T 7: Kosmische Strahlung I

Zeit: Montag 16:00–18:35 Raum: Philo-HS7

Gruppenbericht T 7.1 Mo 16:00 Philo-HS7

Ultra-high energy cosmic rays - Recent results and status of the Pierre Auger Observatory — •Daniela Mockler for the Pierre Auger-Collaboration — Institut für Experimentelle Teilchenphysik, Karlsruhe Institut für Technologie

The Pierre Auger Observatory is the world's largest detector arrangement for detecting extensive air showers initiated by cosmic rays with energies above 3×10^{17} eV. Equipped with 1660 water-Cherenkov stations, the surface detector array (SD) spans an area of 3000 km^2. The combination with 27 fluorescence telescopes (FD) that overlook the atmosphere and measure the calorimetric energy allows for a hybrid detection. The Pierre Auger Observatory is extended by buried scintillators for a direct muon detection (AMIGA) as well as radio antennas measuring the emission of radio signals from air showers (AERA). The current upgrade (AugerPrime) with scintillators on top of each detector station will allow the discrimination between the electromagnetic and muonic shower components. Thus, it will extend the sensitivity for primary masses which allows for an improved search for possible sources of cosmic rays at the highest energies.
An overview of the latest results and the current status of the Pierre Auger Observatory will be given in this talk.

T 7.2 Mo 16:20 Philo-HS7

Derivation of the longitudinal profile of extensive air showers generated by cosmic rays — •Isabel Astrid Goos[1] and Xavier Bertou[2] for the Pierre Auger-Collaboration — [1]Universidad Nacional de San Martín, Buenos Aires, Argentinien — [2]CONICET, San Carlos de Bariloche, Argentinien

The present work focuses on extended air showers generated by high energy cosmic rays. The concept of air shower universality states that all the information about the primary particle can in principle be recovered from the measurement of the observables X_{max} and N_μ. Both observables have a common origin: the production of π^0 and $\pi^{+/-}$, which are produced collectively along the shower axis. The aim is to understand the relationship between these two observables in order to be able to extract information about the development of the hadronic core of the shower.

The pion distribution varies heavily from shower to shower. Thus the first step is to understand the effect of different pion distributions on the values of X_{max} and N_μ. In order to do that our first approach was to analyze sets of Monte Carlo simulations of extensive air showers carried out with CONEX where all secondaries of each interaction can be stored. The procedure used was to add up all the electromagnetic subcascades generated by the neutral pions and then compare the resulting longitudinal profile with the real one corresponding to that shower. This reconstruction adjusts very well the electromagnetic longitudinal profile, even so for ultra-high-energy cosmic rays.

T 7.3 Mo 16:35 Philo-HS7

Air Shower Reconstruction using Deep Convolutional Neural Networks at the Pierre Auger Observatory — •Jonas Glombitza, Niclas Eich, Martin Erdmann, and Lukas Geiger — III. Physikalisches Institut A, RWTH Aachen

The surface detector of the Pierre Auger Observatory measures the footprint of charged particles of ultra-high energy cosmic ray induced air showers on ground level. Reconstructing the properties of primary cosmic rays like energy and mass remains a challenging task. Recently, progress has been made in machine learning by techniques associated with deep neural networks. Applying this new techniques on air shower physics has the potential to improve the reconstruction quality.

In this talk we present AixNet, a deep convolutional network architecture, which is used to reconstruct energy, direction and the mass sensitive observable Xmax. We assess the performance of AixNet using CORSIKA based air showers, discuss network causality and outline the potential of AixNet for data applications by adversarial training methods.

T 7.4 Mo 16:50 Philo-HS7

Improving Photon/Hadron Separation in the Hybrid Data of the Pierre Auger Observatory Utilizing Information from SD Traces — •Philip Ruehl, Marcus Niechciol, and Markus Risse for the Pierre Auger-Collaboration — Universität Siegen, Department Physik

A key question in the field of astroparticle physics is the composition of cosmic rays at the highest energies (above 10^{17} eV). A discovery of photons in this energy range would play a major role in this task and would have an immense impact not only on astrophysics and particle physics, but also on fundamental physics. The Pierre Auger Observatory near Malargüe, Argentina, is the world's largest detector for cosmic-ray-induced extensive air showers. Its two main components, namely the surface detector (SD) and the fluorescence detector (FD) provide complementary information in so-called hybrid events, i.e. air showers which are simultaneously measured by both detectors.

