The primary aim of the work described in this thesis is to study the behaviour of charged particles in magnetic field with spatial variations. The work describes the experiments conducted to study the single reflection of charged particles and plasma from a magnetic mirror as well as the leakage of charged particles due to nonadiabaticity from an adiabatic trap with different magnetic field scale lengths during confinement.

The escape of particles from the mirror traps is regarded as being due to departure of the magnetic moment from adiabaticity. As a consequence of this departure, the value of the magnetic moment changes as the particle traverses certain region of the magnetic field variation. The expression for such a change has been obtained in literature. From the expressions it is seen that even for a single reflection the change in magnetic moment, $\Delta \mu$, depends on various parameters of the system. The nonadiabatic escape of particles from magnetic trap is usually explained as a consequence of the cumulative change in $\Delta \mu$, that makes the particles fall in the loss cone and escape.

In a theoretical work by Varma nonadiabatic leakage of particles have been studied and it is shown that there exist multiple e-folding times in the leakage of the particles having same energy and initial value of the magnetic moment. A literature survey of the earlier theoretical, numerical and
experimental works pertinent to the problem, described in the thesis, is done and presented in Chapter I.

With an aim to investigate the possible existence of multiple life times in the leakage of the charged particles, an experimental system was set up. The design considerations of different subsystems and their integration along with the different diagnostics used are described in Chapter II.

A single reflection experiment was conducted for a low energy electron beam at high vacuum conditions. The experiment was repeated with a simple plasma gun. Chapter III describes the experimental techniques and results obtained from the single reflection experiment. It is observed that the reflectivity of the mirror goes through a minimum, as the nonadiabaticity parameter is increased, and attains a value less than the value for an adiabatic mirror configuration. Based on the experimental observations, it is concluded that nonadiabatic mirror traps can be as effective as the adiabatic mirror trap for sufficiently high density electron beams and plasma streams.

Charged particle confinement in magnetic mirror and the life time measurements for charged particles of different energies under various different conditions are described in Chapter IV. Along with other experimental techniques, numerical analysis of the data is described in detail. The main result obtained from the sets of experiments performed is the
observation of two life times for particles with specified energy and initial magnetic moment, leaking out of the magnetic mirror. Most of the results concerning the variation of the life times with different parameters of the system can be explained with the help of the theoretical work of Varma\textsuperscript{47}.

The results obtained from the experimental works are recapitulated in Chapter V.