

4 - 10 Classical-trajectory Monte Carlo method for the Investigation of the Dynamics of Ion-atom Collisions*

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The reaction microscope (COLTRIMS as well) is a novel technique for the investigation of the dynamics of ion-atoms collisions. Exploiting this technique, a large variety of kinematically complete experiments on electron transfer and ionization have been performed. However, the understanding of these experimental results is far from satisfactory, especially for collision energy in the intermediate-energy range. The classical-trajectory Monte Carlo method (CTMC) proposed by Abrines and Percival^[1] shed some light on the problem. This method has a demonstrated region of applicability in the intermediate-energy range.

We developed a three-body version of CTMC method followed the procedure provided by Olson et al.^[2] As a check of our CTMC computer code, we repeated the total cross section calculations for the single ionization, free-electron production, single capture and double ionization in collisions of protons with He atoms. Our results agree well with those of Reinhold and Falcon^[3].

The CTMC code was then used to investigate the dynamics of the transfer ionization process in collisions of protons with He atoms. The calculations using the CTMC code were compared with our experimental data (Fig. 1). We found that the measured electron momentum spectrum and the calculated spectrum for single ionization are qualitatively quite similar. This comparison indicates that the transfer ionization reaction proceeds in a two-step process of ionization plus capture and the electron correlation effects are minor in this reaction channel. Thus our results suggest that the CTMC method is ideally suited for the investigation of the dynamics of ion-atom collisions.

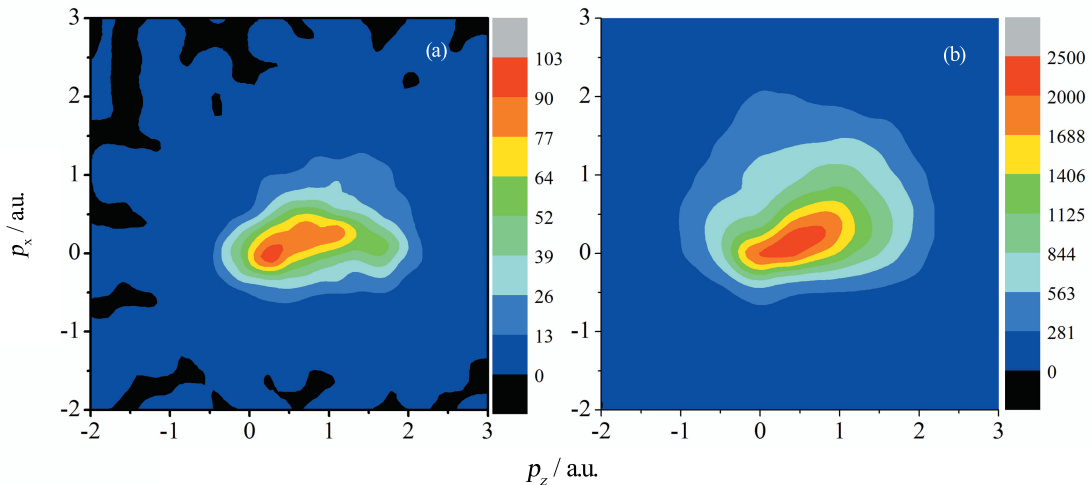


Fig. 1 (color online) The electron momentum projected onto the scattering plane.
(a) CTMC results. (b) Experimental data.

The CTMC method is one of the most promised methods to interpret and understand the experimental results. Extensive theoretical investigations employing the CTMC code are desirable to clarify the role of electron-electron correlations and the dynamics for the intermediate-energy ion-atom collisions.

References

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