In this contribution we explore the possibilities of using the detailed time structure of the SD traces in hybrid events to improve the separation power between photon- and hadron-induced air showers.

Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik.

T 7.5 Mo 17:05 Philo-HS7

Eine rotationssymmetrische Lateralverteilung für Radioemissionen geneigter Luftschauer — •Tim Huege[1,2] und Lukas Brenk[3] — [1]Karlsruher Institut für Technologie, Institut für Kernphysik, Karlsruhe — [2]Vrije Universiteit Brussel, Brussel, Belgien — [3]Karlsruher Institut für Technologie, Institut für Experimentelle Teilchenphysik, Karlsruhe

Die Radiodetektion geneigter Luftschauer erhält im Moment große Aufmerksamkeit. Geneigte Schauer leuchten große Flächen am Boden mit messbaren Radiosignalen aus und sind daher mit wenig dichten Radioantennenfeldern messbar. Zudem verspricht eine kombinierte Messung von Radiosignalen und Sekundärteilchen geneigter Schauer eine hohe Massensensitivität.

Um dieses Potential auszuschöpfen, muss eine Eventrekonstruktion für geneigte Luftschauer entwickelt werden, welche aus den gemessenen Radiosignalen die Energie und ggf. einen Schätzer für die Masse des Primärteilchens ableitet. Der erste Schritt auf diesem Weg ist die Entwicklung eines Modells für die Lateralverteilung der Radiosignale, welche im Fall geneigter Schauer zusätzlich zu den üblichen Asymmetrien durch Ladungsüberschuss und geomagnetische Emission auch noch Asymmetrien durch "early-late"-Effekte aufweist.

In diesem Vortrag stellen wir ein Modell für die Lateralverteilung der Radiosignale geneigter Schauer vor, das sämtliche Asymmetrien herausrechnet und die Lateralverteilung erfolgreich mit einer rotationssymmetrischen Funktion des Energieflusses beschreibt.

T 7.6 Mo 17:20 Philo-HS7

Suche nach primären Photonen mit Energien zwischen 10^{17} und 10^{18} eV am Pierre-Auger-Observatorium — •Simon Eickhoff, Marcus Niechciol und Markus Risse — Universität Siegen

Die Suche nach ultrahochenergetischen Photonen am Pierre-Auger-Observatorium beschränkte sich bisher auf Energien oberhalb von 10^{18} eV. In dem Beitrag wird eine Analyse vorgestellt, die sich auf den Energiebereich von 10^{17} bis 10^{18} eV konzentriert. Hierzu werden Daten verwendet, die von den am Pierre-Auger-Observatorium installierten Niederenergie-Erweiterungen aufgenommen werden: Hierbei handelt es sich um drei zusätzliche Fluoreszenzteleskope (HEAT) sowie zusätzliche Oberflächendetektorstationen, mit denen ein dichteres Netz mit einem halbierten Detektorabstand von 750 m realisiert wurde. In der vorgestellten Analyse werden dieselben Observablen verwendet wie im Energiebereich oberhalb von 10^{18} eV: Zum einen die atmosphärische Tiefe des Schauermaximums (Observable X_{max}), zum anderen Charakteriska der lateralen Verteilung auf dem Erdboden (Observablen S_b und N_{Stations}). Diese Observablen werden in einer multivariaten Analyse kombiniert, um Photon-induzierte Luftschauer von solchen hadronischen Ursprungs zu trennen. Im Beitrag werden die Ergebnisse dieser Studien vorgestellt.
Gefördert durch die BMBF-Verbundforschung Astroteilchenphysik.

