T 21: Kosmische Strahlung, Propagation

Zeit: Montag 16:00–18:30 Raum: ST 7

T 21.1 Mo 16:00 ST 7

Physical interpretations of the Fermi gamma-ray excess — •Neeraj Amin, Iris Gebauer, and Wim de Boer — Karlsruhe Institute of Technology, Karlsruhe, Germany

The so-called gamma-ray excess observed by Fermi-LAT has received different physical interpretations: i) Dark Matter annihilation in the Galactic center ii) a population of millisecond pulsars in the Galactic center, and iii) suppressed emission from molecular clouds. The excess may also be partially caused by detector effects originating from the limited angular resolution of the instrument. In this talk we first discuss the impact of detector effects on the signal shape and then discuss physical interpretation of the signal.

T 21.2 Mo 16:15 ST 7

Modeling the magnetic field configuration in the Galactic Center and the cosmic ray propagation — •Mehmet Guenduez and Julia B. Tjus — Ruhr-Universität Bochum, RAPP-Center, Bochum, Deutschland

This work is aimed at modeling a realistic 3D gas, magnetic field and photon field distribution of the inner 250 pc around the Galactic Center (GC) on purpose of reproducing a reliable cosmic-ray (CR) propagation and secondary emission map . We present our method of modeling the ambient conditions in Central Molecular Zone und the results achieved by implementing these models in the CR propagation tool CRPropa. The results are compared with the polarization map of Nishiyama et al. (2010) and can explain most of the artifacts and configurations. Considering the exact gas distribution, the simulation of the CR propagation can even reproduce the structure of the diffuse gamma-ray emission measured by H.E.S.S. (2016) pretty well. However, a single source does not seem to cause the whole diffuse gamma-ray emission.

T 21.3 Mo 16:30 ST 7

Uncertainties of secondary antiproton production in cosmic rays — •Michael Korsmeier — University of Turin, Department of Physics, Turin, Italy

During the last decade, space-based experiments have drastically reduced the measurement uncertainty of cosmic-ray fluxes. Consequently, systematic uncertainties in the description of cosmic rays become more and more relevant. One important example is the production of secondary antiprotons in our Galaxy. I will give an overview about the current status of the production cross section for cosmic-ray antiprotons and its uncertainties. In cosmic-ray fits, these uncertainties are often neglected or described at an effective level by a covariance matrix. I will review this method and present an alternative approach: We perform a global fit which joins cosmic-ray data and measurements of the antiproton production cross section. By simultaneously fitting cosmic-ray propagation parameters and the parametrization of the antiproton production cross section, we marginalize over the cross section uncertainty. I will briefly discuss the impact on the extraction of cosmic-ray propagation parameters and the putative hint for dark matter in the antiproton spectrum.

T 21.4 Mo 16:45 ST 7

Bestimmung des Diffusionstensors für galaktische Propagation — •Patrick Reichherzer[1], Julia Tjus[1], Lukas Merten[1] und Ellen Zweibel[2] — [1]Ruhr Astroparticle and Plasmaphysics Center, Ruhr-Universität Bochum, Theoretische Physik IV, Bochum, Germany — [2]University of Wisconsin-Madison Department of Astronomy, Madison, USA

Die komplexe Entwicklung der kosmischen Teilchenverteilung kann durch einen Diffusionsprozess für lange Trajektorien mathematisch beschrieben werden. Der Übergang von einem ballistischen zu einem diffusiven Energieregime wird anhand numerischer Simulationen veranschaulicht und zur Berechnung von Diffusionskoeffizienten für homogene Magnetfeldlinien B verwendet, die turbulenten Störungen b unterliegen. Die Ergebnisse werden mit theoretischen Herleitungen der Energie- und Magnetfeldabhängigkeiten des parallelen Diffusionskoeffizienten für schwache Turbulenz verglichen. Die vorliegende Arbeit zeigt, dass die bisher angenommene Extrapolation der Energieskalierung hin zu hohen Turbulenzniveaus für den durch die quasi-lineare Näherung vorhergesagten parallelen Diffusionskoeffizienten keine genaue Beschreibung im diffusiven Energieregime liefert. Es wird gezeigt, dass die numerisch berechneten Diffusionskoeffizienten bei niedrigen Teilchenenergien Unsicherheiten aufgrund fehlender resonanter Wechselwirkungsmöglichkeiten der Teilchen mit der Turbulenz unterworfen sind. Es wird eine Übereinstimmung zwischen der Energieskalierung in dieser Arbeit und der aus früheren Studien gefunden, nachdem diese gemäß den in dieser Arbeit gefundenen Bedingungen angepasst wurde.

T 21.5 Mo 17:00 ST 7

Statistical fluctuations of extragalactic cosmic rays in the Galactic magnetic field — •Alex Kääpä — Gaußstr. 20, 42119 Wuppertal

To account for the flux measured in the energy spectrum of cosmic rays between the so-called “knee” and “ankle”, where the transition from galactic to extragalactic cosmic rays occurs, additions to existing models of cosmic ray acceleration as well as propagation are required. While some proposals for acceleration and propagation mechanisms exist (i.e. re-acceleration or spallation), understanding the bulk propagation of cosmic rays in the Galaxy is vital, particularly for those of extragalactic origin, where rigidity-dependent statistical fluctuations in arrival directions are still possible. In this talk, CRPropa simulations of said fluctuations, focusing on concentration effects in the Galactic magnetic field, will be presented and the possibility to measure these with cosmic ray observatories will be discussed.

