A 248 Magneto-Optical Trap

A 248.1 Aim of the Experiment

The aim of the experiment is to introduce you to the field of laser cooling and trapping of neutral atoms. You will set up a magneto-optical trap for rubidium atoms and measure some of its properties.
The invention of the magneto-optical trap has led to fundamental discoveries and practical applications in diverse fields such as Bose-Einstein condesation, degenerate Fermi-gases cold collisions and quantum information processing. Several magneto-optical traps are used in experiments carried out at the Institute for Applied Physics in Bonn.

A 248.2 Required Knowledge

For the sake of being able to carry out the experiment, you should be familiar with atomic physics in particular you should read about the following keywords.

- **optical cooling:** radiation pressure, red detuning, Doppler shift
- **optical molasses:** counterpropagating beams, 3D, cooling but no caught atoms, Doppler temperature
- **MOT:** Magnetic quadrupole field, circular polarized beams, position-depending force
- **Rubidium:** Rb energy level structure, non-resonant excitation, inelastic collisions, dark states, repumping beam
- **setup:** coils, vacuum chamber, laser system, diode lasers
- **Doppler-free spectroscopy:** pump/signal beam, groups of atoms with similar velocity, Lamb dip, crossover resonance, Rb-spectrum
- **polarisation spectroscopy:** circularly polarized light, anisotropic pumping, birefringence, detection of tilt, dispersion, Kramers-Kronig relation

Note that this is only an incomplete list of keywords!

A 248.3 Literature

- Script, contact tutor to get a copy
- C. Wieman, G. Flowers and S. Gilbert, Am. J. Phys. **63** (1995).
- H. Metcalf and P. van der Straten, *Laser Cooling and Trapping* (Springer, 1999).
- C. Adams and E. Riis, Prog. Quant. Electr. **21**, 1 (1997).
- W. Demtröder, *Laser spectroscopy* (Springer, 1991)
- D. Meschede, *Optik, Licht und Laser* (Vieweg + Teubner, 2008).

A 248.4 Assignments

- All assignments are explained in detail in the script.
- The laboratory assignment E 248 is a double-valued exercise and will be done on two full days. Each group arranges time and date with the tutor.
- The script should be obtained from the tutor at least one week before the laboratory exercise.

Best wishes for a successful experiment! Date: July 2012