Soutenance de thèse

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" Quantum Interferences in the Dynamics of Atoms and Molecules in Electromagnetic Fields "

In this thesis, two specific cases of laser-matter interaction where quantum interference plays a key role are discussed. The first part deals with imaging a molecule using an electron wavepacket, which is created and scattered from that molecule. An intense infrared laser field ionizes the system by creating a laser-driven electron wavepacket in the continuum. As the field changes its phase from positive to negative, the wavepacket is driven back and forth to the molecule and it results in elastic and inelastic collisions. Elastic collision with the core, which is known as laser-induced electron diffraction imprints the image of the molecule in the momentum space as interference patterns. A simple approximate analytical model is developed that can be compared with the numerical simulations. The process is demonstrated in the case of both the HOMO and HOMO-1 of symmetric linear CO_2 and the orbitals are reconstructed with very good accuracy.

The second project is about collective effects in dense atomic vapor samples confined in a nanocell. If the atoms are close enough to be influenced by others, the system responds collectively to a common exciting field. This cooperative nature of the system leads to shifts and broadening of resonances. Once two or more transitions are broad enough to overlap, quantum interference will take place and it leads to destructive interference corresponding to a characteristic frequency determined by the system parameters. It will lead to a minimum in the absorption profile of the system in complement to a peak in the transmission. We have called this transparency induced by dipole-dipole interaction ‹‹ Dipole-Induced Electromagnetic Transparency ›› or DIET.

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