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Kinematically complete experiment for ionization-excitation of helium

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Synopsis We present a newly built reaction microscope for electron induced ionization-excitation of helium. Kinematically complete measurement with 2p state excitation is achieved by detecting the radiated photon, one electron and the He^+ ion in the final state in triple coincidence. Near threshold behavior of the ionization-excitation to 2p state is investigated.

Electron induced ionization-excitation (IE) of helium is a basic four-body Coulomb problem in which all the four charged particles are actively involved. It is much more challenging to both experiment and theory compared to direct ionization with the residual He^+ ion in the ground state. The 2s or 2p separated TDCS data, especially at low incident energy range where the high order effects are expected to play a significant role, would offer the most stringent test to theoretical models. However, only one experiment at high incident energy achieved the TDCSs for 2p state till now due to the small cross section and the low detection efficiency for multi-coincidence events [1].

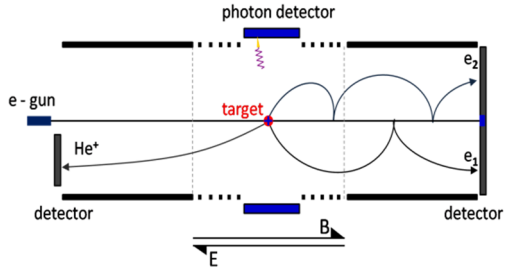

Figure 1. Schematic view of the setup.

Kinematically complete measurement for IE process of helium at low energy is achieved with our newly built reaction microscope. The (e, 2e) reaction microscope is equipped with two multi-channel plate photon detectors (Figure 1). The two electrons, the recoil ion and the photon in the radiative decay from np to 1s state in the final state are recorded either in the (2e+ion) or in the (γ+e+ion) triple coincidence mode. In the (γ+e+ion) case, IE to np state is well isolated from the ns state by the photon signal from decay of np state.

Figure 2 is the timing spectrum of the (γ+e+ion) triple coincidence events, where the IE events to np states could be well separated.

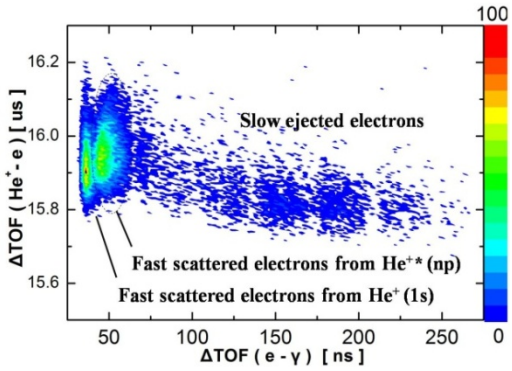

Figure 2. 2D plots for γ+e+ion triple coincidence events versus the time of flight differences ΔTOF(e-γ) and ΔTOF(He^+-e), the incident energy is 150 eV.

We also decreased the incident energy to several eV above the threshold to examine the near-threshold behaviors of IE to 2p process. As predicted by the famous Wannier model [2, 3], the back-to-back pattern of the two outgoing electrons is a key feature for ionization close to the threshold. It is interesting to examine whether the strong correlation from the bound-to-2p electron would disturb the emitting pattern of the two outgoing electrons in the IE process. Our preliminary result shows that there is a pronounced distribution beside the back-to-back pattern, which indicates that the strong enrollment of the 2p electron dramatically influences the behavior of the outgoing electrons.

Detailed discussion for the IE to 2p state in the threshold regime will be presented at the conference.

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References

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