Mechanisms of near-threshold harmonic generation in atoms

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Synopsis Low-order harmonics near the ionization threshold of atoms have been less explored, partially because the spectrum in this region is more complicated from both the theoretical and experimental point of view. Very recently, these harmonics have attracted a lot of experimental and theoretical studies due to their potential applications in VUV regime. In this contribution, we will report our recent progress in the theoretical explorations of these harmonics. We will discuss the great influences of the Coulomb potential and atomic excited states.

Harmonic generation in the plateau and cutoff region have been successfully explained by the three step model, where the Coulomb potential and excited states can be essentially neglected. However, things will be different for the harmonics near or below the ionization threshold [1-2]. On one hand, these harmonics corresponds to the returning electrons with rather low energies, thus the Coulomb potential may easily change their dynamics [3]. For example, multiple return trajectories can play a vital role and impact can be shown on the spectra (see **Fig. 1**). On the other hand, below the ionization threshold, there exist many lower excited or higher Rydberg states, the returning electrons may be temporarily trapped in these states. Depending on different states, they will have drastically different effects on the near-threshold harmonics [4], e.g., resonant enhancement of the harmonic yield, leading to the atomic line emissions or dephasing of the electronic trajectories (see **Fig. 2**). One can also find a relationship between the below-threshold harmonic generation and the frustrated tunneling ionization [5] (see **Fig. 3**).

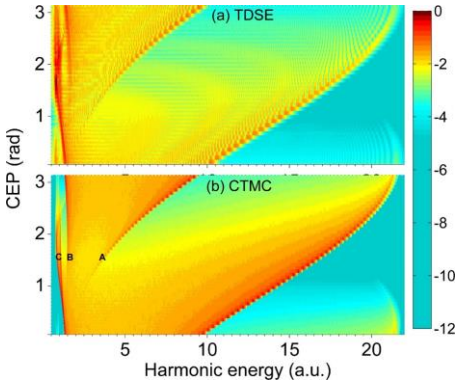

Figure 1. HHG of He for a few-cycle pulse. One can identify the low- and high-energy half-cycle cutoff.

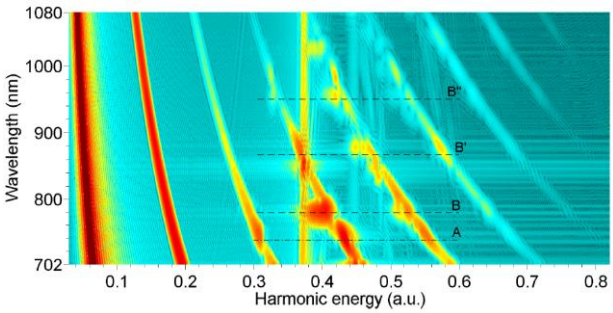

Figure 2. Complicated resonance structures and atomic line transitions in near-threshold harmonics.

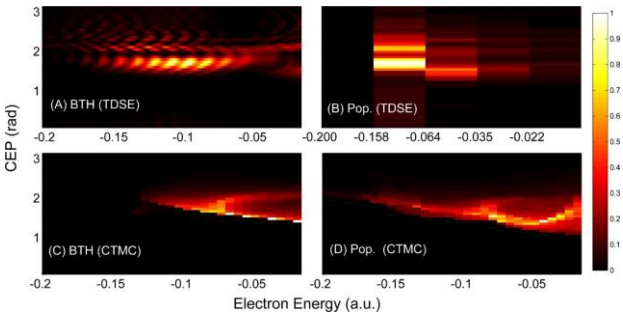

Figure 3. Carrier envelope phase dependence of below-threshold harmonics and frustrated tunneling ionization. They share lots of similarities.

References

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