SUMMARY OF THE THESIS

ENTITLED

ELASTIC SCATTERING OF ELECTRONS FROM ATOMS AND IONS

In the subject of quantum mechanics 'Scattering theory' has been remained as distilled mechanics for the micro-particles and haves its importance in physics, biology, engineering etc. Apart from this the theory is playing a leading part in the establishment of quantum theory and has fundamental importance in the theory of atomic structure.

The elastic scattering process is one in which the internal structure of the system remains same. The elastic scattering of an electron from an atom or ion is a ubiquitous phenomenon occurring in a wide range of physical context such as in astrophysical or atmospheric environments, fusion reactors, technical plasmas used for modifying materials such as semiconductors, etc. Thus the knowledge of reliable atomic and ionic collisional cross-sections are important in the development of scientific and technical fields, which are determined by means of quantum collision theory. For exact analytical solution of a many body problem in the quantum mechanical frame work the approximate method is very important.

Our area of interest is confined to the elastic scattering of electrons by atoms and ions in high-energy region. The energy region in which the first Born approximation gives reliable results. The thesis describes elaborate investigations on elastic scattering of electrons by neutral inert gas atoms (He, Ne, Ar) and He iso-electronic targets. The first chapter is a resume of approximate methods, their mathematical background, cross sections and theoretical aspects.

Validity at high energy and simplicity of the method inspire for the work for the complex atoms. The accuracy is verified by the partial wave analysis calculations. These have created interest for the work in chapter two.

In the second chapter high-energy approximations are treated for inert gas atom targets. Electrostatic interaction between the incident charge particle and undeformed charge distribution of the atomic target is mainly considered by DHFS potential. Various approximations are applied for the superposition of Yukawa type potential. An exact evaluation DCS based on partial wave analysis for the elastic electron-atom scattering process is obtained by the code PWADIR.

The Born approximation has been applied to the elastic scattering of electrons by He, Ne and Ar atoms. The second Born term is also evaluated for these targets. The eikonal Born series (EBS) is studied using various potential fields for elastic scattering of electrons. The EBS approach is also taken up with the scattering amplitude consisting of first Born term, second Born term and Wallace second order correction term. The DCS are calculated over different angles and incident energies. Further a simple treatment, the Das technique, which is effective for including contributions of higher order Born terms is applied. As well as the modified approach in the Das method is also carried out. The partial wave analysis is performed to evaluate exact numerical results. Finally DCS results from the different methods are compared with the exact results.

EBS method is applied well for heavy targets and higher energies. Applicability of the Das technique is justified. The theoretical results do not support the measurement of strong forward peak as given by GML. As energy increases EBS results matched with the exact results.

The recent absolute measurements of elastic scattering of electrons from ion by I.D.Williams et al gives the theoretical interest for the work. Similarly certain experiments require the knowledge of the elastic scattering cross as well as usefulness of the data for modeling plasma environments are the recent interesting factors for this work on electron-ion elastic scattering.

In the third chapter for the case of He and He like +ve ions, direct interaction is obtained using Roothaan-Hartree-Fock wave functions. The average excitation energy playing an important role in real part of the second Born term is valuated from atomic dipole polarizibility and Hartree-Fock wave functions. The effect of exchange is also included according Ochkur approximation to maintain the order (k_i^{-2}). The DCS obtained with the first and second Born terms are compared with the other theoretical and experimental data in the case of He atom.

In this chapter a systematic development of HHOB theory is carried out for He iso-electronic series to evaluate DCS correct up to the order k_i^{-2}., The second Born term is evaluated through the HHOB approximation for the He atom first. Than the same is extended for He-like +ve ions $(Li^{+}, Be^{+2}, B^{+3}, C^{+4})$. The use of traditional FORTRAN programming language is very difficult for these calculations, where complex calculations including integrations as well as partial derivatives of higher order are involved. So the better higher-level language 'Turbo C' has been employed for the calculation of scattering amplitude. For maintaining the accuracy in calculations of partial wave derivatives, involved in scattering amplitude formula, 'Mathematica' software as an advanced tool is used. An attempt has been made to develop Mathematica code for the application of HHOB approximation to He iso-electronic series.

Various methods for finding scattering amplitudes, derivation of their closed form depends on the approximations, evaluation of DCS with different numerical techniques and finally the use of advanced programming language explained with the program structure and code provides a good simplified back ground for basic academic interest.

Finally in the last chapter conclusions are drawn from the recent theoretical calculations on the basis of present understanding of the subject. Fruitful application of the work to other problems as well as systematic extension of the present theoretical work is pointed out for the future work.