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Theoretical study of the macroscopic characters of the gas medium affecting the generation of attosecond pulses[‡]

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Synopsis This research is to study how the attosecond pulse trains be affected by the pressure and thickness of the gas medium.

The production of sub-femtosecond pulses of extreme ultraviolet (XUV) radiation has opened up a new area of attosecond physics [1]. The attosecond pulse should be intense enough to induce the other nonlinear phenomena. To improve the intensity (or photon flux) of attosecond pulse, one way is to control the laser field itself by adding a chirp to a single-color laser or mixing the different colors, another one is to optimize the macroscopic conditions, such as adjusting the relative position of gas jet with the laser focus, varying the gas pressure, changing the thickness of the gas jet, and so on.

In this work, we analyze how the thickness and pressure of the gas jet affect the generation of attosecond pulse trains (APTs). We have adopted the theoretical methods in Ref.[2]. We study the APTs' intensity varying with the pressure and thickness of the gas jet shown in figure 1. For each fixed thickness, the intensity curve of the APTs goes up with increasing the gas pressure when the pressure is relatively low, once it reaches its maximum value at some pressures, it starts to decrease with increasing the gas pressure. On the other hand, if the gas pressure is fixed, the intensity of the APTs does not necessarily increase with increasing the thickness. We also extract the width of APTs which is shown in figure 2. It is shown that for most of the gas thickness, the width of the APTs goes down with increasing the gas. This is not valid for the gas jet equaling to 1 mm only. However, it shows a minimum (i.e. an optimal thickness) when the width varies with the gas thickness for a fixed gas pressure.

Our study indicates that the intensity of APTs doesn't necessarily increases when the pressure or the thickness increases solely. However, the width of the APTs decreases with increasing the pressure at low laser intensity. In the future, to improve the intensity and bandwidth of APTs, the gas pressure and thickness can be optimized simultaneously with the well-established macroscopic propagation model.

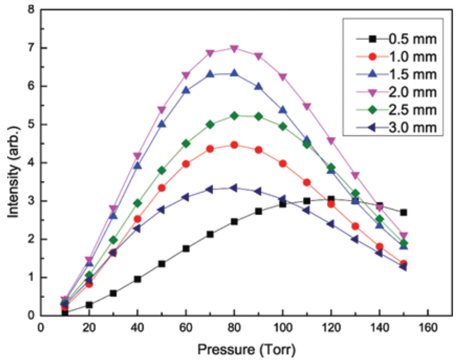

Figure 1. The intensity of APTs varies with gas jet thickness and pressure.

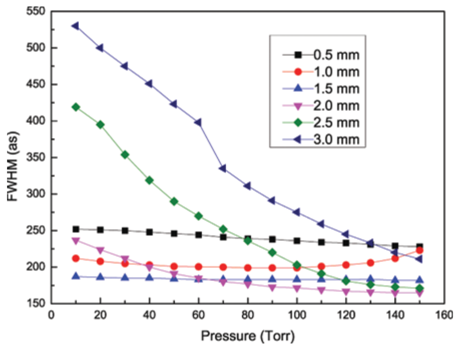

Figure 2. The width of the APTs varies with gas jet thickness and pressure.

References

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