Problem Set 05, Introduction to Laser Physics, WS 10/11 **18/01/11**

Topic: optical resonators

Please answer the following questions until 18/01/2011

Problem 5

The interaction of matter and radiated energy is one of the fundamental aspects of modern science. Studying the energy structure of atoms and molecules can be realized by excitation of their resonance frequencies. A tunable, single mode laser allows to characterize individual resonances because it can be used to excite individual resonances. This is a key aspects of laser spectroscopy.

Problem 5.1

Tunable, single mode lasers are hence key instruments for spectroscopy. What characterizes the single mode emission of lasers? Please give some examples of how to achieve single mode laser emission, how to provide tuneability and how to measure it. Explain why a scanning Fabry-Perot interferometer is the measurement tool of choice for validating the single mode emission of any laser.

Problem 5.3

Describe how to build a scanning Fabry-Perot interferometer. What aspects are to be considered?

Problem 5.2

Before using a scanning Fabry-Perot interferometer it is necessary to assure its functionality. Assume a Fabry-Perot resonator with an air filled cavity ($n \approx 1$) of constant length. The mirrors in this exemplary interferometer have the same reflectivity R. Assume you measure the transmitted power featuring a free spectral range of Δf_{FSR} = 150 MHz and a linewidth (FWHM) of δf = 5MHz. Please calculate:

- the cavity length L,
- its finesse F,
- the mirror reflectivity R

How does the finesse change, when the reflectivity is raised from the value calculated above to 99% and 99.9%. Please describe to what extent Fabry-Perot interferometers with those mirror reflectivities can be used as measurement instruments.