Summary

The phenomena of scattering of electrons by atoms have been investigated in the present thesis.

Apart from providing us with the information of the structure of the atomic system, studies of various atomic collision processes, are of paramount importance in view of their applications in Astrophysics, Plasma Physics, Atmospheric Physics etc. The recent developments of lasers have stimulated further interest along these lines. Resonances in atomic scattering phenomena also play important role in Solid-state Physics.

The present thesis consists of three chapters. In Chapter I we have attempted to give a brief review of some important works on the scattering of electrons by atoms, specially hydrogen and helium atoms, which are more or less connected to our own investigations on $\bar{e} - H$ and $\bar{e} - He$ collisions. The interesting and exciting developments of resonance phenomena in $\bar{e} - H$ scattering have been outlined at the end of the chapter.

Chapter II deals with our own work on the scattering of electron by atomic hydrogen both elastic and inelastic. It consists of three sections A, B and C. In Sections A and B we have discussed the contents of our two papers on the elastic scattering of slow electrons by hydrogen atom. We have used
Hulthen's variational method to calculate the $S$ wave phase shifts and have taken into account the polarisation effect arising out of the distortion of the target atom under the influence of the incoming electron, by means of virtual excitations to $2s$ and $2p_0$ levels. In Section A, we have neglected the exchange effect, whereas in Section B, we have made allowance for this. In both the cases we have obtained a resonance level agreeing favourably with recent experimental findings and the results of other theoretical calculations. In Section C, we have investigated $1s - 2s$ excitation of hydrogen atom by electron impact in the energy range of 13.6 ev to 54.4 ev including exchange effect and considering the distortion of the incident plane wave due to $S$ wave elastic scattering only. The results compare favourably with recent experimental findings.

Chapter III deals with elastic and inelastic scattering of electrons by helium atom. It consists of sections A, B, and C. Under Section A, we have investigated the elastic scattering of slow electrons with allowance for exchange possibility and polarisation effects. Using a two-parameter open-shell wave function for the ground state of helium, the $S$ wave phase shifts for several incident electron energies have been calculated by Hulthen's variational method. Our calculated zero energy cross section compares favourably with the recent experimental findings. In Section B, higher order
phase shifts have been computed in Born approximation. Making use of lower order phase shifts from the calculation of LaBahn and Callaway, we find that the inclusion of the higher order phase shifts considerably improves the value of the total and differential cross sections in bringing them to better agreement with the experimental results. In the intermediate energy region, we have computed higher order partial wave phase shifts in Born approximation for elastic $e$ - He collision and we have studied their effects on elastic scattering of electrons by helium atom.

In Section C, we have applied Ochkur approximation to the problem of elastic scattering of electrons by helium atom as well as excitation of 1's state to 2's state of helium atom by electron impact at several incident electron energies. Good agreement with experiment is achieved particularly at higher energy regions, in differential cross sections of electrons elastically scattered by helium atoms. For the excitation case, our calculated results, agree qualitatively in the threshold energy region, with recent experimental findings of Holt and Krotkov.

In some of our investigations on electron scattering by hydrogen and helium atoms, we have used Hulthén's variational method to calculate the phase shifts and Ochkur approximation to compute the total and differential cross sections for elastic and inelastic scattering. The variational method of Hulthén
makes it possible to obtain reasonably good results when a proper choice is made of the trial wave function, containing a number of adjustable variational parameters. Physical intuition is allowed full play in a variational method. Here we can incorporate the distortion effect in a suitable way. Moreover, this variational method helps us in encountering the menacing difficulties associated with the numerical solution of coupled integro-differential equations, arising out of exchange effect in electron-atom collision problems. Our variational formulation in $\bar{e} - H$ scattering is able to reveal the interesting feature due to the existence of a resonance level in elastic $\bar{e} - H^*$ collision. It may be expected that further refinements and modifications in our variational trial wave function in $\bar{e} - H$ scattering may bring out further details in the structure and position of resonance level. Ochkur approximation which takes into account the exchange effect is simple and yields reliably good results.