Loss of correlations due to mass asymmetry in heavy ion collisions

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INTRODUCTION

Heavy-ion Physics is a branch of physics that helps us to study different properties of nuclear matter in vastly different conditions of density and temperature [1]. Nuclear stopping enable us to study the entrance channel of the nucleons in mass symmetric and asymmetric reactions. The degree of breaking of initial correlations in the entrance channel memory loss is known as memory loss ratio [2]. The entrance channel memory could influence the spherical symmetry of the expanding system. Maximum memory loss is generally observed for the case of full stopping, where the nucleons behave as two hard spheres. Memory loss generally corresponds to the global equilibrium, and the incomplete memory loss or residual memory specify that the global equilibrium is not achieved in central collisions. The degree of entrance channel memory loss can be used to calculate the residual memory and deviation from the equilibrium. So, here we have simulated two reactions and studied their memory loss by switching off the collisions. The formula so used for the calculations of memory loss is:

$$R_{ml} = \frac{R_E - R_E^{entr}}{1 - R_E^{entr}} \qquad (1)$$

where R_{ml} present to the memory loss ratio, R_E is the stopping during N-N collision and R_E^{entr} is the stopping when collisions are switched off.

The comparison of memory loss on the basis of nuclear stopping for different reactions reveals that memory loss vary from reaction to reaction. One can observe that memory loss is less for mass asymmetric reactions, however, it has a greater value for mass symmetric reactions, because in mass asymmetric reactions less number of nucleon-nucleon collisions leads to small distribution of initial correlations among the nucleons

RESULTS AND DISCUSSIONS

Loss of nuclear correlation among the nucleons has been studied within the framework of Isospin-dependent Quantum Molecular Dynamics (IQMD) [3] model. The simulation results show that system mass play a strong role in the estimation of nuclear stopping.

The present analysis of the mass asymmetric nuclear reactions has been carried out by simulating thousands of events of these two reactions: ${}^{108}_{48}Cd$ + ${}^{132}_{56}Ba$ and ${}^{58}_{28}Ni$ + ${}^{58}_{28}Ni$, at incident energies between 20 to 600 MeV/nucleon. We know that Columbic repulsions and symmetry energy plays an important role during nucleon-nucleon collisions, therefore, we have studied the entrance channel memory loss for by switching off the collisions for these two reactions. We have first compared the nuclear stopping for both the reactions with various incident energies at an impact parameter, $\hat{b} = 0.0$; $\hat{b} = \frac{b}{b_{max}}$, where $b_{max} = 1.12\left(A_T^{1/3} + A_P^{1/3}\right)$.

The variation of the memory loss with respect to the incident energy is shown in the lower panel of figure 1.

Our study reveals that nuclear matter in highly mass asymmetric nuclear reactions is less equilibrated compared to symmetric colliding nuclear reactions [5].

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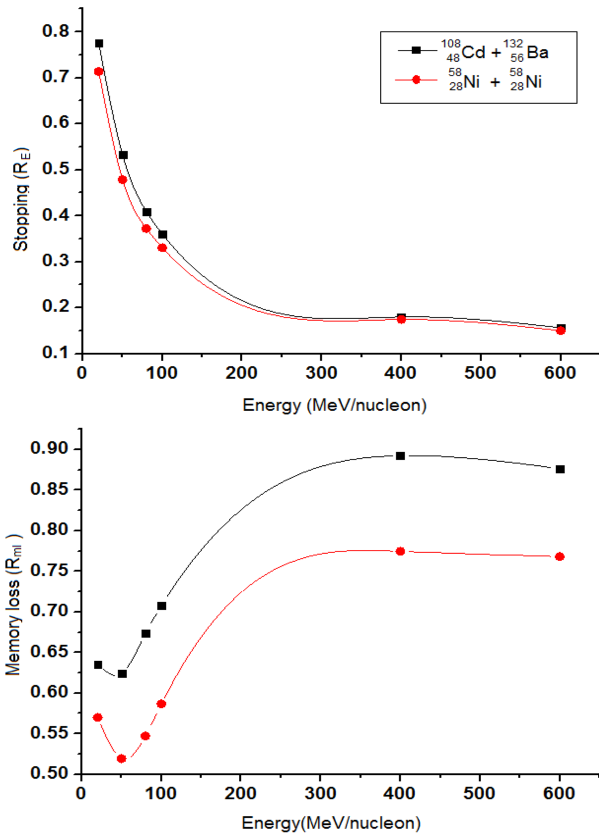

Figure 1: Schematic variation of nuclear stopping for mass symmetric and asymmetric reactions (upper panel) and variation of memory loss between mass symmetric and asymmetric reactions (lower panel).

One can also observe that incident energy has an important role to play in the memory loss of the nucleons. As it is clear from the graph itself that memory loss of the nucleons increases with an increase in the incident energy, however there is a certain decrease in the memory loss at initial stages due to the Columbic repulsions between the nucleons. The nucleons that suffer maximum number of collisions lose their memory [4].

SUMMARY

We have studied that mas asymmetry of a nuclear reaction has an important role to play in nucleon-nucleon interactions, these factors are responsible for the entrance channel memory loss of the nucleons which further depends upon the various parameters, such as the incident energy (E), impact parameter (b) and mass of colliding nuclei.

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REFERENCES

[1] P. B. Gassiaux and J. Aichelin, Phys. Rev. C 56, 2109 (1997).

[2] Jun Su and Feng-Shou Zhang, Physical Review C 87, 017602 (2013).

[3] C. Hartnack et al., Eur. Phys. J A 1, 151 (1998).

[4] Deepshikha and Suneel Kumar, Nucl. Phys. A 978, 13(2018).

[5] Kamaldeep Kaur and Suneel Kumar, Nucl. Phys. A 973, 149(2018).