Evidence of early multi-strange hadron freeze-out in high energy nuclear collisions

N. Xu, H. van Hecke, H. Sorge†*

Recently reported transverse momentum distributions of light and strange hadrons produced in Pb(158AGeV) on Pb collisions and corresponding results from the relativistic quantum molecular dynamics (RQMD) approach are examined[1]. [2]

Experimentally, it is found that the mean transverse momentum ($\langle p_T \rangle$) or the slope parameter (T) depend on the particle mass. The higher the mass, the bigger the value of $\langle p_T \rangle$. This trends is good for π, K, p, d. The experimentally observed transverse momentum distributions, for $\pi, K, p, \Lambda, \Phi, \Xi$, and Ω, can be reasonably reproduced by the transport model calculations.

We argue that the experimental observations favor a scenario in which multi-strange hadrons are formed and decouple from the system rather early at large energy densities (around 1 GeV/fm^3). The systematics of the strange and non-strange particle spectra indicate that the observed transverse flow develops mainly in the late hadronic stages of these reactions.

The importance of the result are several folds: (i) Since the heavy multi-strange hadrons freeze-out at the earlier time relative to other lighter hadrons, they carry precise information when the system still hot and dense. Their slope parameter, extracted from the transverse momentum distribution should be much closer to the the temperature where hadronization occur. (ii) In the subsequent collisions, hadron yields will be readjusted, therefore the question about hadron chemical equilibrium is reopened. It will be interesting to test if these heavy strange particle have ever reach the chemical equilibrium during the collisions. The intrinsic nature of hadronization will have certain influence on the equilibrium properties of hadrons. (iii) From the limited knowledge of cross sections, one can guess that, in heavy ion collisions, the finial baryon and anti-baryon yields will be affected differently in the hot and dense system regardless the mechanism of production. It is therefore important to study the time evolution of the yields of the multi-strange particles (both particles and anti-particles) in $p+p$, $p+A$, and $A+A$ collisions.

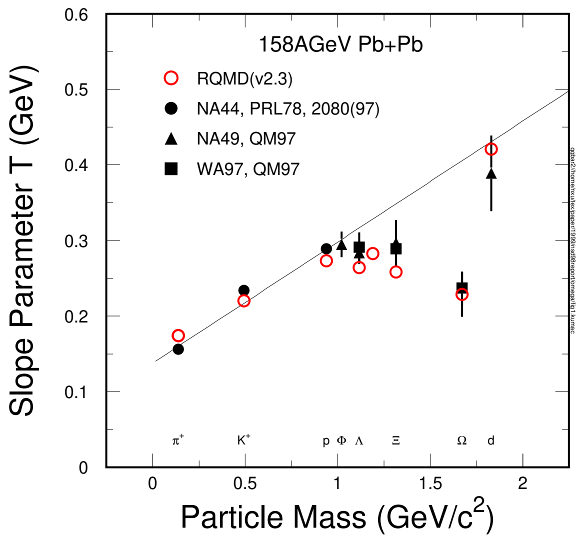

Figure 1: *Experimentally measured slope parameters as a function of particle mass (Ref. 1). The line serves to guide the eye with respect to the non-strange data. The RQMD results are shown as open squares.*

Footnotes and References

*H846, LANL, Los Alamos, NM 87545, USA

†Department of Physics, SUNY at Stony Brook, NY 11794, USA

[1] I. G. Bearden *et al.*, (NA44 Collaboration), Phys. Rev. Lett **78**, 2080(1997); I. Kralik *et al.*, (WA97 collaboration), Nucl. Phys. **A638**, (1998);G. Roland *et al.*, (NA49 collaboration), Nucl. Phys. **A638**, (1998).

[2] H. van Hecke, H. Sorge, and N. Xu, Phys. Rev. Lett. **81**, 5764(1998)