

Ultra-high-energy hadronic physics at the Pierre Auger Observatory

Monday 2 September 2024 14:50 (25 minutes)

The Pierre Auger Observatory, the world's largest observatory of ultra-high-energy cosmic rays (UHECR), offers a unique insight into the properties of hadronic interactions occurring in air showers at energies well above those reached at human-made accelerators. The key probe into the hadronic interactions has, for a long time, been the number of muons arriving at the ground, which can be directly measured at Auger for energies up to 10 EeV using dedicated underground muon detectors or estimated through the observation of highly inclined showers using the surface detector of the Observatory. Further information can be obtained using the hybrid character of the Observatory, which allows the simultaneous observation of the longitudinal development of the shower with the fluorescence (and lately also radio) detector and the ground signal with the surface detector. Several different analyses using hybrid data show a discrepancy between the predictions of simulations based on the latest hadronic interaction models and data when a complex view of the UHECR air showers is obtained. This discrepancy has been long interpreted as a deficit in the number of muons predicted by the simulations with respect to the data. A new analysis using a global fit of the data on selected hybrid showers has shown that the disagreement between models and data is more complex and also involves the predictions for the depths of the maxima of the longitudinal shower development. At the same time, measurements of shower-to-shower fluctuations using inclined hybrid events show good agreement with the predictions, suggesting that the observed muon discrepancy is rather the result of a gradual accumulation of small changes during the shower development than of a major change in the properties of the first interaction. Recently, the Observatory has undergone a significant upgrade, which includes several components aimed at a significant improvement in the measurement of the muon content of the air showers.

Author: EBR, Jan (FZU - Instituted of Physics of the Czech Academy of Sciences)

Presenter: EBR, Jan (FZU - Instituted of Physics of the Czech Academy of Sciences)