Reduced N-N cross-section and fragment production

Karan Singh Vinayak[1] and Suneel Kumar[1*]
[1]*School of Physics and Material Science, Thapar University, Patiala - 147004, (Punjab) INDIA*

Introduction

Investigation of the reduced cross-section effect in various phenomenon of heavy ion collisions has attracted a lot of attention. For example, in low energy regime where phenomenon like fusion, fission, cluster radioactivity, formation of superheavy nuclei etc take place. The contribution of N-N cross section have been reported to scale with energy and density of nuclear matter reached in heavy ion collision.

The multifragmentation, that is the emission of several intermediate mass fragments (IMF's) from a hot compound nucleus, in a phenomenon observed in nuclear reactions over a wide incident energy range. There has been a considerable progress during recent years in experimental studies.Experimental evidence for the statistical property of nuclear fragmentation has been observed and many new quantities have been measured [1].
The quantity which is related to the multifragmentation is the multiplicity of intermediate mass fragments(I.M.F's) i.e. $5 \leq A \leq 65$. The aim of the present study is to pin down the influence of reduced cross section on the production of IMF's at various energies and impact parameters.

The Model

The calculations are carried out within the framework of isospin dependent quantum molecular Dynamics (IQMD) model [2] which is an extended form of the QMD model.
It is a semi-classical model which describes the heavy-ion collisions on an event by event basis. In IQMD model, the centroid of each nucleon propagates under the classical equations of motion .

$$\frac{d\vec{r_i}}{dt} = \frac{dH}{d\vec{p_i}} \; ; \; \frac{d\vec{p_i}}{dt} = -\frac{dH}{d\vec{r_i}} \cdot \quad (1)$$

The H referring to the Hamiltonian reads as:

$$H = \sum_i p_i^2/2m_i + V^{ij}_{Yukawa} + V^{ij}_{Coul} + V^{ij}_{skyrme} + \mathrm{V}^{ij}_{mdi} \cdot (2)$$

Preliminary Results

For the present analysis simulations are carried out for thousand events for the reaction of Au^{197}_{79} with Au^{197}_{79} at various colliding geometries starting from central to peripheral one. The whole analysis is performed for intermediate mass fragments(IMF's). The reaction conditions and fragments are chosen on the basis of availability of experimental data. The relativistic effect do not play role at these incident energies and intensity of sub threshold particle production is very small. The phase space has been generated using IQMD model has been analyzed using the minimum spanning tree with binding energy cut(MSTB) and with momentum cut(MSTP) methods[2] .The entire calculations have been performed at 200 fm/c i.e. the saruration time.

In Fig. 1, we display the multiplicity of intermediate mass fragments (IMF's) as a function of the scaled impact parameter for the reaction Au^{197}_{79}+Au^{197}_{79} at incident energies 100 MeV/nucleon (upper panel) and 250 MeV/nucleon (bottom panel). Here soft

*Electronic address: suneel.kumar@tiet.ac.in

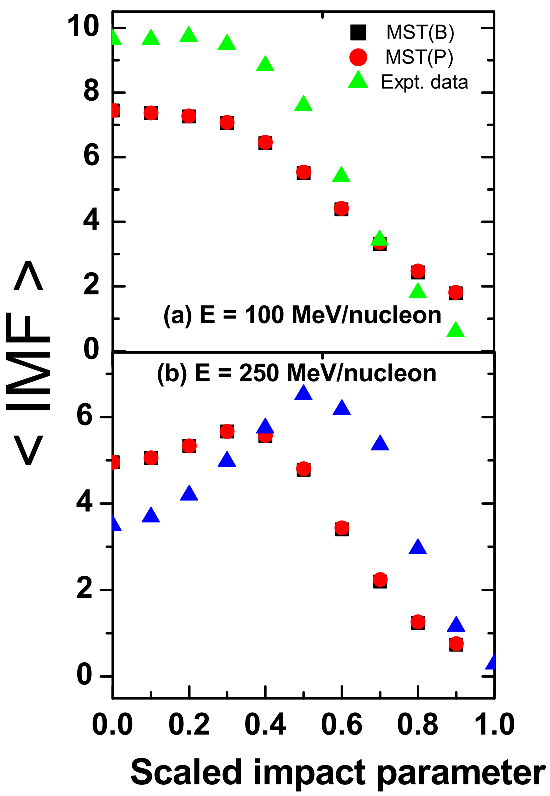

FIG. 1: Impact parameter dependence of the mean fragment multiplicity at E/A = 100 MeV/n(upper panel) and 250 MeV/n(bottom panel) respectively.

.

equation of state has been used with reduced isospin dependent cross section(0.9σ). One can see from the fig 1(a) that multiplicity of IMF's is maximal at 100 MeV/n for smaller impact parameters, which decreases with the increase in the impact parameter. On the other hand, one sees a rise and fall in the multiplicity of IMF's at higher incident energy(250 MeV/nucleon). The dynamics at 100 MeV/nucleon, is mainly governed by the mean field or by the density of the reaction compared to other higher incident beam energies. Due to low excitation energy, central collisions generate better repulsion and break the colliding nuclei into IMF's, whereas for the peripheral collisions, the size of the fragment is close to the size of the reacting nuclei, and therefore, one sees a very few IMF's. On contrary, a rise and fall can be seen at other higher incident energies. For the central collisions, the frequent NN collisions occuring at these energies do not allow any IMF's production, whereas, at peripheral collisions the energy transfered from the participating matter to spectator matter is minimum, and therefore, very few IMF's are seen.

Trend of results obtained is similar to experimental observations [1]. We shall try to achieve closer agreement with data by using the more sophisticated clusterization algorithm [3] .

References

[1] M.B. Tsang *et.al.*, Phy. Rev. Lett. 71, 1502 (1993).

[2] S. Kumar and R.K. Puri , Phy. Rev. C 58, 320 (1998)

[3] R.K. Puri and J.Aichelin , J. comp. Phys. **162**, 245 (2000).