Parton-scattering cross-section dependence of the effective temperature at AGS, FAIR and SPS energies

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Introduction

The idea of asymptotic freedom of strong interaction led the physicist to believe that under the condition of extreme temperature and/or net-baryon density, hadrons might melt into its constituents i.e. quarks and gluons and produces a new state of matter known as Quark-Gluon Plasma (QGP) [1]. This noble phase of matter can be realized in the laboratory by colliding heavy ions with relativistic velocities. The CBM experiment at FAIR will going to explore the phase diagram of excited nuclear matter at moderate temperature and high baryon density [2]. Although exploration of rare probes is the main thrust of CBM experiment, it will going to measure the bulk probes of the fireball with utmost precision. Transverse mommentum (p_t) and transverse mass (m_t) distributions are one of the usual prescription for studying multiparticle production. Since the transverse motion is generated only during collisions and hence transverse mass is sensitive to the dynamics of heavy-ion collisions [3].

Transverse mass distribution of the produced hadrons has already been studied in details by various experiments like WA97, NA44, NA49, NA60 etc [4–6]. The step-like behavior in the energy dependence of the effective temperature observed by the NA49 collaboration has been suggested as the signature of phase transition from confined to deconfined phase of nuclear matter [7] following an early suggestion by Van Hove [8]. It is to be noted that the hadronic transport models like HSD or UrQMD have not been able to describe the above observation. In the present investigation an attempt has been made to study the energy dependence of the effective temperature using the string melting (partonic) version of the AMPT model [9].

Results and discussion

Transverse mass spectra of the studied mesons and baryons i.e. $\pi^{\pm}$, $k^{\pm}$, Λ Ξ^0, Ξ^- and Ω^- have been fitted using the Boltzmann function (Eqn. 1) for Au+Au collisions at 10, 20, 30, 40, 80, 158A GeV both for 3mb and 10mb parton scattering cross-section.

$$\frac{1}{m_t}\frac{dN}{dm_t} \sim \exp\left(-\frac{m_t}{T_{eff}}\right), \qquad (1)$$

The effective temperature ($T_{\rm eff}$) calculated from the transverse mass spectra have been plotted as a function of energy as shown in Fig. 1 and Fig. 2. It is clearly seen from the figures that for both 3mb and 10mb parton scattering cross-section, at lower energies, $T_{\rm eff}$ increases sharply with energy, while, the rate of increase of $T_{\rm eff}$ decreases with energy. The increase of $T_{\rm eff}$ as a function of energy is a clear indication of development of radial collective flow with energy. Further, it is also seen from the figures that the magnitude of effective temperature is different for different parton scattering cross-sections indicating the role of partonic phase in the development of collective flow. Moreover, the energy dependence of the effective temperature for 3mb and 10mb parton scattering cross-section as shown in Fig. 1 and Fig. 2 reveals a remarkable behavior. It could readily be observed from the figure that the effective temperature of baryons is higher for 10mb at all energies, whereas, for mesons, the same is seen to be higher at 3mb parton scattering cross-section. The above observation indicates that the collective flow achieved due

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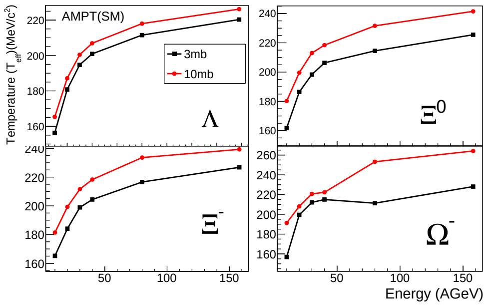

FIG. 1: T_{eff} as a function of energy for different studied baryons.

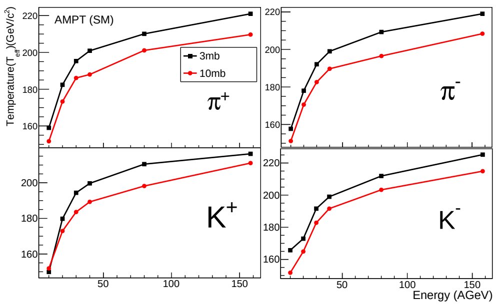

FIG. 2: T_{eff} as a function of energy for different studied mesons.

to the partonic phase is different for mesons and baryons.

References

[1] J. C. Collins and M. J. Perry, Phys. Rev. Lett. 34, 1353 (1975).
[2] V. Friese, Nucl. Phys. A 774, 377 (2006).
[3] I. G. Bearden *et al.* (NA44 Collaboration), Phys. Rev. Lett. 78, 2080 (1997).
[4] F. Antinori *et al.* Eur. Phys. J. C 14, 633-641 (2000).
[5] V. Friese, et al. [NA49 Collaboration], J. Phys. G 30 , 119 (2004).
[6] I.G. Bearden, et al. [NA44 Collaboration], Phys. Rev. C 66 , 044907 (2002).
[7] M. Gazdzicki and M. I. Gorenstein, Acta Phys. Polon. B 30 (1999) 2705.
[8] L. Van Hove, Phys. Lett. B 118 (1982) 138.
[9] Z.W. Lin, C.M. Ko, B.A. Li, B. Zhang, S. Pal, Phys. Rev. C 72 , 064901 (2005).