T 21.6 Mo 17:15 ST 7

Solving the cosmic-ray transport equation with stochastic differential equations: CRPropa’s module DiffusionSDE — •Lukas Merten — Ruhr-Universität Bochum

An appropriate numerical modelling of Galactic cosmic-ray transport is a major challenge in modern astroparticle physics. Multi-messenger observations of cosmic rays and neutral secondary particles like neutrinos and gamma-rays must be connected with source models. This requires a detailed description of the propagation and interaction of all particles.

Over the years many different approaches to describe the Galactic cosmic-ray transport have been developed. From early semi-analytical simplifications to modern simulations frameworks a lot of progress has been made, e.g. the introduction of three-dimensional diffusion in recent tools. Furthermore, new solver techniques for the transport equation based on stochastic differential equations have become available e.g. in CRPropa.

In this talk the differences compared with conventional grid-based solvers are explained. In addition, it will be shown why this ansatz is especially promising in the shin region between the cosmic-ray knee and ankle.

T 21.7 Mo 17:30 ST 7

Improved photo-meson model for UHECR nuclei interactions — •Leonel Morejon[1], Anatoli Fedynitch[1], Denise Boncioli[2], Daniel Biehl[1], and Walter Winter[1] — [1]DESY Zeuthen, Platanenallee 6, 15738 Zeuthen, Brandenmburg, Germany — [2]GSSI, Via Michele Jacobucci 2, 67100 L’Aquila AQ, Italia

Photon-nucleus interactions are a necessary element in radiation models of sources and transport Ultra-High Energy Cosmic Rays (UHECRs). The UHECRs encounter dense photon fields with energies in the range $\mu\mathrm{eV} - \mathrm{MeV}$ which are boosted to $\mathrm{MeV} - \mathrm{GeV}$ in the nucleus rest frame, prompting pion production and thus connecting cosmic rays, gamma rays and neutrino spectra. Photomeson models are used to simulate these interactions above the photopion threshold, and previous works have introduced simplifications which need improvement.

Here we introduce a new photomeson model based on experimental data which improves on the previous models. Specifically, the new model includes shadowing by including an energy dependence of the mass scaling of the total nonelastic cross section above 1 GeV; it also includes pion re-absorption in the nuclear medium by appropriately scaling the photopion cross section with the nuclear surface ($\sim \mathrm{A}^{2/3}$), and finally the model contains enhanced nuclear breakup by the inclusion of multiple disintegration channels.

The relevance of these improvements is illustrated by showing the impact on the results of simulating two proposed source classes which have been found in recent works suitable as UHECRs sources.

T 21.8 Mo 17:45 ST 7

Improvements in the high-energy lepton propagator PROPOSAL — •Jean-Marco Alameddine — Technische Universität Dortmund

PROPOSAL is a Monte Carlo simulation library used to describe the propagation of high-energy charged leptons. These leptons can be muons induced by atmospheric air showers or particles produced from interactions of astrophysical high-energy neutrinos with matter, observed with experiments such as the IceCube Neutrino Observatory. PROPOSAL precisely describes the interaction of these particles with matter, especially the occurring energy losses through ionization, direct pair production, bremsstrahlung and inelastic nuclear interaction. The knowledge of these effects is essential for an accurate event reconstruction. However, there are still systematic uncertainties arising from the theoretical predictions as well as physical effects that are not included yet. This talk presents the latest enhancements in PROPOSAL made to further improve the precision and to reduce the systematic uncertainties of the propagation.

T 21.9 Mo 18:00 ST 7

Effects of the muon cross section uncertainties in IceCube — •Jan Soedingrekso, Tobias Hoinka, and Mirco Hünnefeld — TU Dortmund, Dortmund, Germany

The IceCube Neutrino Observatory measures astrophysical neutrinos through charged secondary particles emitting Cherenkov light. As the reconstruction of these secondaries, thus also the neutrinos, depend on the cross sections used in the Monte-Carlo Simulation, a systematic study regarding the uncertainties of these cross sections is needed. For high energy muons the energy loss processes are ionization, pair production and bremsstrahlung all with uncertainties of a few percents and inelastic nuclear interaction with an uncertainty of 10 to 20 percent. In this talk, the effects of different muon cross sections on the energy reconstruction are presented.

T 21.10 Mo 18:15 ST 7

Higher-order corrections to the energy-loss cross sections of high-energy muons — •Alexander Sandrock and Jan Soedingrekso — Technische Universität Dortmund

Over a large part of the energy range investigated by very large volume neutrino telescopes such as IceCube, pair production and bremsstrahlung dominate the energy loss of muons. The theoretical uncertainties on the energy loss cross sections influence the experimental results as systematic uncertainties. This contribution presents calculations of higher-order corrections to decrease these uncertainties for pair production and bremsstrahlung.