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Universality of particle production and energy balance in hadronic and nuclear collisions

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A study of the universality of multihadron production in nucleus-nucleus and $pp/\bar{p}p$ collisions is performed using the dependencies of the midrapidity pseudorapidity and transverse energy densities and of the mean multiplicity on the collision energy and on the number of nucleon participants, or centrality, in the energy range from a few GeV to a few TeV. The approach in which the multiparticle production is driven by the dissipating centrality-dependent effective energy of participants is introduced exploiting the earlier proposed consideration that combines the constituent quark picture with Landau hydrodynamics. Within this approach, the data on the energy dependence of the global variables studied and the pseudorapidity spectra from the most central nuclear collisions are well reproduced. The centrality dependence of the midrapidity pseudorapidity and transverse energy densities of charged particles are well described pointing to a similarity in the most central collisions and centrality data. The study of the mean multiplicty centrality dependence reveals a new scaling between the measured and calculated pseudorapidity spectra. Using this scaling, called the energy balanced limiting fragmentation scaling, one reproduces the pseudorapidity spectra at all centralities. The obtained scaling clarifies on the differences in the multiplicty centrality dependence from RHIC and LHC as well as on the this dependence of the midrapidity pseudorapidity density vs. multiplicity at RHIC. A complementarity in the multiplicity energy dependence in the most central collisions and centrality data is obtained. A new regime in heavy-ion collisions is pointed out to occur at ~ 1 TeV. The pseudorapidity spectra of photons are also well reproduced within the proposed approach in the entire collision energy range and an explanation of their centrality independence is given. Predictions are made for the forthcoming higher-energy measurements in pp and heavy-ion collisions at the LHC.

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