# T 83: Cosmic rays 6

Time: Thursday 16:00–18:15 Location: Geb. 20.30: 2.059

T 83.1 Thu 16:00 Geb. 20.30: 2.059

**Sensitivity of IceCube-Gen2 for Cosmic-Ray Anisotropy Studies** — •Wenjie Hou for the IceCube-Collaboration — Institute for Astroparticle Physics, Karlsruhe Institute of Technology (KIT)

One of the major unresolved issues in cosmic-ray physics is the transition from galactic to extra-galactic origin of high-energy particles. Pinpointing the exact energy of this transition remains a challenge, as the trajectories of CRs are significantly influenced by the magnetic fields present in the Galaxy, making it difficult to trace individual CRs back to their specific origins. However, constraints can be obtained by studying the large-scale cosmic-ray anisotropy in the energy range from PeV to EeV where the transition is expected to occur. The sensitivity to cosmic-ray anisotropy is in particular a matter of statistics. With the upcoming IceCube-Gen2 surface array, which will cover 8 times more area than the existing IceTop surface array and increase in aperture by factor 28.9. Therefore, there will be an increase in statistics and capability to investigate cosmic-ray anisotropy with higher sensitivity. We will present performed simulation studies of the sensitivity to the cosmic-ray anisotropy signal expected with the IceCube-Gen2 surface array.

T 83.2 Thu 16:15 Geb. 20.30: 2.059

**Effects of the galactic magnetic fields on anisotropies in a catalog based research** — •Luca Deval, Ralph Engel, Thomas Fitoussi, and Michael Unger — Karlsruhe Institute of Technology, Karlsruhe, Germany

Cosmic rays (CRs) are charged particles which, throughout their propagation in the Galaxy, undergo the effect of the galactic magnetic field (GMF). Due to these deflections, the arrival directions of CRs do not point in the direction of their sources. The Pierre Auger Observatory observes a hotspot in the Centaurus region which has been correlated with starburst galaxies at significance of $4\sigma$ but this result has been obtained assuming that the coherent deflections of the arrival directions of CRs can be neglected.

In this work, we investigate the effect of the GMF deflections on this analysis, by constructing 9 different realizations of the turbulent galactic magnetic field. We created a set of 10.000 simulated data sets for every GMF configurations to witch we apply the analysis reported by the Pierre Auger Collaboration with the intention of recovering compatible scenarios. We show that even in the presence of significance coherent deflections, the reported results can be recovered for a large fraction of realizations. However, when studying the local significance (LiMa) of the brightest and second brightest hotpost, we find agreement in only $< 1\mathrm{e}^{-3}$ of the considered simulations indicating a discrepancy between the data and the model assumptions.

T 83.3 Thu 16:30 Geb. 20.30: 2.059

**The Effects of the Galactic Magnetic Field on the Transition from Galactic to Extragalactic Cosmic Rays** — •Veronika Vašíčková and Leonel Morejon for the Pierre-Auger-Collaboration — Bergische Universität Wuppertal, Gaußstraße 20, 42119 Wuppertal, Germany

Identifying the sources of ultra-high-energy cosmic rays (UHECRs) has been a long-standing task of Astroparticle Physics. Understanding the influence of propagation on the energy spectrum and arrival direction is crucial to identifying UHECR sources and their properties. It has been shown that the Galactic Magnetic Field (GMF) affects UHECRs up to the highest energies.

This contribution highlights how the GMF influences the arrival direction and energy composition of cosmic rays in the rigidity range from 10 PV to 100 EV, whether they originated in the galactic plane or outside the Galaxy. This is accomplished through simulations utilising the CRPropa3 software which includes models of the GMF. A variety of potential sources in the Milky Way as well as starburst galaxies and active galactic nuclei is explored. In addition, the fractions of cosmic rays escaping from the Galaxy due to diffusion is calculated and the residence times of the cosmic rays within the Galaxy are computed. Finally, possible injection spectra which fit the observations of the Pierre Auger Observatory are extracted, given the effects of the GMF.

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T 83.4 Thu 16:45 Geb. 20.30: 2.059

**Probabilistic modelling of discrete cosmic ray sources** — •Anton Stall[1], Leonard Kaiser[2,1], Chun Khai Loo[1], and Philipp Mertsch[1] — [1]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, Aachen, Germany — [2]1. Physikalisches Institut, University of Cologne, Cologne, Germany

Cosmic rays can be probed via direct detection at the Earth's position or indirectly through diffuse emissions of gamma-rays and neutrinos produced by the interaction of cosmic rays with the interstellar medium in other parts of the Galaxy. It is commonly assumed in the modelling of galactic cosmic rays that the source density is smooth and steady. However, supernova remnants, the likely sources of cosmic rays, have a point-like and burst-like nature. This renders our predictions very sensitive to the precise positions and times of the sources. Yet observationally, those parameters are not accessible such that the source modelling must be done probabilistically. Fluctuations in locally observed cosmic rays can constrain the energy dependence of escape from the accelerators. Concerning the diffuse emissions, we find that the diffuse sky at GeV energies has a different morphology compared to the one at hundreds of TeV, relevant for observations with LHAASO, Tibet AS-gamma, IceCube and the upcoming SWGO, indicating that extrapolations from lower energies must fail.

