Studies on nuclear reactions with stable and unstable loosely bound projectiles has gained widespread popularity in recent years because of improved experimental facilities. This has been possible because of the availability of intense beams of stable loosely bound nuclei ($^6$Li, $^7$Li and $^9$Be) as well as unstable or radioactive loosely bound nuclei ($^6$He, $^8$B, $^7$Be, etc.). Hence, in the last two decades a large number of nuclear reactions have been performed around the world with loosely bound nuclei as projectiles. Having a low breakup threshold energy, these projectiles are easily susceptible to breakup and this gives rise to many new interesting features. The theoretical side is largely unexplored and the present thesis embodies theoretical work that has been carried out on some important properties of reactions induced by loosely bound projectiles.

From the analysis of experimental fusion cross section data, the empirical values of fusion barrier parameters of a large number of reactions induced by stable loosely bound projectiles on medium and heavy targets ($^{209}$Bi, $^{152}$Sm, $^{144}$Sm, $^{208}$Pb, $^{124}$Sn, etc.) have become available. We first determine the fusion barrier parameters of thirteen number of such reactions using eight different versions of the the proximity potential. The potentials chosen are Prox 77, Prox 88, Bass 73, Bass 77, Bass 80, CW 76, BW 91 and AW 95 as earlier work had shown that these potentials are highly effective in reproducing the barrier parameters of reactions induced by tightly bound projectiles. The results of all the potentials are found to be satisfactory. However, the potentials Bass 80 and BW 91 are found to be most effective in reproducing the
height \( (V_B) \) and position \( (R_B) \) of the barrier, respectively. The parametrized formula 
\( V_B = 1.44Z_1Z_2(R_B - 0.75)/R_B^2 \) connecting \( V_B \) and \( R_B \) has also been tested for the 
above reactions, and the formula is found to be extremely effective. For the reaction
\(^6\text{Li} + ^{152}\text{Sm}\), the deviations of the barrier parameters from the empirical values is
found to be unusually large, and this is attributed to the large static deformation
\( (\beta_2 = 0.26) \) of the target \(^{152}\text{Sm}\). On application of the correction of the Coulomb
potential for the deformed target, the new values of the barrier parameters are found
to be much closer to the empirical values. Study of the nature of the potentials for
the case of deformed target reveals the emergence of distinct potential pocket for
the potentials Bass 77, Bass 80, BW 91 and AW 95 in addition to the potentials
Prox 77 and Prox 88 for which the pocket exists even for the spherical target case.

Then, fusion cross section for the reactions \(^6\text{Li} + ^{209}\text{Bi}, ^9\text{Be} + ^{208}\text{Pb}, ^7\text{Li} + ^{209}\text{Bi} \) and
\(^6\text{Li} + ^{152}\text{Sm}\) is studied using the Wong's formalism and the barrier parameters are
taken from the earlier results. The fusion cross section is also calculated from the
single barrier penetration model (SBPM) using the code CCFULL. The fusion cross
section calculated from Wong's formalism is found to be in agreement with the
SBPM cross section, and is also found to be fractionally greater than the exper­
imental cross section. The reason for the decrease of the experimental cross section
is because of projectile breakup, and this phenomenon is called fusion suppression.
Also, we find that fusion cross section calculated from Bass 80 barrier parameters
gives a much better reproduction of the SBPM cross section. For the reaction
\(^6\text{Li} + ^{152}\text{Sm}\), fusion cross section is calculated considering the cases of spherical as
well as deformed target. The fusion cross section for the case of deformed target is
in much better agreement with the results of the SBPM cross section than the case
of spherical target. This proves conclusively that deformation of nuclei has a great
role to play in fusion cross section.

The most important part of our work is the semiclassical model for the expla­
nation of fusion suppression. Technically speaking, fusion suppression is the ratio
between the experimental and the theoretical fusion cross section. The cause of fusion suppression, as noted earlier, is due to breakup of the projectile. We apply the model to the three $^6\text{Li}$ induced reactions: $^6\text{Li}+^{209}\text{Bi}$, $^6\text{Li}+^{144}\text{Sm}$ and $^6\text{Li}+^{152}\text{Sm}$. $^6\text{Li}$ has the lowest breakup threshold energy of 1.48 MeV, and easily breaks up into a deuteron and an α-particle. The experimental fusion suppression factors observed for the three reactions at energies $\approx 1.1$ to $1.5$ times the barrier energy are 0.36, 0.32 and 0.28, respectively. The basic idea of the model is to find out the cutoff impact parameter for fusion. Then the fraction of projectiles undergoing breakup within the cutoff impact parameter for fusion is determined which is then directly related to the fusion suppression factor. The cutoff impact parameter for fusion is determined by the single barrier penetration model (SBPM), as fusion cross section above the barrier can be approximated by the results of SBPM.

