Abstract

In this thesis, two experimental projects carried out in the field of ultracold quantum gases are presented.

The first one deals with the construction of a magnetic trapping apparatus that is used to create Bose–Einstein Condensation (BEC). Magnetic traps are used to confine and compress neutral pre–cooled atoms and to reach the necessary temperatures and densities for condensation. Along with sophisticated timing and ultra–high vacuum systems, they form the core of nearly every macroscopic BEC experiment. During a visiting appointment at the University of Otago, New Zealand, computer simulations in MATLAB were developed to model the magnetic field distribution of a QUIC (quadrupole–Ioffe–configuration) trap [Ess98]. Based on the results, a coil arrangement was designed and built. The configuration allows flexible optical access to the BEC and is distinguished by a stable and compact mounting system. This first part of the thesis summarizes the related physics of magnetic trapping, as well as the practical issues concerning the design and construction of copper wire coils.

The second project involves the implementation of a laser frequency stabilizing scheme, which is based on the use of an optical mirror cavity and the Pound–Drever–Hall (PDH) technique [Dre83]. The stabilized laser is used to perform experiments with BECs in optical lattice potentials. In the course of a stay in the rubidium BEC laboratory at the University of Innsbruck, Austria, an appropriate cavity together with laser locking electronics were assembled and characterized. The cavity's transmission frequency is controlled by means of a temperature stabilization arrangement. This second part of the thesis summarizes the relevant background on optical mirror cavities, the Pound–Drever–Hall method, and gives constructional details on the lock's components.