T 92: Cosmic Ray IV

Time: Wednesday 17:30–19:00 Location: POT/0013

T 92.1 Wed 17:30 POT/0013

Modeling Diffusive Shock Acceleration with CRPropa* — •Sophie Aerdker[1,2], Lukas Merten[1,2], Julia Becker Tjus[1,2], Dominik Walter[1,2], Frederic Effenberger[1,2], and Horst Fichtner[1,2] — [1]Ruhr-Universität Bochum — [2]RAPP Center Bochum

Ultra high energy cosmic rays are most likely accelerated stochastically in time-dependent, turbulent magnetic field structures present in astrophysical sources and the interstellar medium. One of such processes is Diffusive Shock Acceleration: Diffusive particles gain energy by repeatedly crossing a shock front. The stochastic nature of this process leads to the characteristic power-law spectrum. We study Diffusive Shock Acceleration using a stochastic differential equation solver (DiffusionSDE) of the cosmic-ray propagation framework CRPropa3.2. We show that the expected spectra are reproduced for various configurations, from one-dimensional planar shocks to three-dimensional spherical shocks. The effect of anisotropic diffusion is discussed and how different injection spectra change the resulting spectrum. We clarify constraints for modeling Diffusive Shock Acceleration using stochastic differential equations.

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T 92.2 Wed 17:45 POT/0013

Untersuchung des Einflusses magnetischer Spiegel auf den Transport kosmischer Strahlung — •Seeliger Ines[1,2], Schlegel Leander[1,2] und Tjus Julia Becker[1,2] — [1]Theoretische Physik IV, Ruhr-Universität Bochum, Bochum, Germany — [2]RAPP-Center at Ruhr-Universität Bochum, Bochum, Germany

Seit den ersten Messungen der kosmischen Strahlungen bei den Ballonfahrten von Victor Hess im Jahre 1912, sind die Forschungen zu der Frage der Quellen der hochenergetischen Strahlung noch immer nicht abgeschlossen und Gegenstand laufender Untersuchungen. Numerische Betrachtungen des Transports ergeben, dass Teilchen des beobachteten Energiespektrums der kosmischen Strahlung in unterschiedlichen Transportregimen mit dafür charakteristischem Transportverhalten betrachtet werden können. Ziel dieser Arbeit ist es, insbesondere das Spiegelregime genauer zu untersuchen, indem der Einfluss von magnetischen Spiegeln hinsichtlich des Transportverhaltens relevant wird. Dazu wird numerisch das Verhalten der Teilchen an magnetischen Spiegeln durch analytisch implementierte magnetische Flaschen analysiert und es gilt den Einfluss der Spiegel bei der Simulation der Propagation von Testteilchen mit Hilfe der Software CRPropa zu bestimmen.

T 92.3 Wed 18:00 POT/0013

Unstable cosmic-ray nuclei constrain low-diffusion zones in the disk — •Hanno Jacobs, Philipp Mertsch, and Vo Hong Minh Phan — TTK RWTH Aachen

Gamma ray halos around pulsars indicate a locally suppressed diffusion coefficient. In the past the impact of those zones on galactic cosmic ray transport has been neglected due to their supposedly small filling fraction. Here we show that the determining factor is not the volume of the low diffusion zones, but the effective time spent in pockets of low diffusivity. We derive an averaged diffusion coefficient in the disc and implement it in a semi-analytical model of cosmic ray transport. Upcoming Beryllium data from the AMS-02 and HELIX experiments will be able to constrain the filling fraction of low diffusion zones at the percent level.

T 92.4 Wed 18:15 POT/0013

The CORSIKA 8 air shower simulation framework — •Alexander Sandrock for the CORSIKA 8-Collaboration — Bergische Universität Wuppertal, Gaußstr. 20, 42119 Wuppertal

Originally developed for the KASCADE experiment, the air shower simulation code CORSIKA is now used in the simulation chain of numerous experiments in astroparticle physics. The monolithic hand-optimized Fortran code, that has served the community for the last decades, becomes increasingly difficult to maintain and to expand. For this reason, a community effort has been started in 2018 to rewrite CORSIKA as a flexible air shower simulation framework, making use of the possibilities of modern C++ standards.

By now, CORSIKA 8 is capable of simulating both hadronic and electromagnetic components of an air shower, calculate the radio and Cherenkov emission, and offers a considerably increased flexibility in defining properties and geometries of the media, in which the shower is to take place. Several abilities already go beyond what is possible in earlier versions of CORSIKA, such as cross-media showers or full genealogy of particles.

This presentation discusses the status of the implementation and validation of this new air shower simulation framework.

T 92.5 Wed 18:30 POT/0013

High-energy lepton, photon and air shower simulations using PROPOSAL — •Jean-Marco Alameddine[1], Pascal Gutjahr[1], and Alexander Sandrock[2] — [1]Astroparticle Physics WG Rhode, TU Dortmund University, Germany — [2]Faculty of Mathematics and Natural Sciences, University of Wuppertal

In modern physics experiments, simulations are crucial to apply modern analysis methods to the obtained data. One prime example in astroparticle physics is the simulation of extensive air showers, whose signatures can either be signal or background for experiments that needs to be separated.

PROPOSAL is a customizable C++ and Python library, providing three-dimensional simulations of charged leptons and high-energy photons. One of many applications of PROPOSAL is within the currently developed shower simulation framework CORSIKA 8, the successor of the well-established software CORSIKA 7. For CORSIKA 8, PROPOSAL is used as a library to describe the electromagnetic and muonic shower component.

In this contribution, the basic concepts of PROPOSAL are introduced. Furthermore, validations of electromagnetic showers simulated with CORSIKA 8 are presented, which are obtained by comparing relevant shower parameters such as longitudinal and lateral profiles with CORSIKA 7 simulations.

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T 92.6 Wed 18:45 POT/0013

Air shower genealogy — •Maximilian Reininghaus and Ralph Engel — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

Experiments detecting ultra-high energy cosmic rays rely heavily on air shower simulations and models governing the hadronic interactions. These have to cover a vast phase-space (several combinations of projectile species and target nuclei, interaction energies ranging over many orders of magnitude, final-state kinematic distributions), but not all regions of it share the same relevance for air shower observables.

Using the air shower simulation framework CORSIKA 8 and its *particle history* feature, we investigate the relation between kinematic distributions of pseudorapidity, Feynman-x, and transverse momentum in hadronic interactions and muon distributions from air showers at ground. Additionally, we quantitatively study the energy transfer from the hadronic into the electromagnetic (EM) cascade and the impact of early hadronic interactions on the EM profile and its maximum $X_{\max}$.