高次高調波によるアト秒 X 線パルスの増幅
Amplification of X-ray attosecond pulses

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We have investigated the amplification of attosecond pulses in different atomic gases. The research is based on the single-electron numerical solution of the time-dependent Schrödinger equation (TDSE) for atomic processes in intense laser fields. We have characterized XUV amplification by synchronization of a strong IR fs light pulse with a weak XUV attosecond pulse in Ar. Our results have been compared with experimental results and have nicely confirmed the amplification in the 25 - 50 eV photon energy region.

The results allow us to give a physical explanation of the amplification processes in Ar, which are based on the recombination of highly excited Rydberg states to the 3s sub-valence shell, where atoms are strongly ionized. An study of the different scattering processes has revealed different mechanisms for the amplification, which include continuum-continuum parametric processes (C-C) induced by the XUV pulse. These type of amplifications have not been described yet. The studies for the characterization of such C-C processes include the monotorization of the electron states in time, which is accomplished by projecting the time-dependent electron wave function on the field-free eigenstates and adopting statistical studies for the different absorption and emission. This is a truly computationally time-and-memory consuming study which results however essential to understand the physical mechanisms behind the amplification processes. These C-C processes would in principle allow the amplification of frequencies which are not necessarily linked to the bound states structure of the atomic system, and therefore those are candidates to observe amplification in atoms with a higher ionization potential, such as He and Ne.

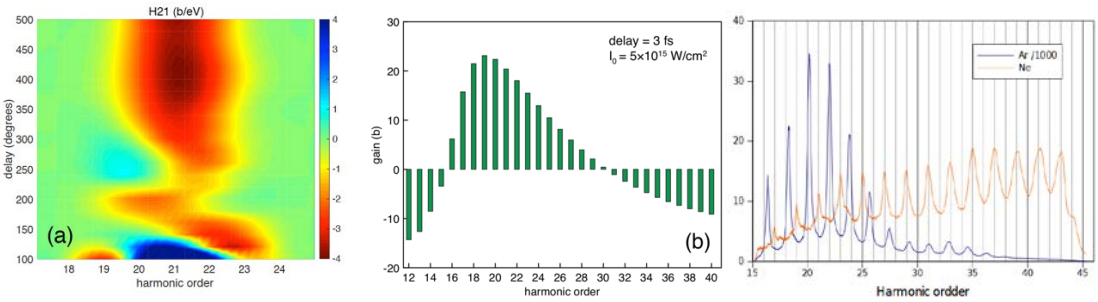

Figure: (a) Amplification map of H21 in Ar. (b) Photon energy region of the amplification in Ar. Right panel: Experimental results for Ar and Ne.