Development of the Time-Resolved Electron Momentum Spectroscopy Apparatus in Hefei

Yaguo Tang, Xu Shan, Zhaohui Liu, Shanshan Niu, Enliang Wang, and Xiangjun Chen [1]

Hefei National Laboratory for Physical Sciences at the Microscale (HFNL) and Department of modern physics, University of Science and Technology of China (USTC), Hefei, 230026, P. R. China

Synopsis We report the recent development of our time-resolved electron momentum spectrometer.

The understanding of the structures and the dynamics of molecular excited states are significant due to its unique properties and potential applications [1]. When a molecule is excited, it may undergo a variety of processes, such as dissociation, radiative and non-radiative transitions and so on. On the other hand, the properties of excited molecules, say, reaction rates, are quite different from the ground state. The employment of the pump-probe technique has led to many wonderful types of experiments on the investigation of the nature of molecular excited states, exhibiting extensive application in chemical physics and material science. However, the direct observation of the electron density distributions and its evolution in the exited states of molecules are still challenging, which will present more direct information on molecular excited states.

Electron momentum spectroscopy (EMS) [2] is a technique based on high energy electron impact (e, 2e) reaction under the Bethe ridge conditions, which is well-known for its unique ability in directly "imaging" electron momentum distributions for individual orbitals for several decades. The combination of EMS and laser pulses in the pump-probe scheme can help people image molecular orbitals in the excited states directly in principle. Fully maximizing the potential of the angle and energy dispersive multichannel technique, the sensitivity of the EMS apparatus has been improved greatly [3, 4], making it possible for researcher to conduct measurement on short-lived electronic excited states when combining ultraviolet laser pulses [5].

A new time-resolved EMS (TRMS) apparatus (Figure 1) has been built in our group for visualizing molecular excited state dynamics. In our design, molecules are pumped by ultraviolet laser pulses produced by the ultrafast laser system. The energy and time resolution of the pump laser can be 160 uJ@260 nm and 1.4 ps at a repetition frequency of 5 kHz. After adjustable time delay, the pulsed electron beam is generated by deflection chopping synchronously. The time resolution of the electron pulse is sacrificed to be nanosecond at first to improve the intensity of the beam current in order to reduce the large statistical error of TREMS results. The molecules in the excited states are detected through the measured binding energy spectra and electron momentum distributions. The detailed results will be shown on the poster.

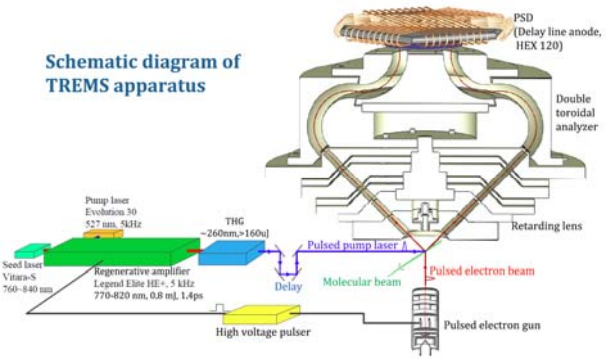

Figure 1. Schematic diagram of TREMS apparatus in our group

References

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[1] E-mail: xjun@ustc.edu.cn