Differential elliptic flow and number of constituent quark (NCQ) scaling at FAIR energies

Partha Pratim Bhaduri[1*] and Subhasis Chattopadhyay[1]
[1] *Variable Energy Cyclotron Centre, 1/AF Bidhan Nagar, Kolkata 700 064, India*

Introduction

The goal of relativistic heavy ion collision experiments performed over past two decades around the world, is to discover a new phase of strongly interacting matter, the so-called Quark Gluon Plasma (QGP). One of the key observables in these nuclear collisions is the elliptic flow parameter, v_2, which signals a strong evidence for the creation of a hot and dense system very early in non-central collisions. In the present work, we have examined the p_T dependence of the elliptic flow parameter v_2 of identified hadrons and the scaling of hadronic v_2 with number of constituent quarks, at top (E_{Lab} = 40 AGeV) and intermediate (E_{Lab} = 25 AGeV) energies of the upcoming Compressed Baryonic Matter (CBM) experiment, at the proposed FAIR facility.

Differential elliptic flow and NCQ scaling

The elliptic flow parameter (v_2) is defined as the 2nd Fourier coefficient of the particle azimuthal distribution with respect to the reaction plane, in non-central nuclear collisions. We have estimated $v_2(p_T)$, for mid-central (b = 5-9 fm.) Au+Au collisions, in the mid-rapidity region (-1 $\leq$ y_{cm} $\leq$ 1). We have used the transport models UrQMD [1] and AMPT [2] with both default and string melting scenario for our study.

Fig. 1 shows the variation of v_2 with p_T as predicted by the the models UrQMD and AMPT at top and intermediate FAIR energies. We have found that v_2 is an increasing function of p_T. AMPT with partonic scattering generates highest v_2 values. A mass-ordering of v_2 for $p_T \leq$ 1.0 GeV/c is observed. In default version of AMPT this ordering is maintained throughout while for UrQMD as well as AMPT with string melting scenario, the ordering becomes inverse for p_T $\geq$1.2 GeV/c.

One of the most striking observations of elliptic flow measurements for Au+Au collisions at RHIC is the approximate quark-number scaling of hadronic v_2 at intermediate p_T regime [3]. Fig. 2 shows the model predictions for variation of v_2/n_q with KE_T/n_q, where KE_T is the transverse kinetic energy. We have found that the default version of AMPT without partonic degrees of freedom does not show any scaling behavior. But the scaling behavior can indeed be produced by both the string melting version of AMPT, which includes partons as well as by UrQMD which is a purely hadronic-string transport model.

Summary

Differential elliptic flow of identified hadrons has been investigated at FAIR energy range. A considerable amount of scaling of hadronic v_2 has been observed using both the hadronic as well as the partonic model. Observation of NCQ scaling behavior with UrQMD prohibits its interpretation as a unique and unambiguous signature for the formation of a partonic phase.

References

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*Electronic address: partha.bhaduri@veccal.ernet.in

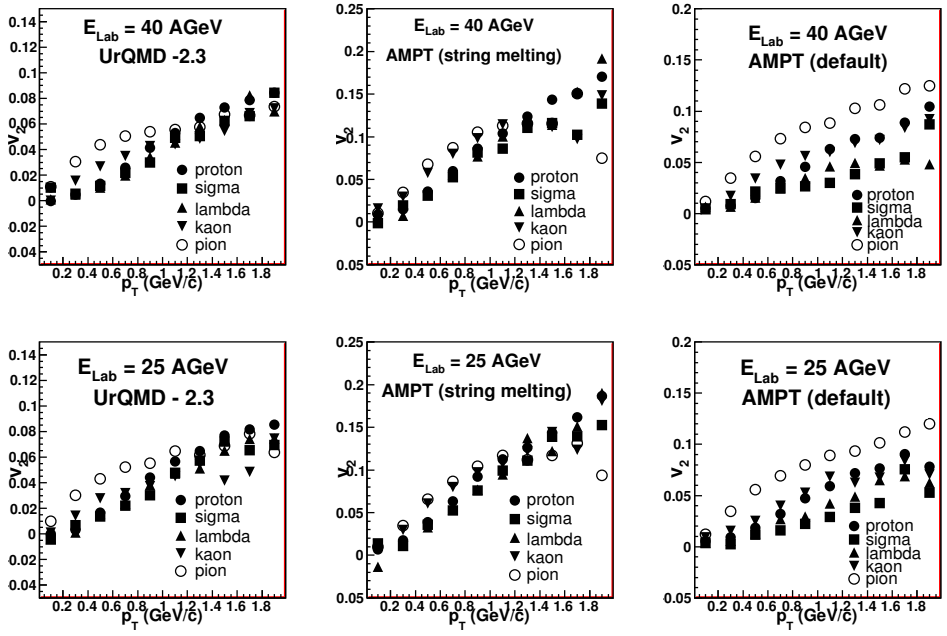

FIG. 1: variation of v_2 with p_T at 40 AGeV (upper panel) and 25 AGeV (lower panel) from different transport models.

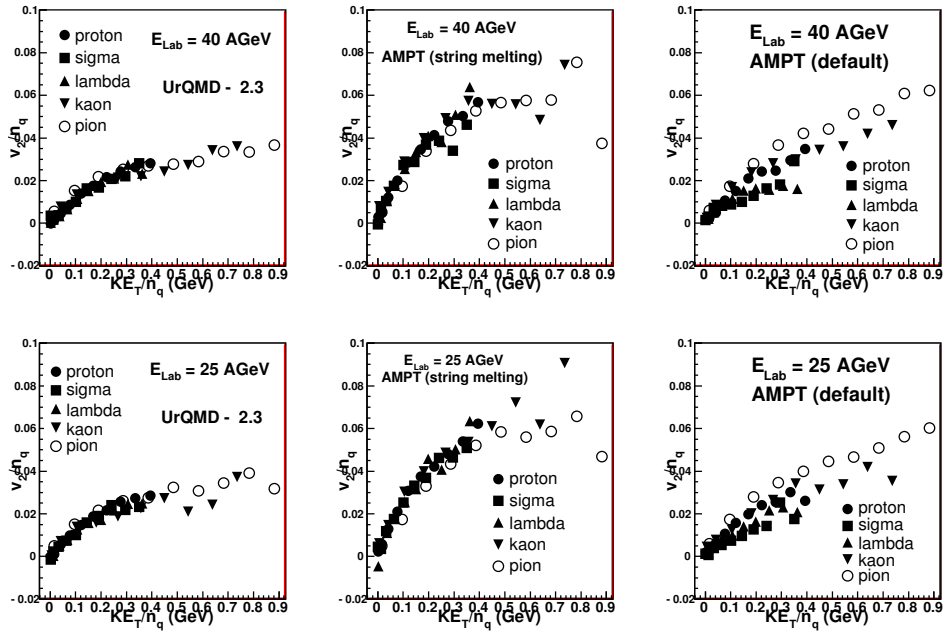

FIG. 2: variation of v_2/n_q with KE_T/n_q at top and intermediate FAIR energies from different models.