T 102: Cosmic rays V

Time: Friday 11:00–13:00 Location: L-3.001

T 102.1 Fri 11:00 L-3.001

Studies of Lorentz Violation using Air Shower Data — •Fabian Dünkel, Marcus Niechciol, and Markus Risse — Universität Siegen, Siegen, Germany

Due to their extremely high energies, cosmic rays are ideally suited to search for new physics, for example violations of Lorentz invariance. Isotropic, nonbirefringent Lorentz violation is considered in the following, specializing to the case of a photon velocity which is larger than the maximum attainable velocity of standard Dirac fermions. Earth-based bounds on this type of Lorentz violation have been determined before by observations of TeV gamma rays. A novel approach to test Lorentz invariance is based on the measurement of extensive air showers induced by cosmic-ray particles in the Earth's atmosphere. Lorentz-violating processes can have a large impact on the longitudinal shower development of air showers, for example reducing the average atmospheric depth of the shower maximum Xmax. For showers with high primary energies, this change is significantly larger than the average resolution of current air-shower experiments. This can be used to obtain new bounds on this type of Lorentz violation, which can be further improved by taking into account composition constraints.

This work is supported by the Deutsche Forschungsgemeinschaft (DFG).

T 102.2 Fri 11:15 L-3.001

Study of Lithium Isotopic Composition in Cosmic Rays with AMS-02 — •Manbing Li — I. Physikalisches Institut B, RWTH Aachen

AMS-02 is a multi-purpose magnetic spectrometer designed for precise measurements of cosmic ray fluxes above Earth's atmosphere. The isotopic compositions of cosmic ray nuclei are of great interest since they directly reflect processes related to cosmic ray propagation through the Galaxy. In seven years of data taking, AMS has collected the largest available dataset on fluxes of nuclei. The AMS Ring Imaging Cherenkov detector provides particle velocity measurements with a resolution better than 0.1%, and the silicon tracker measures the particle momentum inside the 0.14 Tesla field created by the AMS magnet. With these measurements, the mass of the selected events can be calculated, which allows the measurement of relative isotopic abundances. Here we present the study of lithium isotopic composition in the energy range from about 1 GeV/n to 10 GeV/n where no other precise measurements are currently available.

T 102.3 Fri 11:30 L-3.001

Composition Study of Cosmic Rays using IceCube Experiment — •Paras Koundal for the IceCube-Collaboration — KIT, Karlsruhe

The IceCube Neutrino Observatory is a large-scale physics experiment constructed at the Amundsen-Scott South Pole Station in Antarctica. It consists of more than five thousand sensors located in the Antarctic ice, distributed over a cubic kilometer. Besides its main purpose of neutrino astronomy, IceCube, and in particular its surface component IceTop, is also used for cosmic ray detection and analysis.

The composition studies of cosmic rays are extremely challenging because of the significant dependence of flux and primary-particle estimation, on the hadronic-interaction model one chooses to interpret the air-shower measurements. This talk will be focused on motivating new techniques which can be used for studying the mass composition and energy spectrum of high-energy cosmic rays measured with IceCube. For the mentioned purpose, I will be using the tools of Neural Networks. This will aim to benefit from the information about the high-energy muons which IceCube provides; in addition to the charged particle component measured at the surface array; hence together acting as a unique three-dimensional cosmic ray detector.

T 102.4 Fri 11:45 L-3.001

Search for ultra-high energy photons with the AugerPrime upgrade of the Pierre Auger Observatory — •Paulo Ferreira, Thomas Bretz, Adrianna García, Thomas Hebbeker, Julian Kemp, and Tobias Pan for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory is the world's largest experiment for the detection of ultra-high energy extensive air showers. It consists of a surface array of 1660 water Cherenkov detectors and 27 fluorescence telescopes, which allows for a hybrid reconstruction of air showers.
An air shower detected by the observatory can have its origin in nuclei, but also in very energetic photons. Analysing the photon flux is crucial to understand the flux suppression of cosmic rays above 50 EeV.
Until now, no photon-induced air shower has been detected by the Pierre Auger Collaboration. Recent studies allowed for better upper limits for the photon flux at the ultra-high energy, but they are constrained by the current discrimination power between different types of primary particles. AugerPrime, an on-going upgrade of the Pierre Auger Observatory, brings, among other improvements, an additional scintillator detector to be installed on top of each water Cherenkov detector station. Thereby, a more precise measurement of the number of muons is aimed at, which will increase the sensitivity to primary photons significantly. As such, new analysis frameworks exploiting the additional information obtained using AugerPrime are being developed. First studies of the performance to be expected will be presented.

