Hadro-chemical freeze-out at RHIC

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At the recent Quark Matter 2001 conference[1], all RHIC collaborations had reported the particle ratios around the mid-rapidity from the Au+Au collisions at $\sqrt{s_{NN}} = 130$ GeV. Those measured mid-rapidity ratios are: $\overline{p}/p$, $\overline{\Xi}^+/\Xi^-$, $\overline{\Lambda}/\Lambda$, $\overline{p}/\pi$, K^+/K^-, π^-/π^+, $K^{*0}/(h^- + h^+)$, $K^-/(h^- + h^+)$. Generally, one finds that those ratios are relatively constant as a function of rapidity (for $|y| \leq 0.5$), transverse momentum p_t, and centrality[1].

At lower bombarding energies, most of the particle production have been analyzed within the framework of statistical models[2] These approaches are applied to the results of both elementary collisions[3] ($e^+ + e^-/p + p/\overline{p} + p$) and heavy ion collisions[2] ($Au + Au/Pb + Pb$). While many features of the data indeed imply that a high degree of chemical equilibration is reached both at AGS and SPS energies, the three most important results are: (i) at high energy collisions, the chemical freeze-out (when the inelastic collisions ceases) occurs at about 160-180 MeV and it is 'universal' to both elementary and heavy ion collisions; (ii) the kinetic freeze-out (when elastic scatterings cease) occurs at a lower temperature $\sim 120 - 140$ MeV; (iii) the compilation of freeze-out parameters[2] in heavy ion collisions in the energy range from 1 - 200 AGeV shows that a constant energy per particle $\langle E \rangle / \langle N \rangle \sim 1$ GeV can reproduce the behavior in the temperature-potential ($T_{ch} - \mu$) plane.

In order to study the hadro-chemical properties for collisions at RHIC, we performed the thermal fit[4] to the measured particle ratios[5] and the results are shown in Figure 1. The chemical temperature parameter and baryonic potential are 190±20 MeV and 45± 15 MeV, respectively. At RHIC, the large rapidity span ($|y| \leq 5$) leads to the small value of the baryonic potential. On the other hand, the temperature parameter seems to be larger than that extracted from the low energy collisions. It is too early to draw conclusions because: (i) Most of the measured ratios are equal mass ones. These ratios tend to be more sensitive to the temperature parameter than the chemical potentials; (ii) As mentioned above, the ratios were measured around mid-rapidity, not 4-π. This may lead to some systematic deviation from the 4-π results[4].

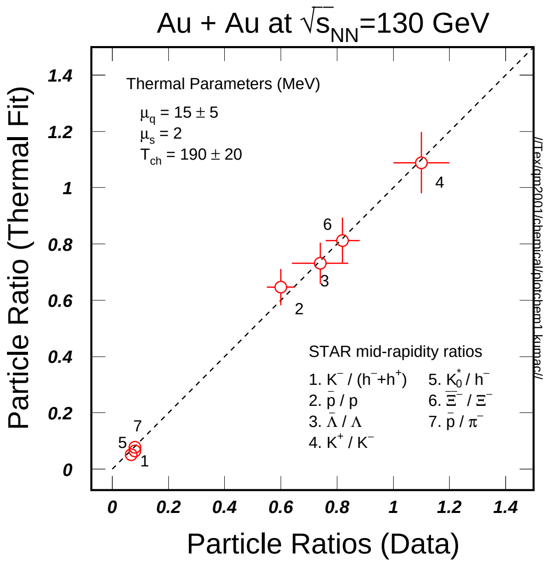

Figure 1: *Thermal fit of the particle ratios as a function of the measured particle ratios. Note that the measured data are mid-rapidity only and has not extraplated to 4-π.*

Footnotes and References

[1] *'Quark Matter 2001 Proceedings'*, Stony Brook, January 15-20, 2001.

[2] J. Cleymans and K. Redlich, Phys. Rev. Lett. **81**, 5284(1998); P. Braum-Munzinger, J. Stachel, J. Wessels, and N. Xu, Phys. Lett. **B344**, 43(1995); Phys. Lett. **B365**, 1(1996); P. Braum-Munzinger, I. Heppe, and J. Stachel, Phys. Lett. **B465**, 15(1999).

[3] F. Becattini, Z. Phys. **C69**, 485(1996); F. Becattini and U. Heinz, Z. Phys. **C76**, 269(1997).

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[5] J. Harris, (STAR Collaboration) *'Quark Matter 2001 Proceedings'*, Stony Brook, January 15-20, 2001.