High Harmonics from Noble Gas Clusters

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Cluster targets may serve as efficient sources for the generation of high-harmonics [1] and they are easily available from gas jets generated by using commercially available pulsed valves, nevertheless the number of corresponding works is surprisingly low. The required high density for cluster generation can be a disadvantage for phase matching and for propagation. Ionization sets an upper limit for the applicable laser intensity as well [2]. Last but not least the mechanism of high harmonic generation from clusters is still a subject of intense debates. Recently a model was suggested with tunnel ionization from a partly delocalized electron wave function and recombination to this wave function, i.e. to the cluster itself [3].

Experiments were carried out in three different noble gases from valves of commercial gas jets with 1 to 20 bar backing pressures. He, Ar and Xe gases were used, from which in He no cluster is expected, whereas in Xe cluster effects are expected even for low backing pressures, and Ar is an intermediate case. Harmonics spectra were obtained by using a toroidal grating which made a wavelength-dependent image of the target on a microchannel plate (MCP) detector equipped with a phosphor screen. The visible light was then recorded by a CCD camera.

The results reveal the effect of cluster structure to the generated harmonic spectra: Ionization of the jet causes a blue shift of the harmonics, increasing with increasing intensity. On the other hand if the intensity is kept constant and the pressure and thus the cluster production is increased, then in case of cluster generation signature of nanoplasmas in the form of a relative red shift is observed which is an order of magnitude smaller than the blue shift caused by the free electrons in the interaction region. In order to investigate the mechanism of harmonics generation the polarization dependence of high harmonics generation is investigated by using a home-made 3-mirror polarization analyzer [4].

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