Journal of Physics: Conference Series

PAPER • **OPEN ACCESS**

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To cite this article: I R Khairulin *et al* 2020 *J. Phys.: Conf. Ser.* **1412** 092012

Generation of attosecond pulses in "water window" range by a plasma-based X-ray laser

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Synopsis We suggest a technique to generate a train of attosecond pulses in "water window" range by hydrogen-like C^{5+} plasma-based X-ray laser with two sequentical active plasma channels irradiated by two different optical laser fields with orthogonal polarizations. We show also the possibility to transform the radiation of a plasma-based X-ray laser dressed by an optical laser field into a train of attosecond pulses in a resonant absorber irradiated by the different optical field.

Plasma-based X-ray lasers are unique laboratory sources of short-wavelength coherent radiation with a relatively high pulse energy [1], which is typically much greater than that attainable via high-harmonic generation of an optical radiation. However, picosecond duration of the pulses produced by X-ray lasers prevents their application for study of the ultrafast processes unfolding on femto- and attosecond time scales.

Recently, we have shown that modulation of active medium of a hydrogen-like plasma-based X-ray laser by a strong linearly polarized optical laser field allows to transform a quasimonochromatic seeding X-ray field of the same linear polarization into a train of attosecond pulses [2]. The transformation occurs due to spectral broadening of the amplified X-ray field during its propagation through the medium, caused by sub-optical-laser-cycle modulation of frequency of the inverted transition by the optical field via the linear Stark effect.

In this contribution, we show that generation of the attosecond pulses can be implemented without using the seeding field. Instead, the active medium of the X-ray laser should be split into two parts, irradiated by the two different optical fields with mutially orthogonal polarizations. The first part of the active medium serves as a source of the linearly polarized seeding field, while the second part transforms it into an attosecond pulse train. Another option for the attosecond pulse formation is to replace the second part of the active medium by a resonant absorber dressed by an optical laser field. Our analytical and numerical results show the possibility to produce trains of attosecond pulses within "water window" range ($\lambda = 3.4$ nm) by C^{5+} plasma-based X-ray laser, see Fig. 1.

This work was partially supported by the Ministry of Education and Science of the Russian Federation under contract No.14.W03.31.0032 executed at the Institute of Applied Physics of the Russian Academy of Sciences.

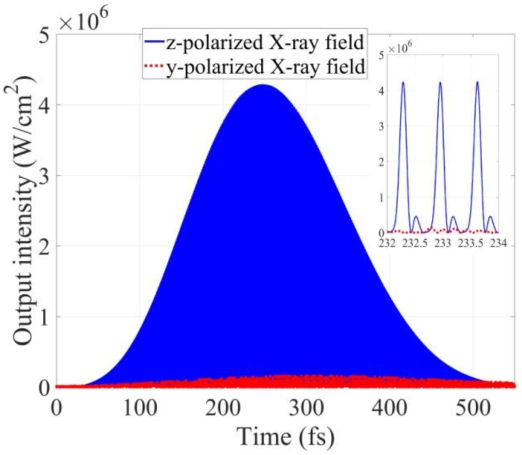

Figure 1. An X-ray field generated by a plasma-based X-ray laser after its transformation into a train of attosecond pulses in a resonant absorber dressed by an optical laser field.

References

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