Photoelectron imaging of interstellar medium anions

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Synopsis A state-of-the-art photoelectron spectroscopy (PES) experimental setup is designed and built to study the structure and dynamics of interstellar medium anions, in particular polyaromatic hydrocarbon chain (PAH) anions.

Study of fundamental processes like photoionization, photodetachment, photodissociation, electronic excitation, and electron attachment, help us to understand the structure and dynamics of interstellar medium (ISM) anions, including clusters. Studies on anions are of paramount importance as they are the best-suitable systems to study the role of electron correlations.

Towards this study, a state-of-the-art photoelectron spectroscopy (PES) experimental setup is newly designed and constructed in our laboratory. This setup will be employed to probe the electronic structure of molecules (particularly, PAHs), which are proposed constituents of ISM. The constituents will then be identified by comparing our results with diffuse interstellar bands (DIBs), obtained by very high-resolution astronomical telescopes.

The experimental setup consists of a pulsed supersonic expansion discharge ion-source (one includes a solenoid valve and the other consists of piezo valve) [1] and is coupled with Wiley-McLaren type [2] time-of-flight (TOF) mass spectrometer, for mass selecting the desired anions. This source produces cold ions and thus helps in minimizing the spectral congestion. We have also constructed cold-cathode plasma source for the production of negative ions. TOF spectra obtained from our newly constructed experimental setup are presented in Fig. 1 and Fig. 2.

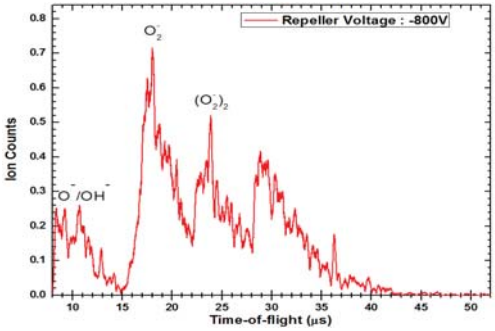

Figure 1. TOF spectra for the precursor, oxygen, is presented. In this case, we have used pulsed supersonic discharge ion source (solenoid valve). Supersonic expansion through 150μm nozzle has yielded cluster anion.

The mass-selected negative ions are photodetached using a Nd: YAG laser. The photoelectron kinetic energy released and angular distributions are simultaneously measured using a home-built velocity-map imaging (VMI) [3-5] spectrometer. For a given anion, the photoelectron angular distributions will be characteristic of the electronic state, from which they are photodetached. Our results on molecular oxygen anion (O_2^-) clusters [6, 7] and SF_6^-, will be presented in comparison with the reported experimental and theoretical data.

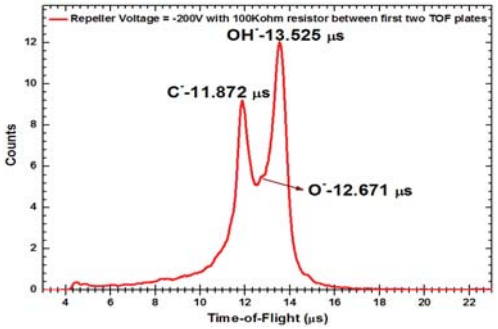

Figure 2. TOF spectra with air as the discharge medium. In this case, we have used cold-cathode plasma source. Unlike the supersonic source, this source does not yield cluster anions.

References

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