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An updated analysis of the KASCADE-Grande data on the muon content of cosmic-ray air showers at high energies

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Abstract

The number of muons in extensive air showers (EAS) is a useful quantity to investigate the composition of high-energy cosmic rays by indirect detection techniques. It is also a sensitive probe for tests of high-energy hadronic interaction models at laboratory energies that are several orders of magnitude larger than those achieved at current particle physics facilities. For these reasons, it is important to study this observable. In this work, using KASCADE-Grande data on EAS with energies from 10 PeV and 1 EeV and zenith angles below 40 degrees, we have investigated the number of muons in air showers at different zenith angle intervals. The data is presented as a function of the primary energy. For the energy calibration, we used a technique based on comparisons between the muon number distributions from the data and MC predictions from a cosmic-ray spectrum of reference. For such analysis, MC simulations were produced with the hadronic interaction models QGSJET-II-04, EPOS-LHC and SIBYLL 2.3c, using the GSF model and an energy scale similar to the one employed in the Pierre Auger observatory. We compared the results with the corresponding expectations from the above mentioned hadronic-interaction models. Derived from the analysis of the data, we found that the measurements are closest to the expected values from the post-LHC models, using the energy spectrum of reference, for inclined events than for vertical data. We also see that for showers detected from vertical directions, the actual muon number of EAS tends to be smaller than the MC predictions obtained with the reference spectrum.

Comments

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