Quantum-optical Precision Experiments: from the simplest molecule to the optical atomc clock

Prof. S. Schiller

Lecture, 3 h per week

(First meeting: Oct. 13, 17:00, Room 25.42.U1.24)

Master-Studiengang Physik, Ergänzungsmodul „Quantenoptik und Quanteninformation“

In this lecture I will describe the theoretical concepts and experimental implementation of experiments that seek to attain extremely precise measurements of the transition frequencies in atoms and molecules. Such measurements are of interest for testing physical theories, e.g.:

- Is quantum-electrodynamics (QED) a precise description of matter?
- Are the fundamental constants of physics really constant in time and in space
- Is the effect of time dilation corretly described by Special and General Relativity?

These precision experiments are also potentially interesting for more practical applications, such as mapping the gravitational potential of the earth.

The contents of the lecture will include:

- Motivation and overview
- techniques for trapping atoms and ions (ion traps, magneto-optical traps, optical traps)
- techniques for cooling atoms and ions (laser cooling, sympathetic cooling)
- an introduction to atomic and molecular physics relevant in particular for the diatomic molecular ion HD^+ and neutral Helium-like atoms
- lasers and laser techniques to probe atoms and molecules
- experimental aspects of atomic and molecular clocks
- the physics of the interaction of atoms and molecules with the surroundings (systematic effects)

N.B. The lecture will be given in English or German, depending on the composition of the student audience