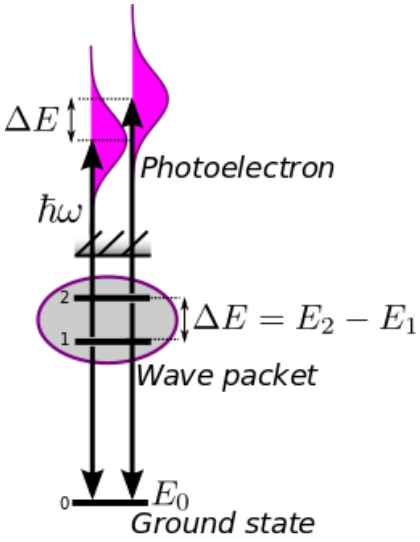
Master Thesis Project:

Time-dependent Extreme Pulse-Control by Bound-Wave Packets

We live in a revolutionary time when quantum control of microscopic processes is possible thanks to the development of new extreme light sources. This development is taking place at Lund University, and at many other institutes around the world, in a research field called attosecond science (*"atto"* = 10^{-18}). Atoms driven into **quantum superposition of states, so-called coherent wave packets, exhibit remarkable properties that are different from those of "ordinary matter" in its ground state**. As an example, we have recently shown that the absorption of extreme light pulses depends critically on the exact time when the light hits the atom, relative to the bound electron wave packet motion! [1]

Project Description:

During this project at the *Mathematical Physics Division* at *Lund University*, you will use state-of-the-art numerical methods to propagate the many-electron Schrödinger equation using the Time-Dependent Configuration-Interaction Singles (TDCIS) approximation [2], which has been recently implemented and tested to describe *attosecond transient absorption* [3] of extreme light pulses by coherent bound electron wave packets [1]. You will study numerically how the absorption of light is affected by photoelectron emission, in combination with driven transitions back to the initial ground state of the atom (see cartoon to the right). These types of processes may find important applications as **ultra-fast light switches in fundamental science**.



You should have a genuine interest in quantum mechanics with a focus on light–matter interaction, optics or numerical simulations. You will learn to compile and run large atomic physics codes (already written in *FORTRAN*) for hydrogen and noble gas atoms and you will then perform data analysis in *Python* and develop your own analytical models to interpret the numerical results. Familiarity with *Linux* systems is a plus. Estimated project time is half a year.

If you are interested in this Master project (or something similar), don't hesitate to contact:

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Read more: **http://www.matfys.lth.se/staff/Marcus.Dahlstrom/**

References:

1. Dahlström, J. M., Pabst, S. & Lindroth, E. Attosecond transient absorption of a bound wave packet coupled to a smooth continuum. *J. Opt.* **19,** 114004 (2017).

2. Greenman, L. *et al.* Implementation of the time-dependent configuration-interaction singles method for atomic strong-field processes. *Phys. Rev. A* **82,** 23406 (2010).

3. Wu, M., Chen, S., Camp, S., Schafer, K. J. & Gaarde, M. B. Theory of strong-field attosecond transient absorption. *J. Phys. B At. Mol. Opt. Phys.* **49,** 62003 (2016).