T 54: Cosmic rays 5

Time: Wednesday 16:00–18:00 Location: Geb. 20.30: 2.059

T 54.1 Wed 16:00 Geb. 20.30: 2.059

Tidal Disruption Events as the origin of UHECR — •Pavlo Plotko[1], Chengchao Yuan[1], Cecilia Lunardini[2], and Walter Winter[1] — [1]Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, 15738 Zeuthen, Germany — [2]Department of Physics, Arizona State University, 450 E. Tyler Mall, Tempe, AZ 85287-1504 USA

We present a detailed study of the contribution of Tidal Disruption Event (TDE) populations to the spectrum and composition of ultra-high-energy cosmic rays (UHECRs) and the corresponding neutrino flux. We categorize TDEs into three distinct populations: those similar to the AT2019dsg, AT2019fdr, and AT2019aalc events. We find that the dominant contribution to the UHECR and the neutrino flux at EeV energies comes from the aalc-like population. Additionally, we investigate various models of disrupted stars, including Main Sequence (MS), Red Super Giants (RSG), Wolf-Rayet (WR) stars, Carbon-Oxygen White Dwarfs (CO-WD), and Oxygen-Neon-Magnesium White Dwarfs (ONeMg-WD). Our findings indicate that an enhancement in the acceleration of heavy nuclei is essential to account for the observed composition data of UHECRs. We present predictions of the diffuse neutrino EeV fluxes observable by future neutrino observatories such as IceCube-Gen2, RNO-G, and GRAND.

T 54.2 Wed 16:15 Geb. 20.30: 2.059

The Impact of the Temporal Luminosity Evolution on the Signal of Ultra-High-Energy Cosmic Rays — •Magdalena Litwin[1,2], Björn Eichmann[1,2], and Julia Becker Tjus[1,2,3] — [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]Department of Space, Earth and Environment, Chalmers University of Technology, 412 96 Gothenburg, Sweden

While the origin of cosmic rays at the highest energies remains unclear to date, nearby radio galaxies are considered as potential candidates. Limiting the sources of ultra-high-energy cosmic rays (UHECR) to such a small number, their finite lifetime would have a significant impact on the resulting energy spectrum and mass composition at Earth. This is due to the so-called magnetic horizon effect that yields hard spectra of the individual CR nuclei. In this work, we illustrate this effect and examine its influence by an analysis of different potential source luminosity evolutions. The results demonstrate a good agreement with the experimental data, if the sources have shown an increased luminosity in the past according to either a normal or log-normal evolution.

T 54.3 Wed 16:30 Geb. 20.30: 2.059

UHECR probability distributions in bursting sources — •Leonel Morejon — Wuppertal University, Gaußstr. 20, 42119 Wuppertal

The origin of Ultra-High Energy Cosmic Rays (UHECRs) is still unknown, although much progress has been made in understanding the necessary conditions to produce them. The current list of potential sources is reduced to a few classes of extreme phenomena, many of which are transient or experience variable emission (bursts). Source parameters (luminosity, size, magnetic field, etc.) may be inferred from the observed electromagnetic emissions, but estimating the ejected UHECRs requires knowledge of the injected composition and precise modelling of the nuclear interactions producing nuclear cascades. This means computing the energy densities of ∼100 nuclear species for a wide range of initial conditions and source scenarios accurately and fast. A framework able to do this within seconds would be a strong asset in the study of UHECR sources. This contribution discusses ongoing efforts to develop such framework with a novel stochastic approach to describe the interactions and cascades of UHECRs up to their escape from the source. Results are shown for examples of bursting sources where possible ejected compositions are obtained with associated likelihoods. The efficiency and simplicity of the approach is demonstrated by comparison with the Monte Carlo code CRPropa widely employed to simulate nuclear interactions in the propagation of UHECRs.

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T 54.4 Wed 16:45 Geb. 20.30: 2.059

The ABC of UHECR source searches: Charting cosmic paths with Bayesian statistics — Nadine Bourriche and •Francesca Capel — Max Planck Institute for Physics, Garching bei München, Germany

UHECRs at the most extreme energies provide strong constraints on their possible sources. We propose to use the reconstructed properties of individual detected UHECRs to map out three-dimensional constraints on the locations of their unknown sources. In this work, we focus on three events detected by the Pierre Auger Observatory and three events detected by Telescope Array and use CRPropa 3 to model all relevant propagation effects, including deflections in the Galactic and extra-Galactic magnetic fields. We consider key input quantities such as distance, position, and spectral index as free parameters and five mass group representatives, H, He, N, Si, and Fe for the source composition. We use Approximate Bayesian Computation (ABC) to derive constraints on the source locations for these six events and demonstrate the impact of uncertainties in the reconstructed UHECR properties on these results. We also highlight possible astrophysical sources that are compatible with these regions and requirements. This complementary perspective serves as a foundation for building more physically-motivated source catalogues and statistical analyses in the future.

