Influence of gas jet structure on high harmonic generation

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Spatially coherent X-rays are a potentially useful source for imaging biological and crystalline material at nanometre length scales [1]. Such radiation can be produced via high harmonic generation (HHG), commonly achieved by focussing a high-energy ultrashort laser pulse into a jet of noble gas [2]. However, gas jets have a complex three-dimensional density and velocity profile [3], and since the generation efficiency depends on both the density of nonlinear material present and the degree of phase matching, the profile of the gas jet can have a significant influence on the generation process.

It is well known that the balance between the Gouy, atomic and plasma dispersion used for phase matching in a gas jet means that positioning of the laser focus with respect to the jet along the laser axis has a significant influence on the HHG intensity/efficiency [2]. This work describes the importance of the position of the laser focus along the jet axis. We show that when the laser focus is placed at four different positions along the jet axis (see figure 1) the intensity of the generated extreme-UV radiation varies by approximately three times. The highest flux is observed when the laser is focussed into the Mach disc. The work demonstrated here will aid in the optimisation of HHG from gas jet sources.

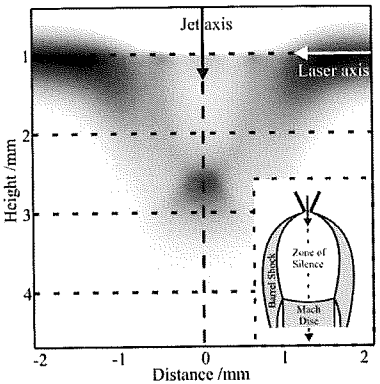

Figure 1: Fluorescence image of the jet at 420 nm from excited Ar atoms created in the HHG process at 100 mbar backing pressure, with the four levels of probing marked. Inset - schematic of free jet expansion.

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