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Nonextensivity and KNO scaling of charged particle production

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Abstract

We study the charged particle production in ultrarelativistic collisions within the color string fragmentation picture. In this picture, we describe the p_T spectrum as the convolution of the Schwinger mechanism with string tension fluctuations. Importantly, reproducing the power-law tail of the experimental p_T spectrum requires heavy-tailed distributions. For instance, the recently introduced q-Gaussian string-tension fluctuations yield a Tricomi function that captures the low and high p_T regimes. In this work, we study the power-law tail in the p_T spectrum, present in several models, including the Hagedorn function, the two-component model, and the description for the softened hadron production. Interestingly, these models can be studied in the high-p_T regime as Pareto-type string tension fluctuations, which are compatible with the KNO scale invariance required for describing hard processes. Additionally, the heavy-tailed string tension fluctuations are accompanied by temperature fluctuations, indicating that the medium where the particles are produced is out of equilibrium. We apply this framework to ALICE data and extract the effective temperature and the power-law trend of the high-p_T particle production. The latter shows clear trends with event multiplicity and collision centrality, consistent with enhanced hard-particle production in small systems and with high-p_T particle suppression in heavy ion collisions.

Primary author(s) : Dr. ALVARADO GARCÍA, J. Ricardo (Benemérita Universidad Autónoma de Puebla)

Co-author(s) : Dr. FERNANDEZ TELLEZ, Arturo (Benemerita Universidad Autonoma de Puebla); Ms. ROSALES HERRERA, Diana (FCFM-BUAP); JHONY, Ramírez (FCFM-BUAP)

Presenter(s) : Dr. ALVARADO GARCÍA, J. Ricardo (Benemérita Universidad Autónoma de Puebla)

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