Study of different components of potential in Isobaric pair collisions

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Introduction

The knowledge of nucleon-nucleon (NN) interaction potential in heavy ion collision (HIC) is essential in order to understand the role of different components of potential in the reaction dynamics. A number of studies are available in the literature which have been directed to study the heavy ion collision dynamics by using the NN interaction potential. The different parameterizations of the Skyrme force have been used to study the HIC dynamics at low energies [1] whereas few efforts have been made in the literature to study such effects at the intermediate energies. The studies show that Coulomb potential affect the fragment production at low energy but its role starts decreasing with increase in bombarding energy [2]. Moreover, the momentum dependence of mean field potential plays an important role in the reaction dynamics at intermediate energies and is found to affect the fragmentation drastically [3]. The combination of different components of potential i.e. Skyrme, Yukawa, Coulomb, momentum-dependent and density-dependent symmetry potential gives the total NN interaction potential. These different components of NN potentials affect the various phenomena of HICs at intermediate energies. The studies show the role of different components of potential on balance energy for symmetric reactions [4] while little efforts have been made to study the collective effect of different components of potential on fragment production. In the present work, we try to understand the importance of different components of potential in isobaric pair collisions having different proton and neutron content.

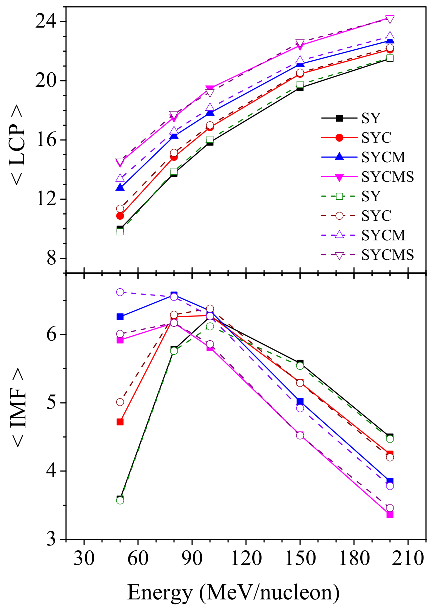

FIG. 1: The variation of multiplicity of LCPs and IMFs with energy for isobaric collisions of ^{74}Ge+^{74}Ge and ^{74}Kr+^{74}Kr at b=0 fm. (The solid squares represent different potentials for Ge+Ge and open circle symbols represent different potentials for Kr+Kr system)

Isospin dependent Quantum Molecular Dynamics (IQMD) Model

Isospin dependent quantum molecular dynamics model is an improved version of QMD model [5], which is based on event

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by event method. The heavy ion collision are simulated by generating the phase space (x,y,z,p_x,p_y,p_z) of two colliding nuclei at different time steps such that (x,y,z) are the position coordinates and (p_x,p_y,p_z) are momentum coordinates. The simulation process consists of three steps:

1.Initialization of projectile and target $f_i(r,p,t)=\frac{1}{\pi^2\hbar^2}\ e^{\frac{-(r-r_i(t))^2}{2L}}\ e^{\frac{-(p-p_i(t))^2.2L}{\hbar^2}}$

2.Propagation of A_P+A_T nucleon system Each nucleon propagate under classical Hamilton's equation of motion given as

$$\frac{dr_i}{dt} = \frac{d<H>}{dp_i}; \frac{dp_i}{dt} = \frac{-d<H>}{dr_i} \qquad (1)$$

with $<H>=<T>+<V>$ is the Hamiltonian

The interaction potential V^{ij} is given as V^{ij}=V_{Sky}+ V_{Yuk}+ V_{Coul}+ V_{MDI}+V_{symm}

3.NN collision and pauli blocking.

d $<|r_i - r_j|= \sqrt{\frac{\sigma_{nn}}{\pi}}$

Calculations and Discussions

To study the role of different components of total interaction potential in isobaric collisions several thousand events of ^{74}Ge+^{74}Ge and ^{74}Kr+^{74}Kr have been simulated at b=0 fm for energy varying from 50 to 200 MeV/nucleon. Fig. 1 shows the variation of multiplicity of light charged particles (LCPs) and intermediate mass fragments (IMFs) with energy for isobaric collisions of ^{74}Ge+^{74}Ge and ^{74}Kr+^{74}Kr for central collisions. The acronyms SY, SYC, SYCM, SYCMS stands for Skyrme+Yukawa potential, Skyrme+Yukawa+Coulomb potential, Skyrme+Yukawa+Coulomb+momentum dependent, Skyrme+Yukawa+Coulomb+momentum dependent+symmetry potential respectively. The multiplicity of LCPs increases with increase in energy for both the pairs due to increase in violence of collision whereas IMFs shows well known trend of rise and fall. For SY potential the multiplicity is less. With the addition of Coulomb potential, momentum dependent potential and symmetry potential, the multiplicity of LCPs increases because of repulsive nature of these potentials. We note that the role of SY potential is nearly same in both isobaric pairs collisions for LCPs and IMFs. At low energies 50, 80, 100 MeV/nucleon, the role of Coulomb potential is clearly visible while at higher energies its effect decreases. The role of different potentials is reversed at higher energies for IMFs. This is due to the reason that that repulsion generated due to momentum dependent interactions and symmetry potential tends to reduce the IMF production.

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