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# Entropy and Multifractal Characterisitcs of Multiparticle production in pp collisions at ISR, SPS and LHC energies

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Energy dependence of information entropy is examined using the multiplicity distributions(MDs) of produced charged particles in pp collisions at ISR, SPS and LHC energies. The findings reveal that MDs at these energies exhibit a new type of scaling if the variable involved is the 'Information entropy' of the distribution, $S = -\Sigma P n ln P n$. Similar entropy scaling has also been observed too in AA collisions at AGS and SPS energies. The observed entropy scaling has been argued to be a special case of the more general case of multifractal structure. The analysis is extended to estimate the Reyni's order q information entropy, $I_q = \frac{1}{q-1} ln(\Sigma(Pn)^q)$, for q $\neq$ 1. For q = 1 $\lim_{q \to 1} I_q = I_1 = S$. This in turn gives the generalized dimensions of order q as, $D_q = I_q/Y_m$; $Y_m$ being the maximum rapidity. As the quantity $\Sigma(Pn)^q$ scales with improving resolution $\delta\eta$, like multifractal moments $G_q$, Renyi's entropy may also be used to study the multifarctal characteristic of multiparticle production. It is observed that $D_q$ monotonically decreases with increasing order q(= 2 to 8). This can be correlated to q point integral and hence the observed trends of q dependence of $D_q$ suggest the multifractal nature of MDs. In CHS (constant specific heat) approximation, $D_q$ dependence of q may be represented by the relation $D_q \simeq (a-c) + c(lnq/q-1)$, where a is the information dimension $D_1$, while c is referred to as the multifractal specific heat.

The observed linear dependence of $D_q$ on lnq/q-1 for the various data sets considered does suggest the presence of multifractality in pp collisions in the energy range $\sim$ 30 GeV to 7 TeV. Furthermore, the values of multifractal specific heat c are found to be nearly the same $\sim$ 0.1 in full and limited $\eta$ windows for all the data sets considered. Almost similar values of c have also been obtained earlier for hadron-hadron collisions in the energy range $\sim$ 19 - 540 GeV. Such a linear dependence of $D_q$ on lnq/q-1 has been reported in heavy-ion collisions in the energy range $E_{Lab} \sim$ 10 to 200A GeV/c. The values of c in these investigations have been obtained to be $\sim$ 0.25, somewhat higher than those observed for pp data. These observations, therefore, suggest that the CHS approximation is applicable to multiparticle production in pp and AA collisions at relativistic and ultra-relativistic energies and the parameter 'c' may be regarded as the universal characteristic at high energy hadronic collisions. The findings are compared with the Monte Carlo Model PYTHIA-8.2. Event samples corresponding to various energies are simulated and analyzed. The effects of multiparton interaction(MPI) and color re-connection(CR) have also been looked into. The event samples are simulated by setting the codes in different modes; MPI on or off and CR on or off for the purpose. These results will be presented.

## Session

Heavy Ions and QCD

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