Electron-ion coincidence set-up for large molecule spectroscopy

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Synopsis Electron impact ionization (e, 2e) with secondary electron-ion coincidence measurement is used to study the structure and dynamics of large molecules. The instrumentation as well as technique is described. Xenon high energy auger process is studied for calibration of the system. From our ToF mass spectrum, we have observed that the yields of multiply charged Xenon ions vary according to auger process. Furthermore, from the position spectra of Xe at 520 eV, an angular anisotrpy in the auger electron emission can be observed.

Charged particle or photon interaction with large molecules can help us to elucidate their structural and dynamical properties. It is interesting to understand the stability of large molecules like polycyclic aromatic hydrocarbons (PAHs)in the interstellar medium under abundance of charged particle and photon interaction. Plasmon excitation plays a great role in the stability of large molecules in these environment [1]. Electron impact ionization (e, 2e) with secondary electron-ion coincidence measurement is a useful tool to probe the survival of these molecules by studying the structural changes. The electron-ion coincidence set-up developed at IIST, Thiruvananthapuram consists of an electron gun (E-gun), produces a beam of electron which interacts with the gaseous molecular sample (injected to the system perpendicular to the electron beam direction). We use a high efficiency cylindrical mirror analyzer (CMA) [2] for secondary electron energy measurement. Furthermore this is coupled to a linear [3] or reflectron time-of-flight mass spectrometer (ToFMS) to probe the molecular ions. By using this system (CMA in unison with ToFMS) direct impact ionization process (single particle process) from auto ionization / collective excitation can be separated in large molecules. This experimental set-up has been developed by optimizing the geometrical/experimental parameters and designed using SIMION8.0 and SOLIDWORKS packages respectively. High voltage MOSFET switches (HVMS) and Arduino have been utilized for pulsing and data acquisition.

The auger process of Xenon has been utilized to calibrate our system. The high energy electron from this process has been chosen as the background electrons can interfere with low energy auger electrons. It has been observed that at 520 eV of secondary electron from Xe, a significant enhancement in the intensity as compared to the energies nearby. As a preliminary study, the position information of these secondary electrons (at 520 eV) is shown in fig.1. An anistropy in the angular distribution of these electron can be observed, thus from this experimental setup one can gain information not only about the energetics of the secondary electrons but also their angular distribution. From our ToF mass spectrum, we have observed that the yields of multiply charged Xenon ions vary according to auger process. Furthermore, when CMA and ToFMS is used in unison we gain insights regarding the dissociation dynamics, preferred channels of dissociation when a secondary electron of specific energy is emitted. Study of correlation between secondary electron emission and fragmentation dynamics in large molecules is under progress.

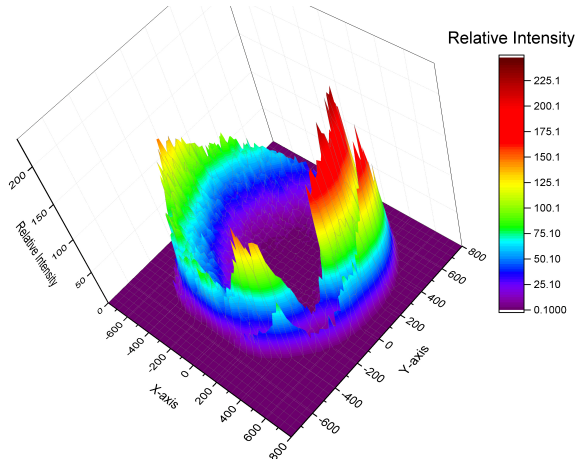

Figure 1. Position image of Xenon $M_{4,5}N_{4,5}N_{4,5}$ auger using CMA at 2 keV electron impact

References

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