8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

Intense attosecond pulse generation from a plasma mirror

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When a powerful laser field interacts with a dense material, it can create a thin plasma known as a plasma mirror. High harmonic generation (HHG) from the plasma mirror has shown promise in producing intense attosecond pulses in the extreme ultraviolet (EUV) and X-ray wavelengths. However, a significant challenge in exploring HHG from a plasma mirror is the damage of the target, which has limited experiments to low repetition rates.

This study demonstrates successful HHG from a liquid plasma mirror in both the coherent wake emission (CWE) and relativistic oscillating mirror (ROM) regimes. The liquid flat jet was made by colliding two liquid jets as shown in Fig. 1. We obtained CWE harmonic radiations continuously at a repetition rate of 1 kHz by using a liquid flat-jet. In the 1-kHz CWE experiments, we used a Ti:sapphire laser system (Femtopower X CEP, 10 mJ, 30 fs, 800 nm, 1 kHz) [1]. The temporal contrast of the output laser pulse was 10^6 at 4 ps before the main pulse, which was measure by tunnelling ionization with a perturbation for the time-domain observation of an electric field (TIPTOE) [2]. We were able to observe the structure of the CWE harmonics for various laser parameters, including polarization, ellipticity, dispersion and energy.

We also demonstrated HHG from the liquid plasma mirror in the ROM regime using a 150-TW-laser with a pulse energy of 5J. High harmonic radiations were obtained with energies of ~mJ or even higher. These estimations indicate that the liquid plasma mirror is a promising light source for the generation of intense, high-repetition-rate attosecond pulses. Consequently, the results of this study will significantly extend the applicable areas of HHG from a plasma mirror, including time-resolved pump-probe studies and attosecond streaking experiments.

This work was supported by the Institute for Basic Science (IBSR012-D1) and by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MIST) (No. 2022R1A2C3006025) and (No. RS-2023-00218180).

References

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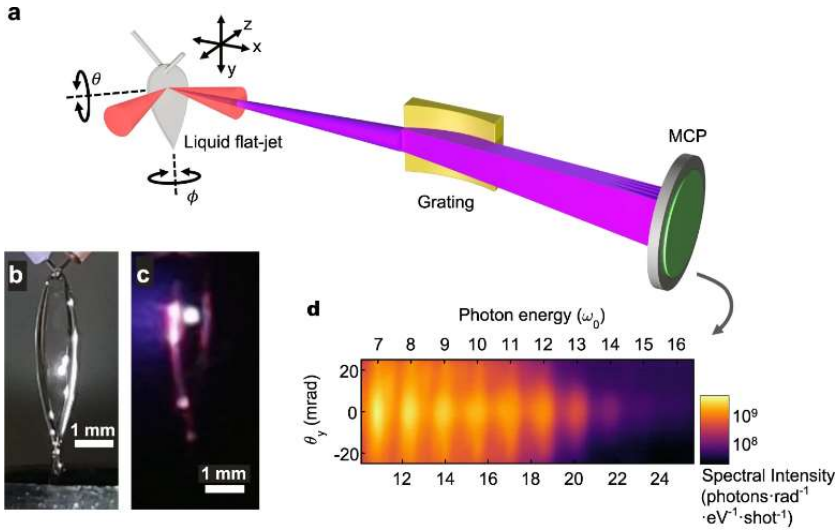

Fig. 1 High harmonic generation from a liquid plasma mirror. (a) HHG experiment setup using a liquid plasma mirror. (b) Liquid flat jet. (d) Interaction of a laser field and a liquid target. (d) Coherent wake emission HHG spectrum observed in the experiment.