T 102.5 Fri 12:00 L-3.001

Estimation of the mass composition of ultra-high energy cosmic rays with the Pierre Auger Observatory — •Olena Tkachenko for the Pierre Auger-Collaboration — Institute for Nuclear Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

The mass composition of ultra-high energy cosmic rays (UHECRs) is of crucial importance for the understanding their origin. One of the most robust techniques for estimation of the mass composition is based on the depth of atmospheric shower maximum, X_{max}, as measured by the fluorescence detectors of the Pierre Auger Observatory.

In this talk we present a study of the composition of UHECRs from the X_{max} distributions using the Markov Chain Monte Carlo (MCMC) algorithm. We estimate the fractions of different mass groups as a function of energy and we discuss the corresponding statistical and systematic uncertainties.

T 102.6 Fri 12:15 L-3.001

Studies of the energy resolution and bias in the Pierre Auger Observatory — •Adrianna García, Thomas Bretz, Paulo Ferreira, Thomas Hebbeker, and Julian Kemp for the Pierre Auger-Collaboration — III. Physikalisches Institut A, RWTH Aachen University

The Pierre Auger Observatory is the largest experiment built for the study of cosmic rays (CRs). It consists of a hexagonal array of 1660 water-Cherenkov detector stations and 27 fluorescence telescopes located at five sites around the array to record hybrid signals from the extensive air showers produced by CRs during their interaction with the Earth's atmosphere.

Monte Carlo simulations of primary CRs have been performed using CORSIKA. The resulting showers are processed by the standard simulation and reconstruction framework Offline of the Pierre Auger Observatory, which includes the detector simulations and the data reconstruction algorithm. Two different simulated data sets were generated by applying different cuts taking into account two different detection methods. The first data set contains events that were recorded just by the surface detector, and the second one includes the hybrid events recorded by the surface detectors and, at least, two fluorescence telescopes simultaneously.

The discrepancies in the energy reconstruction of the observatory between the two different detection modes (surface detector only and hybrid mode) have been studied in order to correct for the possible bias in the cosmic ray primary energy. Preliminary results are going to be presented.

T 102.7 Fri 12:30 L-3.001

The science case for the AugerPrime Radio Detector — •Tim Huege for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie — Vrije Universiteit Brussel

Within the AugerPrime upgrade, the Pierre Auger Observatory is currently being equipped with additional detectors and improved readout electronics. In the course of this upgrade, each of the 1660 Water-Cherenkov surface detectors will also be equipped with an integrated radio antenna for measurements in the 30-80 MHz band. These ra-

dio antennas will allow us to measure the electromagnetic component of inclined air showers with zenith angles above 65°. Simultaneous measurement of the muon content of inclined air showers by the Water-Cherenkov Detectors then provides mass-composition information complementary to the combined measurements with Water-Cherenkov and Scintillation detectors used at zenith angles below 60°. In this talk, we will discuss the expected performance and scientific potential of this upcoming Radio Detector of the Pierre Auger Observatory.

T 102.8 Fri 12:45 L-3.001

First data from the pre-production stations of the Auger-Prime Radio Detector* — •Julian Rautenberg for the Pierre Auger-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal, Germany

The success of the radio detection of inclined air showers with the Auger Engineering Radio Array at the Pierre Auger Observatory proved the feasibility of radio detection at the 1.5 km spacing of the Surface Detector (SD). A first design of a possible radio extension to the SD stations was deployed in May 2019 on one station at the Observatory. With this station, the first successful integration of radio measurements into data acquisition was shown. Consequently, a full design of the antenna with its mounting was completed. In parallel, the front-end board, which samples the amplitudes and feeds them into the digital electronics of the station, was developed. In November 2019, the first 10 antennas were deployed on SD stations. For seven of these stations, the upgraded electronics were available, allowing the installation of the radio front-end boards. We present the first data from these SD stations which were extended with the pre-production version of the radio detectors.

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