T 101: Cosmic Ray 6

Time: Thursday 16:15–18:30 Location: T-H33

T 101.1 Thu 16:15 T-H33

Implications of turbulence dependent diffusion on Galactic cosmic ray — •Julien Dörner[1,2], Patrick Reichherzer[1,2,3], Julia Becker Tjus[1,2], and Horst Fichtner[1,2] — [1]Theoretische Physik IV, Ruhr University Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr University Bochum, Bochum, Germany — [3]IRFU, CEA, Université Paris-Saclay, F-91191 Gif-sur-Yvette, France

The motion of Galactic cosmic rays is dominated by spatial diffusion. Therefore, in order to describe their transport, a detailed knowledge of the diffusion tensor $\hat{\kappa}$ is necessary. This tensor depends on the particle energy, the structure of the local background field $\vec{B}$, and its turbulent component $\vec{b}$. Recent numerical analyses of diffusion coefficients in three-dimensional, isotropic turbulence show a discrepancy between its energy scaling for intermediate turbulence levels b/B and the corresponding quasi-linear prediction.

In this talk we report about probing different models for the diffusion tensor and its dependence on energy and turbulence level. We compare the results with observations of the gradient in the cosmic-ray density and of the spectral energy behavior in the Milky Way by Fermi-LAT.

T 101.2 Thu 16:30 T-H33

Optimization of the Numerical Calculation of the Field Line Random Walk Diffusion Tensor — •Jan-Niklas Bohnensack[1], Patrick Reichherzer[1,2], Julia Becker Tjus[1,2], Leander Schlegel[1,2], and Julien Dörner[1,2] — [1]Theoretical Physics IV: Plasma-Astroparticle Physics, Faculty for Physics & Astronomy, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]Ruhr Astroparticle And Plasma Physics Center (RAPP Center), Bochum, Germany

The goal of this talk is to calculate the Field Line Random Walk (FLRW) diffusion coefficient. FLRW is the random movement of the magnetic fieldlines in a turbulent field, particles with low rigidities follow those lines and diffuse accordingly. The FLRW diffusion coefficient only depends on the turbulence of the magnetic fields and is particle-energy independent. That makes their calculation more universal and computationally more efficient. Therefore, the coefficient is of high relevance for providing astrophysical simulations for cosmic-ray transport with a fundamental description of the diffusion tensor. These can be applied in environments such as the Milky Way, but also relativistic plasmoids in jets of active galaxies. To check the agreement of the fieldlines to the corresponding particle trajectories, a GPU based visualization software based on the software Vispy was developed in this bachelor thesis. With the optimized FLRW software, we will present first results and interpretations of the FLRW diffusion tensor for different turbulence levels. Furthermore, we will show examples of 3D plotted fieldlines and particle trajectories with our visualization tool.

T 101.3 Thu 16:45 T-H33

Proton event reconstruction with the MAGIC experiment — •Alicia Fattorini and Maximilian Noethe for the MAGIC-Collaboration — Astroparticle Physics WG Elsässer, TU Dortmund University, Germany

Air showers induced by cosmic protons and heavier nuclei form the dominant background for very high energy gamma-ray observations with Imaging Air Cherenkov Telescopes. Even for strong very high energy gamma-ray sources the signal-to-background ratio in the raw data is typically less than 1:5000, so a very large statistic of cosmic proton and heavier nuclei induced events are available as a byproduct of gamma-ray source observations. In this contribution, we present the reconstruction of the particle type of primary events and the energy reconstruction of the events classified as protons. For this purpose, we used a random forest method trained and tested by using Monte Carlo simulations from the MAGIC telescopes, for energies above 70 GeV. We use the aict-tools framework, which includes machine learning methods for the particle type classification and energy reconstruction. The open-source Python project aict-tools was developed at TU Dortmund University and its reconstruction tools are based on scikit-learn predictors. Finally, an unfolding taking into account the background is performed to compensate for the typical bias of the random forest results. Here we report on the performance of the proton event reconstruction using the well-tested and robust random forest approach.

T 101.4 Thu 17:00 T-H33

Search for heavy antimatter with AMS — •Robin Sonnabend — 1. Physikalisches Institut B, RWTH Aachen

The Alpha Magnetic Spectrometer (AMS-02) on the International Space Station has been performing precision measurements of cosmic rays in the GeV to TeV energy range since 2011. The search for heavy antimatter (Z>=2) requires advanced methods for the suppression of instrumental background which arises from the mis-reconstruction of the charge sign. I will present a set of dedicated multivariate estimators for different event topologies designed to achieve this goal.

