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New Results on Baryon and Meson Production at SPS Energies

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One of the main objectives of the NA61/SHINE experiment at CERN SPS is to search for the critical point on the transition line between the two phases of matter, the quark-gluon plasma and the hadron gas. In this talk we present first results on three new observables relevant for the properties of the system as it cools back from the QGP down to the hadronic phase, which recently enriched the NA61/SHINE strong interaction programme.

We investigate proton density fluctuations as a possible order parameter of the phase transition in the neighborhood of the critical point. To this end, we perform an intermittency analysis of the proton second scaled factorial moments (SSFMs) in transverse momentum space. A previous analysis of this sort revealed significant power-law fluctuations in the NA49 heavy ion collision experiment for the "Si"+Si system at 158A GeV/c. The fitted power-law exponent was consistent with the theoretically expected critical value, within errors, a result suggesting a baryochemical potential for the critical point in the vicinity of ˜250 MeV. We now extend the analysis to NA61 systems of similar size, Be+Be and Ar+Sc, at 150A GeV/c.

We present the first ever measurements of Phi meson production in p+p collisions at 40 and 80 GeV/c, and most detailed ever experimental data at 158 GeV/c. We demonstrate the superior accuracy of the present dataset with respect to existing measurements. The comparison of p+p to Pb+Pb collisions demonstrates a non-trivial system size dependence of the longitudinal evolution of hidden strangeness production, contrasting with that of all the other mesons.

The electromagnetic (EM) effects on charged meson production give, for the first time, a consistent picture of the longitudinal evolution of the system at SPS energies. We discuss the role of energy-momentum conservation in the latter and discuss the system size dependence of EM effects as a possible new tool for studying the space-time evolution of the particle production and spectator fragmentation processes. This gives an extended update of the orginal proposal for studying EM interactions with NICA as discussed in [1].

[1] A. Rybicki et al., Studying the interplay of strong and electromagnetic forces in heavy ion collisions with NICA, Eur. Phys. J. A52 (2016) no.8, 221.

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