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Investigation of hadronic interaction models through muon content analysis in EAS with the LHAASO-KM2A

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This study investigates hadronic interaction models through a detailed analysis of muon content in extensive air showers (EAS) using the LHAASO-KM2A detector. The primary objective is to evaluate the consistency of muon production predictions from three hadronic interaction models (EPOS-LHC, QGSJET-II-04, and SIBYLL 2.3d) and spectral models (Gaisser H3a, Horandel, GSF, and LHAASO spectrum) against experimental data. Data collected between August 2021 and December 2023 from the full LHAASO-KM2A array are analyzed, covering cosmic ray energies from 300 TeV to 30 PeV. Key measurements include the muon content, its lateral distribution, relative fluctuations, and attenuation length. Comparisons between MC predictions and data highlight discrepancies in existing models, particularly in their treatment of muon production at ultra-high energies. These findings underscore the necessity of refining hadronic interaction models to better align with experimental observations, thereby enhancing the accuracy of cosmic ray composition studies and EAS simulations. This work contributes to resolving long-standing challenges in high-energy astrophysics, and validates LHAASO-KM2A's capabilities in advancing our understanding of cosmic ray interactions.

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