XUV Rectification Effect in the IR-Dressed Medium

A V Flegel[1,2] and M V Frolov[1,2]

[1] *Department of Physics, Voronezh State University, 394018, Voronezh, Russia*
[2] *Department of Radiophysics, Lobachevsky State University of Nizhny Novgorod, Nizhny Novgorod, Russia*
Contact Email: flegel@cs.vsu.ru

The optical rectification effect is one of the well-known phenomena in nonlinear optics [1], which consists in inducing of the quasi-static dipole moment (QSDM) in a target system. Since the optical rectification is forbidden in the dipole approximation for centrally symmetric systems, this effect has not drawn too much attention to atomic targets. In this work we show that QSDM can be induced in an atomic system jointly interacting with a short XUV and intense IR laser pulses. We emphasize that the realization of the proposed XUV rectification effect is possible in the dipole approximation.

Our main result consists in the following analytic expression for QSDM $d(t)$

$$d(t) = \frac{F_{\mathrm{XUV}}^2}{4} f_{\mathrm{XUV}}^2(t-\tau) \frac{\partial \alpha(\omega_{\mathrm{XUV}}, \mathcal{F}_t)}{\partial \mathcal{F}_t},$$

where F_{XUV}, f_{XUV}, and ω_{XUV} are the peak strength, envelope, and carrier frequency of the XUV pulse respectively; τ is the time delay between XUV and IR pulses, and α is the dynamic polarizability of an atomic system in DC field with the strength $\mathcal{F}_t$ equal to the instantaneous IR-field strength, $\mathcal{F}_t = F_{\mathrm{IR}}(t)$. For XUV-photon energy exceeding the ionization potential, the atomic polarizability has the imaginary part indicating a dissipative process through the one-photon ionization. The real and imaginary parts of complex QSDM represent respectively the polarization of an atomic target and the total current at the near zero frequencies. We illustrate the XUV rectification effect within the δ-potential model, for which the analytic expression for α is known [2]. The short duration of QSDM and its IR-controllable direction make possible to use the XUV rectification effect for ultrafast optical gating.

References

[1] J A Armstrong, N Bloembergen, J Ducuing and P S Pershan, Phys. Rep. **127**, 1918 (1962)

[2] N L Manakov, M V Frolov, A F Starace and I I Fabrikant, J. Phys. B: At. Mol. Opt. Phys. **33**, R141 (2000)