TWO-DIMENSIONAL ELECTRON MOMENTUM SPACTRA OF ATOMS IONIZED BY SHORT INTENSE LASERS

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When atoms are exposed to an intense short laser pulse, the ejection of the electrons can be conveniently distinguished into two regions by using the Keldysh parameter, γ. If $\gamma > 1$, *i.e.*, in the multiphoton ionization regime, the liberation of the electron is understood to proceed through the absorption of many photons, leading to the above-threshold ionization (ATI) peaks in the electron spectra. In this region, the energy spectra and the angular distributions are often dominated by complex structures due to the Freeman resonances. Many experimental electron spectra, in particular, of rare gas atoms, have been carefully studied and examined theoretically. At higher laser intensities, when $\gamma < 1$, tunneling ionization becomes dominant. Recently two dimensional electron momentum spectra in the small- γ region has been investigated experimentally, but existing theoretical electron spectra for ionization in the tunneling region have not been directly compared to measurements. In the small-γ region, the ionization rate is very large; thus the depletion effect should be considered. Experimentally measured spectra can be compared to theoretical calculations only after the latter have been integrated over the laser focus volume of the gas jet. This means that the electron spectra have to be calculated at many intensities using very small incremental steps. In this work we carried out such studies in view of the recent detailed high-resolution electron spectra.

The ejected electron momentum spectra for each fixed peak intensity are calculated from solving the time-dependent Schrödinger equation in the single active electron approximation. For a peak intensity I_0, the electron signal with momentum **p** is given by

$$S(\mathrm{p}, I_0) \propto \int_0^{I_0} P_I(\mathrm{p}) \left(-\frac{\partial V}{\partial I} \right) dI$$

where $P_I(\mathbf{p})$ is the ionization probability for a particular intensity of I and $-\partial V/\partial I dI$ represents the volume element for having the intensity between I and $I+dI$. We assume the spatial distribution of the laser intensity is Lorentzian in the propagation direction and Gaussian in the transverse direction. The computational methods are summarized in Ref. [1].

In Fig. 1, we show an example of the comparison of our results with the experimental data by Maharjan *et al.*[2]. The agreement between the theory and experiment looks quite reasonable. We also analyzed differential intensity dependence of the ionization yield multiplied by the volume element, and found that the most contributions come from $\sim 2\times 10^{14}$ W/cm^2, corresponding to $\gamma \sim 1$.

Further details of the analysis including fan-like structure in the spectra as well as the high energy regime of the momentum spectra will be presented at the conference.

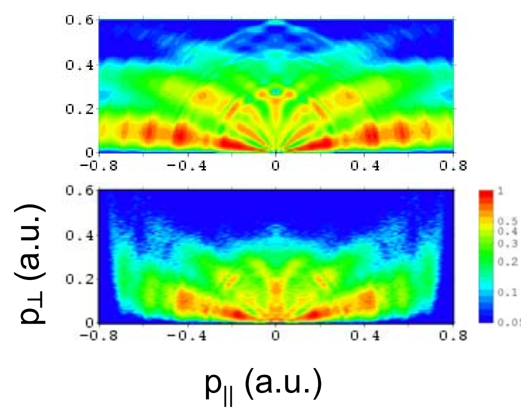

Fig. 1 Comparison of theoretical (top) and experimental (bottom) electron momentum distributions of Ar by 640 nm, 40 fs laser pulse with peak intensity of 8.2×10^{14} W/cm^2.

References

[1] T. Morishita *et al.*, Phys. Rev. A **75**, 023407 (2007).
[2] C. M. Maharjan *et al.*, J. Phys. B **39**, 1955 (2006).