Observing population of HeI excited states during recombination after optical field ionization with ultra-fast spectroscopy

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We probed population of He excited states after optical field ionization with technique based on ultra-fast spectroscopy. The study is motivated by the recent proposal of realizing gain in the XUV and X-ray regime via quantum coherence in He and He-like ions\textsuperscript{1}. He atoms are ionized with 800nm 50fs Ti: Sapphire laser with intensity on the order of $10^{15}$ W/cm\textsuperscript{2}. Both the emission spectra and absorption spectra following the ionization are recorded indicating the population evolution during the recombination process. At initial helium density of $5\times10^{18}$/cm\textsuperscript{3}, the population in excited He due to the ionization process and the recombination process can be distinctly seen as the fast peak and slower peak. The technique will be useful in monitoring population in recombination based lasers with or without population inversion, as well as in other applications such as plasma diagnosis.

Fig: (left) Emission spectra for the $3^3D-2^3P$ transition (right) peak absorption for the transitions $3^3D-2^3P$, $3^1D-2^1P$ and $2^3P-2^3S$ of He I following optical field ionization. (initial Helium density: $5\times10^{18}$/cm\textsuperscript{3}).

1. E. A. Sete, A. A. Svidzinsky, Y. V. Rostovtsev, H. Eleuch, P. K. Jha, S. Suckewer, M. O. Scully “Using quantum coherence to generate gain in the XUV and X-ray: Gain swept superradiance and lasing without inversion”, to be submitted for publication