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Constraints of the entropic index of Tsallis statistics in the context of hadronic collisions at ultra high energies using measures of the depth of maximum of air showers

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Cosmic rays of ultra-high energy are one of the great puzzles of modern physics. So far their production mechanisms, sources, chemical composition and abundances as a function of energy are unknown. One can infer the primary mass composition from the depth of maximum,
Xmax, of the longitudinal development of air showers induced by cosmic rays. Measurements of the evolution of this observable as a function of energy performed by the Pierre Auger Collaboration indicate the presence of a heavier component in the absence of new physics in the range of 100 TeV. These results are sensitive to the dynamics of the first interaction and depend on the validity of the hadronic interaction models extrapolated from data at lower energies. Additionally, recent data from the Large Hadron Collider (LHC) at CERN, for p-p and A-A collisions at center of mass energy ˜ TeV indicate a significant increase on the multiplicity of hadrons produced with respect to the multiplicity predicted by models generally used. This result, as well as the transverse momentum distribution of the particles produced in the collision are parameterized by the Tsallis distribution favoring a thermodynamic / statistical interpretation of the hadronization process. In this work we constrain the values of the entropic index q of the Tsallis model by comparing its Xmax predictions with measurements performed by the Pierre Auger Collaboration, under the assumption of a proton primary composition.

Collaboration

– not specified –

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