T 54.5 Wed 17:00 Geb. 20.30: 2.059

Comparison of surface-detector based mass estimators for UHECR observatories — Lorenzo Apollonio[1,2], Lorenzo Caccianiga[1,2], Martin Erdmann[4], Jonas Glombitza[5], Niklas Langner[4], Markus Roth[3], •Maximilian Stadelmaier[1,2,3], and Darko Veberic[3] — [1]INFN, Milano, Italy — [2]UNIMI, Milano, Italy — [3]KIT, Karlsruhe, Germany — [4]RWTH, Aachen, Germany — [5]ECAP, Erlangen, Germany

Ultrahigh-energy cosmic rays (UHECRs) might be the messengers of the most extreme events in our extra-galactic neighborhood. To conduct arrival direction studies with high-rigidity particles only, however, their mixed mass composition necessitates the discrimination of heavy and light nuclei. Using the surface-detector data of an UHECR observatory, this is challenging and only possible by estimating mass-sensitive observables indirectly.

We present recent developments of event-level mass estimators for UHECRs, using data collected by the surface detector of the Pierre Auger Observatory. In detail, we compare the functionality and performance of classical likelihood-based fit models against deep neural networks. Furthermore, we discuss the expected increase in performance for Phase 2 of the Observatory.

T 54.6 Wed 17:15 Geb. 20.30: 2.059

Parameterising the lateral distribution function for the SD-750 array of Auger including small signals — •Philipp Meder for the Pierre-Auger-Collaboration — KIT, IAP

Implementation of triggers sensitive to smaller signals in the surface detector array (SD) of the Pierre Auger Observatory requires changes to the signal likelihood formalism used in the reconstruction of the lateral distribution function (LDF) and the energy of events. In this contribution, we discuss the choice of the LDF shape and changes in the likelihood minimisation for events recorded by the array with 750 m detector spacing (SD-750) of the Observatory. We present a new approach for the SD reconstruction, which will enable us to retune the LDF parameterisation and derive an updated spectrum for the energy range of cosmic rays between $10^{17.5}$ to $10^{18.5}$ eV.

T 54.7 Wed 17:30 Geb. 20.30: 2.059

Detecting cosmic rays with the LOFAR radio telescope — •Karen Terveer — Erlangen Centre for Astroparticle Physics (ECAP), Friedrich-Alexander-Universität Erlangen-Nürnberg

The LOw Frequency ARray (LOFAR) is the worlds largest radio telescope. With antenna fields distributed across Europe and its core in the Netherlands, it can be used for various astronomical observations. One of the key science questions is the measurement of radio signals from cosmic ray induced air showers.

The existence of radio emission from air showers has been known since the seventies, but only the past decade brought the powerful digital signal processing techniques needed to study it. Now radio is a

powerful tool for the investigation of cosmic rays - with various advantages over more traditional methods. LOFAR is one of the pathfinder experiments paving the way for next generation radio telescopes such as the Square Kilometre Array (SKA).

An important challenge to overcome is the high amounts of data, noise and the computationally expensive reconstruction of an air shower event. A new reconstruction method utilising the Bayesian inference based Information Field Theory (IFT) could be a possible solution to this.

T 54.8 Wed 17:45 Geb. 20.30: 2.059

Accessing the Cosmic-Ray Energy Scale with the Auger Engineering Radio Array — •Max Büsken[1,2] and Tim Huege[3,4] for the Pierre-Auger-Collaboration — [1]ETP, KIT, Karlsruhe, Germany — [2]ITeDA, UNSAM, Buenos Aires, Argentina — [3]IAP, KIT, Karlsruhe, Germany — [4]Astrophysical Institute, VUB, Brussels Belgium

The Pierre Auger Observatory is the largest ground-based observatory for the detection of extensive particle showers in air induced by ultra-high energy cosmic rays. It is situated in the Argentinian Pampa near the city of Malargüe. Multiple different detectors are operated and allow for hybrid measurements of the same shower. An absolute calibration of the reconstructed cosmic-ray energies is determined with the fluorescence detector (FD) and transferred to the surface detector (SD) through cross-calibrations.

The radio detection of air showers provides an independent access to the cosmic-ray energy scale. At the Pierre Auger Observatory, the radio detection is so far performed with the Auger Engineering Radio Array (AERA), and within the next year will be extended to the highest energies with the upcoming Radio Detector. The hybrid detector environment allows to compare the energy scales set by FD and AERA. In this contribution, we show how we can independently determine the cosmic-ray energy scale at the Pierre Auger Observatory with hybrid measurements from AERA and SD.

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