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Validity of the hadronic freeze-out curve

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In nucleus-nucleus collisions we distinguish early hadro-chemical freeze-out, fixing hadronic concentrations, and final kinetic freeze-out to spectral and flow features, occuring at the end of the hadronic "cascade" phase. This view has been adopted in all recent analysis of hadron production rates, which are well described in the grand canonical statistical equilibrium model. The derived freeze-out systematics in the (T,mu(B)) plane occurs in all present sketches of the QCD matter phase diagram. It merges with the lattice QCD parton-hadron coexistence line at small mu(B).

The preservation of the equilibrium pattern of hadronic yields (established in the close vicinity of hadronization) throughout the final hadronic expansion phase still remains to be explained, and substantiated.
In order to systematically assess the effect of the hadronic cascade stage we employ the hybrid version of the UrQMD transport model. In it, a high density hydrodynamic evolution stage is matched, via the Cooper-Frye formalism, to the final hadron/resonance expansion evolution. Matching occurs at a fixed critical energy density. These calculations are carried out at the energies covered by the
SPS Pb+Pb program, 6.3 < squrr(s) < 17.3 GeV. At each energy we determine, both, the hadron yield distribution arising directly after hadronization, and the eventual distribution resulting from the UrQMD hadron/resonance expansion "afterburner" stage. The latter turns out to preserve the bulk production channels but to systematically reduce the antibaryon yields, with exception of the Omega/Antiomega. We revisit the data in view of these predictions.

Finally we analyze all these yield distributions with the grand canonical statistical model, determining the freeze-out curve before/after the cascade afterburner. A significant shift of this curve occurs (to lower T, higher mu(B)) which, however, is essentially absent if the antibaryon yields are excluded, but with exception of the Omega/antiOmega yields. The cascade stage thus appears to distort the initially imprinted equilibrium distributions, but only selectively so: an effect that must be avoided in the data analysis. Thus one recovers the T, mu(B) established before the cascade stage.

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