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Muon deficit in simulations of air showers inferred from AGASA data

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Multiple experiments reported evidences of a muon deficit in air-shower simulations with respect to data, which increases with the primary energy. In this work, we study the muon deficit using measurements of the muon density at 1000 m from the shower axis obtained by the Akeno Giant Air Shower Array (AGASA). The selected events have reconstructed energies in the range $18.83 \leq \log_{10}(E_R/\mathrm{eV}) \leq 19.46$ and zenith angles $\theta \leq 36^\circ$. We compare these muon density measurements to proton, iron, and mixed composition scenarios, obtained by using the high-energy hadronic interaction models EPOS-LHC, QGSJetII-04, and Sibyll2.3c. We find that AGASA data are compatible with a heavier composition, lying above the predictions of the mixed composition scenarios. The average muon density divided by the energy in AGASA data is greater than in the mixed composition scenarios by a factor of $1.49 \pm 0.11\,(\mathrm{stat}) \pm 0.18\,(\mathrm{syst})$, $1.54 \pm 0.12\,(\mathrm{stat}) \pm 0.18\,(\mathrm{syst})$, and $1.66 \pm 0.13\,(\mathrm{stat}) \pm 0.20\,(\mathrm{syst})$ for EPOS-LHC, Sibyll2.3c, and QGSJetII-04, respectively. We interpret this as further evidence of a muon deficit in air-shower simulations at the highest energies.

Keywords

Muon deficit; AGASA; Air showers

Collaboration

Auger

other Collaboration

Subcategory

Experimental Results

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