DAMOP07-2007-020008

Abstract for an Invited Paper
for the DAMOP07 Meeting of
the American Physical Society

Laser-induced nonsequential double and multiple ionization of atoms: what can be learned from models[1]

WILHELM BECKER, Max-Born-Institut

The significance of a nonsequential channel to double and multiple ionization in some parameter regimes has been long since established. More recently, at least for near-infrared frequencies, consensus has developed that the mechanism is related to recollision of a tunnel-ionized electron with its parent ion. With ab-initio calculations being extremely time consuming, S-matrix theory allows for comparatively straightforward computation, once the responsible diagrams have been identified. A crucial element of such a description is the electron-electron interaction that is responsible for the ionization of the second (or more) electron(s) by the first. In this talk, I discuss different choices for this interaction and their consequences for the ion and electron momentum distributions that have been recorded in experiments. I also discuss various methods of how to compute the S-matrix element, including saddle-point methods that lead to the concept of quantum orbits and a certain limit that is classical but for the initial tunneling of the first electron. If the electron-electron interaction is of contact type, the latter model becomes a statistical model, which only depends on the tunneling rate, the rescattering kinematics, and the volume of phase space for given final momenta. This statistical model can also be applied for an elliptically polarized laser field. For ellipticities exceeding $\xi \approx 0.3$, interesting effects begin to develop in the momentum distributions.
An additional parameter that reflects the joint action of the electron-electron, electron-ion, and electron-field dynamics, can be introduced by assuming a delay between the time of recollision and the later time when a subset of electrons has thermalized with the returning electron and leaves the immediate vicinity of the ion. The existence of such a delay is supported by classical-trajectory calculations. Comparing model calculations with reality one can infer a value of this delay time. For triple and quadruple ionization of neon, a thermalization time below 500 attoseconds gives good agreement with the existing data. In collaboration with P.B. Corkum, C.F.M. Faria, S.P. Goreslavski, P.J. Ho, X. Liu, S.V. Popruzhenko, H. Schomerus, and N. Shvetsov-Shilovski.

[1]Supported in part by Deutsche Forschungsgemeinschaft