T 7.7 Mo 17:35 Philo-HS7

A Method of Searching for Origins of Cosmic Rays correcting for Galactic Magnetic Field Deflections and Charge Composition — •Martin Urban, Martin Erdmann und Marcus Wirtz — III. Physikalisches Institut A, RWTH Aachen University, Deutschland

We present a new method of searching for origins of ultra-high energy

cosmic rays directly from observed data. We include corrections for deflections in the galactic magnetic field according to the individual cosmic ray charges. The analysis procedure is iterative and consists of the following steps. Initially, we assign to each cosmic ray a charge hypothesis and apply corresponding corrections for the galactic field to obtain directions outside our galaxy. We then search for directions indicating an enhanced cosmic ray arrival probability using a clustering algorithm. The cluster directions form a set of source candidates. Hereafter, the initial charge assignments of the cosmic rays are disregarded, and a stacked source analysis is performed to evaluate the validity of the set of source candidates. The consistency of the observed cosmic rays with the expected arrival probability distributions on Earth is used in a likelihood ratio method on one hand for the evaluation of the set of source candidates, and on the other hand for assigning charges to each cosmic ray. The procedure can be repeated optimizing for the most likely set of sources. We present the method and its performance using a simulated astrophysical scenario.

T 7.8 Mo 17:50 Philo-HS7

Analysis of non-event trigger data of the Pierre Auger Observatory — •Martin Schimassek, Darko Veberič, and Ralph Engel for the Pierre Auger-Collaboration — Karlsruher Institut für Technologie, Deutschland

The Pierre Auger Observatory was built to measure cosmic rays of the highest energies and lowest flux. For this purpose, the 1660 surface detectors of the detector array cover an area of about 3000 km^2 and are overlooked by four telescope stations. Additionally to the high energy event data, the time stamps of the triggers of each detector station of the surface array are stored since the beginning of 2016. In this contribution, the potential of this data set with respect to non-standard physics analyses is highlighted. This includes considerations of trigger efficiency for very inclined events, lightning related trigger patterns, and searches for spatially extended events.

T 7.9 Mo 18:05 Philo-HS7

Cosmic ray anisotropy searches with AMS-02 — Iris Gebauer, Kai Fabian Bindel, Maura Graziani, and •Stefan Zeissler — Karlsruher Institut für Technologie (KIT)

The Alpha Magnetic Spectrometer (AMS-02) is a state-of-the-art particle detector designed to operate as an external module on the International Space Station (ISS). In this unique space environment, cosmic particles can be measured with high precision over an energy range from GeV up to TeV. The AMS collaboration provided precise measurements of the electron and positron fluxes, which indicate an additional source of positrons among the various cosmic particles. Possible candidates for such a source are local pulsars, a local source of positrons produced in proton-gas interactions or dark matter annihilation. In the first two cases, a possible anisotropy in the electrons and positrons incoming direction at Earth might be detectable. To determine the level of isotropy, the measured data is compared to reference maps, which simulate a measurement of the isotropic sky. A common choice of reference maps are proton count maps or shuffled maps, which redistribute measured incoming directions over the whole measuring time. Both options lead to difficulties in the reconstruction of a marginal signal with large expansion over the galactic sky as it would be the case for charged cosmic particles. We developed a method to construct reference maps based on fundamental detector characteristics such as the livetime and the geometric acceptance. Using this, we are able to reconstruct the isotropic sky as it would be seen by the detector. We demonstrate the performance of the method using AMS-02 data.

T 7.10 Mo 18:20 Philo-HS7

Large Acceptance Analysis of Electrons and Positrons with AMS-02 — •Fabian Machate — RWTH Aachen, Aachen, Germany

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station performs precision measurements of cosmic rays in the GeV to TeV energy range. The published analyses of the electron and positron fluxes rely on the electromagnetic calorimeter (ECAL) for energy measurements and background rejection. The geometrical acceptance for the conventional analyses is restricted by the weight limitations for the calorimeter.

A new method to reject background with a Multivariate Analysis (MVA) using information from the Transition Radiation Detector (TRD) will be presented. This analysis has a significantly larger geometrical acceptance and can increase the statistics by a factor of up to ~ 4.