T 83.5 Thu 17:00 Geb. 20.30: 2.059

**Improvement of the Cosmic Ray Fit in the Galactic Diffuse Emissions Model CRINGE** — •Lasse Ausborm[1,2], Jakob Böttcher[2], Philipp Fürst[2], Sven Günther[1], Hanno Jacobs[1], Philipp Mertsch[1], Anton Stall[1], and Christopher Wiebusch[2] — [1]Institute for Theoretical Particle Physics and Cosmology (TTK), RWTH Aachen University, 52056 Aachen, Germany — [2]III. Physikalisches Institut B, RWTH Aachen University, 52056 Aachen, Germany

CRINGE (Cosmic Ray-fitted Intensities of Galactic Emission) is a model used to calculate the galactic diffuse emission of gamma-rays and high-energy neutrinos. These emissions are the result of Cosmic Ray (CR) interactions, mostly proton and helium, with the interstellar medium. The distribution of these CRs in the Galaxy is calculated by fitting the source and transport parameters to the local proton and helium flux measured by AMS-02, DAMPE, KASCADE and IceTop, along with electron, positron, carbon, and B/C-ratio data from AMS-02. In this talk, we focus on improvements of the CR modeling of CRINGE by including new data from DAMPE and HAWC, as well as modifiying the model parameterization. Additionally, we discuss the uncertainty estimation in the high-energy CR data. We present these improvements and their significance.

T 83.6 Thu 17:15 Geb. 20.30: 2.059

**Studying effects of Lorentz violation in the photon sector using extensive air shower simulations** — •Nico Spornhauer, Fabian Duenkel, Marcus Niechciol, and Markus Risse — Center for Particle Physics Siegen, Experimentelle Astroteilchenphysik, Universität Siegen

Ultra-high-energy cosmic rays induce extensive air showers involving secondary particles, which can exceed the energies reached by today's accelerators. The effects of isotropic, non-birefringent Lorentz violation in the photon sector can be studied at these high energies. Using the 1-dimensional air shower simulation program CONEX, bounds on the studied Lorentz violation were set based on the significant reduction of the average atmospheric depth of the shower maximum $\langle X_{\max}\rangle$ and its shower-to-shower fluctuations $\sigma(X_{\max})$. We implemented modifications achieving Lorentz violation into the 3-dimensional air shower simulation program CORSIKA. The aim is an improved search for Lorentz violation by including observables unavailable to a 1-dimensional simulation such as those connected to the lateral particle distribution. We present preliminary results for the 3-dimensional shower simulations.

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T 83.7 Thu 17:30 Geb. 20.30: 2.059

**Micromirror confinement of sub-TeV cosmic rays in galaxy clusters** — •Patrick Reichherzer[1], Archie F. A. Bott[1], Robert J. Ewart[1], Gianluca Gregori[1], Philipp Kempski[2], Matthew W.

Kunz[2], and Alexander A. Schekochihin[1] — [1]University of Oxford, UK — [2]Princeton University, US

Recent observations reveal that cosmic rays (CRs) are more tightly confined in various astrophysical systems than current theories predict. We propose that microscale magnetic fluctuations, particularly from the mirror instability, significantly influence CR transport. Our theory is supported by simulations of CRs in the intracluster medium (ICM) of galaxy clusters. Our results indicate that sub-TeV CR confinement in the ICM is much more efficient than previously thought based on extrapolating existing Galactic-transport theories.

T 83.8 Thu 17:45 Geb. 20.30: 2.059

**Modelling hadronic interactions of Galactic Cosmic rays in Giant Local Molecular Clouds with CRPropa*** — •Julien Dörner[1,2], Leonel Morejon[2,3], Julia Becker Tjus[1,2,4], and Karl-Heinz Kampert[2,3] — [1]Theoretical Physics IV, Plasma Astroparticle Physics, Faculty for Physics and Astronomy, Ruhr University Bochum, 44780 Bochum, Germany — [2]Ruhr Astroparticle and Plasma Physics Center (RAPP Center), Germany — [3]Bergische Universität Wuppertal, Department of PhysicsGaußstraße 20, 42103 Wuppertal, Germany — [4]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

For Galactic Cosmic rays (GCRs) the hadronic interaction with the ambient gas are the most relevant energy loss channel. These interactions produce gamma-rays in the very high energy band as well as neutrinos, electrons and positrons. One tracer of the interactions of the GCRs of the local interstellar spectrum are gamma-ray observations of local giant molecular clouds (GMCs).

In this talk the implementation of hadronic interactions for primary protons on a proton target, based on different parametrisations of the production cross-section, is presented. We apply different interaction models to simulate the interactions of GCRs with the GMC Rho-Oph. The results of the parametrised models are compared to directly interfaced event generators and current observations.

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T 83.9 Thu 18:00 Geb. 20.30: 2.059

**Hybrid modeling of particle acceleration in MHD-jet simulations using stochastic differential equations** — •Patrick Günther, Karl Mannheim, and Sarah Wagner — Julius-Maximilians-Universität Würzburg

Fluid-dynamical simulations of jets generated by accreting supermassive black holes have made great progress in recent years showing the evolution of the thermal particle parameters along the jets. The observed jets, however, show non-thermal emission from particles accelerated in situ at shock waves and magnetic reconnection sites. To connect the non-thermal particles with the simulated bulk of the thermal particles, we study the diffusive propagation and energy losses of energetic particles in the test-particle approximation. We use the equivalence to a set of stochastic differential equations to solve the underlying Fokker-Planck equation and apply the code to the case of both Fermi-type acceleration mechanisms (diffusive shock acceleration and stochastic acceleration). Integrating the stochastic differential equation with a basic Euler scheme does not lead to the analytically expected power-law indizes in the case of shock acceleration, but accuracy can be improved by applying a semi-implicit second-order scheme. This method enables us to calculate particle distributions emerging from arbitrary shock szenarios efficiently. We show first results and develop a perspective on the potential of hybrid simulations.