We apply the two-dimensional classical trajectory method for determining the fraction of projectiles undergoing breakup. From the three-body Lagrangian for the system of target and two-body projectile, the classical equations of motion are obtained. For obtaining numerical solutions, initial conditions have to be provided. For obtaining the initial conditions, we propose a semiclassical model of the $^6\text{Li}$ nucleus. The two postulates of the $^6\text{Li} \rightarrow ^4\text{He} + ^2\text{H}$ cluster model are: (a) The total energy of the deuteron and the α-particle system is equal to the breakup threshold energy (binding energy) of the $^6\text{Li}$ nucleus, and (b) The total angular momentum of rotation of the deuteron and the α-particle about an axis through its centre of mass is equal to $\sqrt{I(I+1)}\hbar$, where $I$ is the spin quantum number of the $^6\text{Li}$ nucleus. From the calculations, the distance between the deuteron and the α-particle comes out to be 2.27 fm. Using the initial conditions, numerical solutions are obtained and the trajectories are studied. Three distinct types of trajectories are obtained and these are: scattering-like, incomplete fusion and no-capture breakup. We define a breakup condition for a trajectory or projectile. If the distance of separation between the deuteron and the α-particle is greater than 2.27 fm then its
a breakup trajectory, otherwise its a nobreakup trajectory.

Taking a sample of fifty trajectories at each impact parameter, the breakup fraction is determined. Then a formula is proposed for the explanation of fusion suppression according to which fusion suppression is given by the average of breakup fractions calculated at different impact parameters. The range of impact parameters lie between a head-on collision and the cutoff impact parameter for fusion. On application of the above formula to the three $^6$Li induced systems, we find that there is excellent agreement between the experimental fusion cross section ($\sigma_{\text{exp}}$) and the calculated fusion cross section ($\sigma_{\text{cal}}$). However, for the reaction $^6$Li+$^{152}$Sm there is slight disagreement at higher energies because of deformed nature of the target $^{152}$Sm. Also, the relationship between the cutoff angular momentum for fusion ($L_c$) and energy ($E_{\text{cm}}$) is studied, and a linear relationship is established. Using the proximity potential, the linear relationship is explained.

The last part of our study concerns the reduced reaction cross section of radioactive halo projectiles. For systematic analysis of reaction cross section data, Gomes' reduction procedure is widely followed in which the dependence of the cross section on the barrier radius ($R_B$) is eliminated, and the energy is scaled with respect to the barrier height ($V_B$). Study of reduced reaction cross section ($\sigma_{\text{red}}$) versus reduced energy ($E_{\text{red}}$) for a variety of systems has revealed that separate trajectories are followed for reactions induced by tightly bound, loosely bound, and radioactive halo projectiles. Also it has been pointed out that the reason for the separation of the trajectories of loosely bound and radioactive halo systems is that the Coulomb barrier is slightly lowered, and the barrier radius is marginally increased for radioactive systems in comparison with normal loosely bound systems. The reactions considered for radioactive halo systems are, $^6$He+$^{27}$Al, $^6$He+$^{64}$Zn, $^6$He+$^{209}$Bi and $^8$B+$^{58}$Ni. The corresponding reactions induced by normal nuclei are, $^4$He+$^{27}$Al, $^4$He+$^{64}$Zn, $^4$He+$^{209}$Bi and $^{10}$B+$^{58}$Ni. Using six different versions of global nuclear potentials on the above reactions we provide an explanation for the separation of
the barrier parameters. However, for the proton halo system $^{10,8}B^{+58}Ni$, the change in the barrier parameters can only be accounted if proper radius of the halo nucleus $^8B$ and the normal nucleus $^{10}B$ is taken into account. This is because of the fact that experimentally the radius of the halo nucleus $^8B$ is found to be greater than $^{10}B$, but all the six global nuclear potentials predict a decrease in the radius of $^8B$.

The study is extended to Be-projectile induced systems, and similar conclusions are drawn. Also, using the modified Wong's formula, the total reaction cross section is explained for the reactions $^7Be^{+27}Al$ and $^6He^{+27}Al$. The modified Wong's formula is a phenomenological formula containing three dimensionless parameters whose values are chosen by the $\chi^2$ minimization technique.

There is potential future research prospect, particularly, in the semiclassical model of fusion suppression. The model of fusion suppression developed here is a two-dimensional classical trajectory model. The obvious generalization would be a three-dimensional model. It would be interesting to see whether the formula for fusion suppression proposed here for the two-dimensional model would still be applicable for the three-dimensional model. In the three-dimensional model, the orientation of the projectile is not necessarily confined to a single plane which is the case for the two-dimensional model. Finally, a fully quantum mechanical model of fusion suppression could be attempted in future even though it may be a highly challenging task. For this it would be necessary to develop a fully quantum mechanical version of the model of $^6Li$ nucleus that has been proposed here.