Study of heavy ion reactions $^{48}Ca+^{48}Ca$, $^{40}Ca+^{40}Ca$ and $^{40}Ca+^{48}Ca$ using Classical Molecular Dynamics Model

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Various classical microscopic and macroscopic approaches have been used for studying heavy-ion reaction [1-5] because of validity of classical approximations due to the small de Broglie wavelength of heavy ions even at lower energies,clarity of interpretations and computational ease. It is easily possible to include all the degrees of freedom in a completely unconstrained microscopic calculation which includes vibrational and rotational degrees of freedom such as Classical Molecular Dynamics Model (CMD-Model)[2]. In CMD-Model, the trajectories of all the nucleons are computed in the center-of-mass frame of colliding system by solving coupled equations of motion as the nuclei approach each other from large initial separation. In the present work, the simulation of heavy ion collision for mass symmetric reactions: $^{40}Ca+^{40}Ca$, $^{48}Ca+^{48}Ca$ and mass asymmetric reaction: $^{40}Ca+^{48}Ca$ is carried out at and around barrier energies using CMD-Model and the fusion cross-sections are calculated using barrier parameters which are obtained from the dynamically evolved ion-ion potential using Wong's Formula [6]. The calculated fusion cross-sections using CMD-Model are compared with DC-TDHF[7] and experimental data[8]. For all three systems: $^{40}Ca+^{40}Ca$, $^{48}Ca+^{48}Ca$ and $^{40}Ca+^{48}Ca$, it is shown that at higher energies fusion cross-sections calculated using CMD-Model closely reproduce experimental fusion cross-sections and DC-TDHF results but at lower energy it exceeds slightly experimental data. To study the role of vibrational excitation, fusion cross-sections obtained using CMD-Model are compared with those calculated using Classical Rigid Body Dynamical Model (CRBD-Model) in which rigid body constraints are imposed on the nuclei and only rotational and translational degrees of freedom are taken into account[9]. At low energies an enhancement in fusion cross-sections using CMD-Model is observed compared to the fusion crossections calculated using CRBD-Model. The effect of vibrational excitations is observed to be more in systems: $^{40}Ca+^{40}Ca$ and $^{40}Ca+^{48}Ca$ as compared to $^{48}Ca+^{48}Ca$.

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