T 101.5 Thu 17:15 T-H33

Galactic gamma-ray and neutrino emission from interacting cosmic-ray nuclei — •Mischa Breuhaus[1], James Anthony Hinton[1], Vikas Joshi[2], Brian Reville[1], and Harm Schoorlemmer[1,3] — [1]Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany — [2]Friedrich-Alexander-Universität Erlangen-Nürnberg, ECAP, Erwin-Rommel-Str. 1, D 91058 Erlangen, Germany — [3]IMAPP, Radboud University Nijmegen, Nijmegen, The Netherlands

We present a study of the expectations for very/ultra high energy (VHE/UHE) gamma-ray and neutrino emission from interacting cosmic rays in our Galaxy and a comparison to the latest results for the Galactic UHE diffuse emission. We demonstrate the importance of properly accounting for the mixed cosmic-ray composition as well as gamma-ray absorption. We adopt the wounded-nucleon model of nuclei interaction and provide parameterisations of the resulting gamma-ray and neutrino production. Nucleon shielding due to clustering inside nuclei is shown to have a measurable effect on the production of gamma-rays and is particularly evident close to breaks and cut-offs in mixed composition particle spectra. The change in composition around the 'knee' in the cosmic ray spectrum has a noticeable impact on the diffuse neutrino and gamma-ray emission spectra. We show that current and near-future detectors can probe these differences in the key energy range from 10 TeV to 1 PeV, testing the paradigm of the universality of the cosmic ray spectrum and composition throughout the Galaxy.

T 101.6 Thu 17:30 T-H33

Vacuum-Cherenkov radiation in UHE air showers: a way of probing Lorentz violation — •Fabian Duenkel, Marcus Niechciol, and Markus Risse — Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen

In extensive air showers induced by ultra-high energy (UHE) cosmic rays, secondary electrons are expected to be produced at energies far above those accessible by other means. Those high energies can be used to search for new physics, in particular we study the effects of isotropic, nonbirefringent Lorentz violation in the photon sector. In the case of a photon velocity which is larger than the maximum attainable velocity of standard Dirac fermions, vacuum-Cherenkov radiation becomes possible, which can lead to significant changes of the shower development. Implementing this Lorentz-violating effect in air shower simulations, we present first results on the impact on the shower development, specifically on the average atmospheric depth of the shower maximum $\langle X_{\mathrm{max}} \rangle$ and its shower-to-shower fluctuations $\sigma(X_{\mathrm{max}})$.

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T 101.7 Thu 17:45 T-H33

CoREAS simulation for the GRAND project — •Chao Zhang, Tim Huege, Tanguy Pierog, Markus Roth, Andreas Haungs, Frank Schroeder, and Ralph Engel — Institut fuer Astroteilchenphysik, Karlsruher Institut fuer Technologie-Campus Nord, Post-fach 3640, 76021 Karlsruhe, Germany

The GRAND project starts deploying antennas this year, which will give birth to its first stage, GP300 with 300 antennas in the near future. A new version of CORSIKA7 has been adapted and validated to simulate upward-going air showers for radio detection which will be the main detection channel in this project. A library of air showers is made with CoREAS by applying the best knowledge of GRAND including the atmospheric model and magnetic field of the site. A detailed analysis of the new patterns induced by inclined air showers

leads to a better understanding of the scenario of their radio emission from higher to lower air density.

T 101.8 Thu 18:00 T-H33

Diffractive and radiative corrections to muon energy loss cross-sections — •Alexander Sandrock — Bergische Universität Wuppertal

High-energy muons can travel large distances before reaching underground detectors, for example cosmic-ray detectors and neutrino telescopes. The accurate simulation of muon transport through matter is therefore especially important for underground experiments. The dominant energy loss processes are ionization and at higher energies pair production, bremsstrahlung and inelastic interaction with nuclei. To reduce uncertainties in the simulation of muon transport, the calculation of higher-order corrections to these cross-sections is necessary. In this contribution, diffractive and radiative corrections to the cross-sections of bremsstrahlung and pair production are discussed.

T 101.9 Thu 18:15 T-H33

Results from a Pilot Study on Measurement of Fragmentation of Intermediate Mass Nuclei with NA61/SHINE at CERN — •Neeraj Amin for the NA61/SHINE-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology, Karlsruhe, Germany

Cosmic-ray propagation in the Galaxy can be constrained by modeling the secondary-to-primary cosmic-ray flux ratios, like the Boron-to-Carbon flux ratio that reaches Earth. While these fluxes are currently measured with high precision (<5%) by space-based detectors like AMS-02 and CALET, insufficient knowledge of nuclear fragmentation cross sections hinders the precision with which we can constrain cosmic-ray propagation. Therefore, new laboratory measurements of fragmentation cross-sections above 10 A GeV/c are needed.

In this talk, we report on the analysis of pilot data on fragmentation taken in 2018 with the NA61/SHINE experimental facility at CERN with ^{12}C projectiles at a $p_{\mathrm{beam}} = 13.5$ A GeV/c. The main aim of this pilot run was to demonstrate the ability of NA61/SHINE to measure nuclear fragmentation cross sections in C+p interactions. Two fixed targets, polyethylene (C_2H_4) and graphite were used to achieve this. We present a preliminary measurement of Boron production in C+p interactions including the contribution from the short-lived 'ghost nucleus' ^{11}C.