani[1] — [1]Universita degli Studi di Milano — [2]Istituto Nazionale di Fisica Nucleare — [3]Laboratoire Univers et Théories, Observatoire de Paris, Université PSL, Université Paris Cité — [4]Universita di Roma La Sapienza

The paleo-detector technique proposes to use long-age minerals, which have been exposed to an enormous flux of particles, as astroparticle detectors. Some of these particles should have interacted with mineral nuclei, generating linear defects in the crystalline structure in the form of tracks. The paleo-detectors have been proposed to detect dark matter and neutrinos, using minerals found well deep in the ground, shielded by the cosmic rays. These studies take advantage of the enormous exposure, even to these rare events, that can be acquired through age with a small amount of material. By contrast, we propose to use the paleo-detectors as cosmic rays detectors. Since the cosmic rays can be shielded, we can find optimal exposure windows during which the minerals were exposed to the flux and then shielded. We take as example the dessication of the Mediterranea Sea during the Messinian ($\sim 6\,\mathrm{Myr}$ ago). After the dessication, several evaporites were formed, exposed to the flux of cosmic rays (for $\sim 300\,\mathrm{kyr}$) and then submerged again. The large amounts of tracks expected is enough to measure the variation of 1% of the flux, making this technique optimal to identify a potential transient events happened during the exposure window.

T 107.6 Fri 10:15 Geb. 20.30: 2.059

Cosmic-ray tomography for a safe & secure harbor — •Maximilian Perez Prada, Angel Bueno Rodriguez, Maurice Stephan, and Sarah Barnes — German Aerospace Center (DLR), Institute for the Protection of Maritime Infrastructures, Fischkai 1, 27572 Bremerhaven, Germany

Cosmic-ray tomography (CRT) is emerging as a promising non-destructive testing technology for a rising number of potential applications: study of archaeological or geological sites, additional tool in safeguards and border protection, new forms of inspection in civil engineering, and many more. Muon scattering tomography is one technique within the domain of CRT to infer target material properties by utilizing the path deflection of cosmic muons resulting from Coulomb scattering processes.

The Institute for the Protection on Maritime Infrastructures of the German Aerospace Center (DLR) contributes to the development of this technology to enhance safety and security in the maritime domain. Currently two promising methods within the application of muon scattering tomography for shipping container scanning are studied: the analysis of secondary particles for the reconstruction of the container content on top of the results from muon scattering measurements, and the usage of automized anomaly detection algorithms for more efficient container processing. The methods themselves, as well as their current status and results will be explained and presented. Furthermore, an outlook into future applications in the maritime domain, as well as in the scope of safety and security will be given.