Atmospheric shower fluctuations and the constant intensity cut method

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abstract

We explore the constant intensity cut method that is widely used for the derivation of the cosmic ray energy spectrum, for comparisons of data obtained at different atmospheric depths, for measuring average shower profiles, and for estimates of the proton-air cross section from extensive air shower data. The constant intensity cut method is based on the selection of air showers by charged particle or muon size and therefore is subject to intrinsic shower fluctuations. We demonstrate that, depending on the selection method, shower fluctuations can strongly influence the characteristics of the selected showers. Furthermore, a mixture of different primaries in the cosmic ray flux complicates the interpretation of measurements based on the method of constant intensity cuts. As an example we consider data published by the Akeno Collaboration. The interpretation of the Akeno measurements suggests that more than $60 - 70\%$ of cosmic ray primaries in the energy range $10^{16} - 10^{17}$ eV are heavy nuclei. Our conclusions depend only weakly on the hadronic interaction model chosen to perform the simulations, namely SIBYLL and QGSjet.