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Type: Talk

Mass Composition Studies at the Pierre Auger Observatory

Tuesday 29 July 2025 17:00 (25 minutes)

The Pierre Auger Observatory is the world's largest cosmic-ray detector, designed to study ultra-high-energy cosmic rays (UHECRs). A key observable for determining their mass composition is the depth of the maximum of air showers, $X_{\max}$. Using the Fluorescence Detector (FD), $X_{\max}$ is measured with high precision, albeit with a limited duty cycle. A recent analysis extends the FD dataset to include all data up to the end of 2021, increasing statistics and improving measurements of the energy evolution of both the mean and fluctuations of $X_{\max}$ above $10^{17.8}$ eV. These results help constrain the composition and test hadronic interaction models. Complementary to this, a deep-learning-based reconstruction of $X_{\max}$ has been developed using the Surface Detector (SD) array, which operates with nearly 100% duty cycle. The method employs a neural network with long short-term memory (LSTM) layers and hexagonal convolutions, trained on simulations and calibrated with hybrid events. Applied to over 48,000 SD events recorded between 2004 and 2018, it achieves a resolution better than 25 g/cm^2 above 2×10^{19} eV, enabling the measurement of the mean and fluctuations of $X_{\max}$ up to 10^{20} eV using SD data alone. The results confirm a trend towards heavier and more uniform composition at the highest energies and reveal features in the composition evolution that correlate with spectral structures in the energy distribution. In this talk, we will summarize these recent results and discuss their implications for understanding the nature of UHECRs.

Internet talk

No

Is this an abstract from experimental collaboration?

Yes

Name of experiment and experimental site

Pierre Auger Observatory

Is the speaker for that presentation defined?

Yes

Details

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