Popular abstract to the master thesis
“Generation and Characterization of Intense Attosecond Pulses”

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How to observe the shortest light pulses

The shortest time frame one can imagine is perhaps the blink of an eye or a flick of a finger. These events are rarely faster than 100 milliseconds. The attosecond pulses which are produced at the Intense XUV Beamline in Lund are way shorter than that. If they were lined up one after the other, one could fit a quadrillion pulses within this time. Of course, nobody is sitting there counting these pulses, but even measurement instruments have a hard time with this task. There is no sensor or electronical device which is able to detect them directly. A tough method named after a cute animal, the so-called RABBIT technique is used to obtain the information. Hereby, the fact that light behaves like a wave and interferes is used. By a lucky coincidence of nature, two attosecond pulses of the same energy are always generated. Since they are created at the same time, they interfere with each other in such way that a special pattern is formed that can be reliably measured when scanning over a much larger time frame of femtoseconds (one trillion of a second).

A picture is received which shows how many photons are measured depending on the time (in femtoseconds) and electron kinetic energy, which is proportional to the wavelength of the pulses we have generated. The part of most interest is how the line structures in this picture, referred to so-called harmonics or sidebands, oscillate over time. Advanced methods are applied for analysis and improvement of the phase extraction of this oscillation. That information allows us to reconstruct the real pulse structure over time. This explains why RABBIT stands for **R**econstruction of **a**ttosecond laser **b**eating **b**y **i**nterference of two photon **t**ransitions. Two different noble gases, helium and neon are investigated in this thesis by applying this technique.

So far, we have seen how to measure the pulses, but no explanation for the reason *why* there is a need for doing this has been stated. What’s special about the pulses is that they are amongst the shortest we are currently able to create and not many research facilities are doing this at the time. Whenever we venture into previously unexplored areas there are also great discoveries. The research on attosecond pulses brings us closer to the explanation on how ionization of atoms is happening since this process takes place on a very short time frame as well, the femtosecond range. Hence, the observation requires even shorter pulses than that in order to resolve what is happening. Finally, this is an approach to a better understanding of fundamental physics and the result will contribute to an improved basic theory about charge migration processes in atomic physics and chemistry.

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