Holographic imaging of atoms

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The momentum distribution of continuum electrons created during the ionization of atoms by few-cycle laser pulses is modulated by interference effects, which are the results of superposition between electronic wave packets following different spatial and temporal paths [1]. The spatial interference, is one from the numerous possible interference scenarios [1], and occurs when wave packets emitted at the same time (during the same quarter pulse cycle), but following different spatial paths are coherently added in the continuum. The formed radial interference pattern is the result of the interference between the direct (unscattered) and the scattered wave packets [2, 3]. By considering the direct wave packet as reference, while the scattered wave packet as a signal wave, the spatial interference pattern can be interpreted as the holographic mapping (HM) of the target atom's state [2].

With the help of *ab initio* calculations (direct numerical solution of the time-dependent Schrödinger equation) we have studied the physics behind the formation of the HM pattern. We showed [3, 4, 5] that the influence of the driving laser field on the HM pattern can be described with a single parameter (z_0), which is the maximum distance reached by the electronic wave packets before the scattering event leading to the formation of the HM pattern happens. Furthermore, by performing calculations for different target atoms (H, He, Ne, Ar) we observed, that the shape of the HM pattern is significantly influenced by the shape of the bounding potential, i.e. the atomic species of the target.

References

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