Electron emission, fragmentation, and plasmon excitation in PAHs by high-perturbation collisions

C Bagdia[1,2 *]

[1]Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai, 400005, India.
[2]Current affiliation- James R. Macdonald Laboratory, Kansas State University, Manhattam, Kansas, 66502, USA.

Synopsis The strong electon-electron correlation in PAH molecules resulting in giant plasmon resonance is excited effectively by high-perturbation collisions. It has been observed as a characteristic peak in the double differential cross section of electron emission spectrum.

The polycyclic aromatic hydrocarbons (PAH) are established to be present in the interstellar medium [1-2] and have attracted a lot of attention in the last few decades. The PAHs are in general planar molecules having delocalized π-electron cloud that can oscillate collectively upon external perturbation. The collective excitation are also known as giant plasmon resonance (GPR), which results from strong e^--e^- correlations. We studied the absolute double differential cross section (DDCS) of electron emission using electron spectroscopy as well as the ratio of double-to-single ionization (DI-to-SI) by using TOF-RIMS techniques in collisions with highly charged ions (HCI).

The GPR primarily decays via electron emission. However, observation of the GPR in the e-emission channel is challenging due to the presence of large Coulomb ionization background of low-energy electrons. A novel idea is demonstrated of using the highly charged ions to create large perturbation strength in order to excite the plasmons effectively. For the first time, the GPR in a PAH molecule has been observed as a characteristic peak in the DDCS of electron emission [Fig. 1] and its angular distribution has been studied [3-4].

We also studied the fragmentation of PAH molecule using the TOF spectroscopy. The electron correlation effects manifests in the double ionization (DI) process. The DI-to-SI ratios for PAHs upon HCI impact have been found to be substantially large as compared to the atoms and smaller gas molecules such as CH_4 [5]. The detailed projectile charge (q_p) and velocity (v_p) dependence of the ratio has been studied for three different PAH molecules. The influence of GPR in these PAH molecules resulting from the strong e^--e^- correlations has been shown by modeling the q_p and v_p dependence of the ratio.

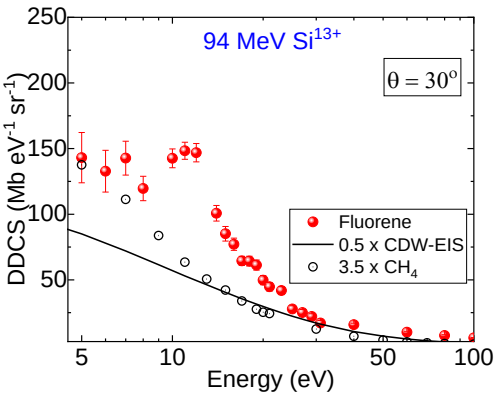

Figure 1. DDCS of e-emission from fluorene and CH_4 at 30° in collisions with 94 MeV Si^{13+} ion impact.

The detailed results of the e-emission, as well as the DI-to-SI ratio will be presented.

References

[1] Tielens A G G M 2008 *Annu. Rev. Astron. Astrophys.* **46** 289
[2] Tielens A G G M 2013 *Rev. Mod. Phys.* **85** 1021
[3] Bagdia C et al. 2021 *Phys. Rev. A (Lett.)* **104** L060802
[4] Bagdia C et al. 2021 *J. Phys. B: At. Mol. Opt. Phys.* **54** 155202
[5] Bagdia C et al. 2021 *Eur. Phys. J. D* **75** 37

* E-mail: chandanbagdia@gmail.com