Systematic study of transverse momentum spectra

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Introduction

In recent years, investigations of the nuclear matter equation of state (EOS) at extreme conditions of temperature and density have been one of the primary driving forces in heavy ion studies at intermediate energies. In the low energy heavy ion collisions, fusion, decay of excited compound nucleus and fission dominate the process [1] whereas at intermediate/high energies the transparency and complete disassembly of nuclear matter happens. In intermediate energy heavy ion reaction several new phenomena such as multifragmentation [2], collective flow [3-5], sub-threshold strangeness production as well as nuclear stopping [6] and so on have been measured (and/or predicted) that may shed light on the nature of hot and dense nuclear matter formed during a collision. All these quantities have found to be sensitive towards nuclear matter equation of state and/or in medium nucleon-nucleon cross section. Here we aim to show that the p_T spectra of nucleons is sensitive to nucleon-nucleon cross section alone and is insensitive to other model input parameters such as EOS, Gaussian width, symmetry energy and so on. For the present study we use isospin dependent quantum molecular dynamics (IQMD) model [7].

The Model

The quantum molecular dynamics model (QMD) is an n-body theory to predict the behaviour of heavy ion collisions at intermediate energies on event by event basis. The IQMD model which is an improved version of QMD model considers various aspects of isospin effects: differing density distributions for neutrons and protons, the asymmetry potential term in mean field, the σ_{nn} experimental cross section for nucleon-nucleon interaction and Pauli blocking for neutrons and protons separately. In IQMD model the two body potential interaction contains the coulomb interaction and real part of G-matrix. The later one can be divided into four parts: the contact Skyrme type interaction, a finite Yukawa potential, momentum dependent interaction and symmetric potential part.

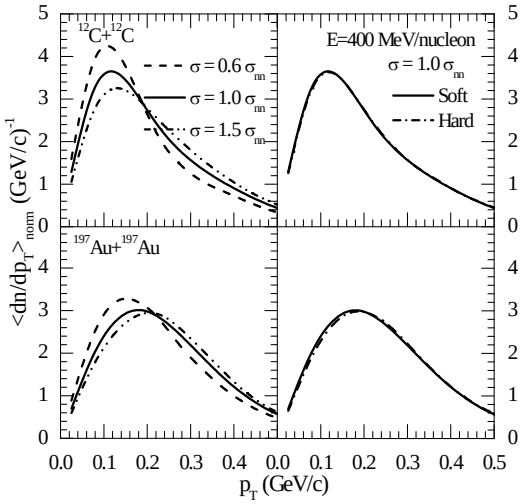

Fig. 1: p_T spectra at 400 MeV/nucleon

Results and Discussion

We study the transverse momentum (p_T) spectra of nucleons throughout the mass range from ^{12}C +^{12}C → ^{197}Au +^{197}Au and incident energy range from 100-1500 MeV/nucleon for central colliding geometry. We use soft equation of state along with isospin and energy dependent nucleon-nucleon cross section. In Fig. 1 we display the normalized p_T spectra at 400 MeV/nucleon for ^{12}C +^{12}C (upper panels) and ^{197}Au +^{197}Au (lower panels). In left panels we vary the cross section and in right panels we vary the EOS. The cross section is varied by applying the constant factor to the standard isospin and energy dependent cross section. For both the systems p_T spectra is insensitive to the EOS. For ^{197}Au +^{197}Au the peak of the spectra shifts towards high p_T region with increase in cross section whereas for ^{12}C +^{12}C the height of peak changes substantially with change in cross

section, thus making the slope of the spectra around the peak to be sensitive to cross section.

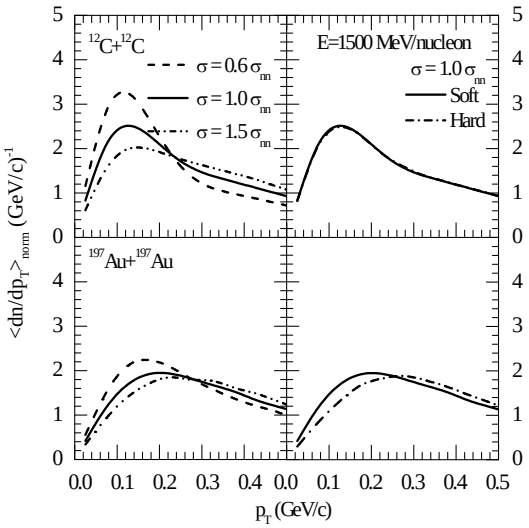

Fig. 2: p_T spectra at 1500 MeV/nucleon.

In Fig. 2 we display similar curves at 1500 MeV/nucleon. For lighter system the slope of spectra around the peak is still sensitive to cross section whereas for heavier system the spectra is sensitive to both EOS and cross section. Thus at lower energies p_T spectra for both lighter and heavier systems show sensitivity to cross section whereas at higher energies only lighter systems show the sensitivity toward cross section. Moreover the spectra has been found to be insensitive to other model parameters such as Gaussian width, radius of the nuclei, symmetry energy, isospin dependence of cross section and so on. Thus our preliminary results show that the p_T spectra can be an observable to measure the strength of in medium nucleon-nucleon cross section.

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