## PREFACE

This thesis describes the experimental study of different aspects of fast electron and ion collisions with atoms, small molecules and large biomolecules alongwith certain theoretical models. In the first part an electron beam gun was used to carry out e-impact ionization studies of molecules for impact energies between 2 and 8 keV. The beamline was optimized for this experiment. In the second part the highly charged heavy ions were used for such collision experiment which were obtained from two different accelerators. The high energy i.e. 40-66 MeV ions were obtained from the 14 MV Pelletron accelerator and the hundreds of keV energy ions were extracted from the 14.5 GHz electron cyclotron resonance ion-accelerator at TIFR, Mumbai. All the experiments were carried out using ejected electron spectroscopy technique involving hemispherical electrostatic analyzer, high vacuum scattering chamber, vapor sources of biomolecules. The Young type interference effect from the ejected electron spectrum for multi electronic diatomic molecules, $N_2$ and $O_2$ under fast electron impact were investigated in the present experiments. A clear signature of the interference oscillation was observed for both the molecules, which helped to settle the issue of apparently conflicting results obtained from the photo ionization and heavy-ion impact ionization. It was shown that the DDCS ratio i.e. the ratio of double differential cross section for molecular -to- atomic target clearly indicate the oscillations for each emission angle. In addition the forward-backward-asymmetry provided unambiguous evidence of the interference mechanism. The signature of second order interference was also seen through a oscillatory structure with double frequency in the asymmetry parameter. The angular dependence of the frequency of oscillation under electron impact showed marked difference from that for heavy ion induced ionization. In addition, detailed measurements of the double differential (DDCS), single differential (SDCS) and total ionization cross sections (TCS) for e-impact ionization of $N_2$ are studied over the incident energy range of 3 -to- 8 keV.

In order to study the collision dynamics at keV and MeV energy range three different atomic and molecular targets were used. We have measured the absolute DDCS of the electrons emitted from an atomic target He and two molecular targets $CH_4$ and $O_2$ when ionized by 200-keV/u protons. Double differential cross-section measurements have also been carried out for $O_2$ in collisions with 5.5-MeV/u bare C ions. These two projectiles were chosen such that the perturbation strengths for both projectiles were nearly the same. The angular distribution shows a distinctly different character for the two different projectiles. From the study of the angular asymmetry parameter it was found the the perturbation strength $q/v$ (charge state/ velocity of projectile) alone cannot characterize completely the asymmetry and two-center effect.

We have further investigated the ion impact ionization of uracil, a nucleobase of RNA as well as bromouracil. The double differential cross section for electron emission from uracil and bromouracil were measured in case of 42 and 66 MeV $C^{6+}$ ions obtained from the 14 MV Pelletron accelerator. Heated oven was used to get fine effusive jet of uracil or bromouracil vapor target. This study was further extended for 200 keV proton impact using the ECRIA (electron cyclotron resonance ion-accelerator) at TIFR, Mumbai. The details of the energy and angular distribution of the electron DDCS for uracil and bromouracil target were studied for wide angular range. The KLL-Auger electron technique was used for absolute normalization. Apart from obtaining the absolute double differential cross sections (DDCS), we have further deduced the enhancement in electron emission from bromouracil compared to that for uracil. A substantial enhancement has been obtained which makes it a possible candidate to provide the radiobiological sensitivity. All the e-DDCS measurements are compared with different state-of-the-art theoretical models. In case of fast ion impact ionization, the measured quantities are compared with the CDW-EIS (continuum distorted wave - eikonal initial state) model. Similarly, for electron impact ionization, the experimental results were compared with the CB1 (first Born approximation with correct boundary conditions) and the CTMC (classical trajectory Monte Carlo) models. The CTMC model provided best agreement to the experimental data. We have also carried out calculations using the CSP-ic (complex scattering potential - ionization contribution) approximation for deducing the total ionization cross section in case of electron impact ionization. The DDCS for electron emission from uracil as well as bromouracil was well reproduced by the CDW-EIS model qualitatively while the ratio could not be well addressed by this model. It turns out that to explain the substantial enhancement in the bromouracil/uracil e-emission ratio, one may need to include the different contributions such as the Auger cascade and giant dipole resonance processes.