Raman Effect

In the experiment the Raman spectra of the molecules CH_2Cl_2, $CHCl_3$, $CDCl_3$, $CHBr_3$ and $CDBr_3$ are measured. By rotating the direction of polarization of the laser beam by 90°, the degrees of depolarization of each individual Raman line can be determined. A comparison of the Raman spectra with the results of group theory allows the structural clarification of the investigated samples.

I. Skills necessary

Vibrational spectra of simple molecules; Raman effect; Infrared active and Raman active modes; application of group theory to molecular vibration; principle of HeNe laser; basic setup of Raman spectrometer.

II. Literature

(1) Peter W. Atkins: Physical chemistry, Oxford Univ. Press, 2014

(2) H. Haken, H.C. Wolf: Molecular physics and elements of quantum chemistry, Springer, 2004

(3) W. Demtröder: Atoms, molecules and photons: an introduction to atomic-, molecular- and quantum-physics, Springer 2010

III. Experimental tasks

1. First measure the transmission of the three optical filters with the white LED. Normalize the transmission to the LED spectrum measured without filter.
2. Adjust the setup. The fine adjustment is made in darkness by optimizing the intensity of one single Raman line. When changing the samples and especially when changing the polarization direction the adjustment needs to be checked.
3. Record the Raman spectrum of CH_2Cl_2 (probe 1). Choose the polarization of the laser so that the intensities of the Raman lines are at maximum.
4. For the other probes (sample 2 contains $CHCl_3$) measure the intensities at maximum and the position of Stokes- and Antistokes lines.
5. Rotate the polarization direction of the laser by 90° and measure the intensities at maximum and the position of Stokes- and Antistokes lines.

IV. Experimental evaluation

1. Plot the data of all Raman spectra against the relative wave number relating to the laser line. Convert the wave length of the lines into relative wave numbers.
2. Calculate the Boltzmann constant from the relations of intensity of Stokes- and Antistokes lines for all samples.
3. Match the unknown probes no. 3-5 to the substances $CDCl_3$, $CHBr_3$ and $CDBr_3$ by comparing them to the known substances and applying the isotope effect.
4. Calculate the degree of polarization of the Raman lines and asign the Raman lines to the normal modes of the investigated molecules.
5. Calculate the temperature for a vibration of your choice, where Stokes and Antistokes lines would have the same intensity.

V. Take note

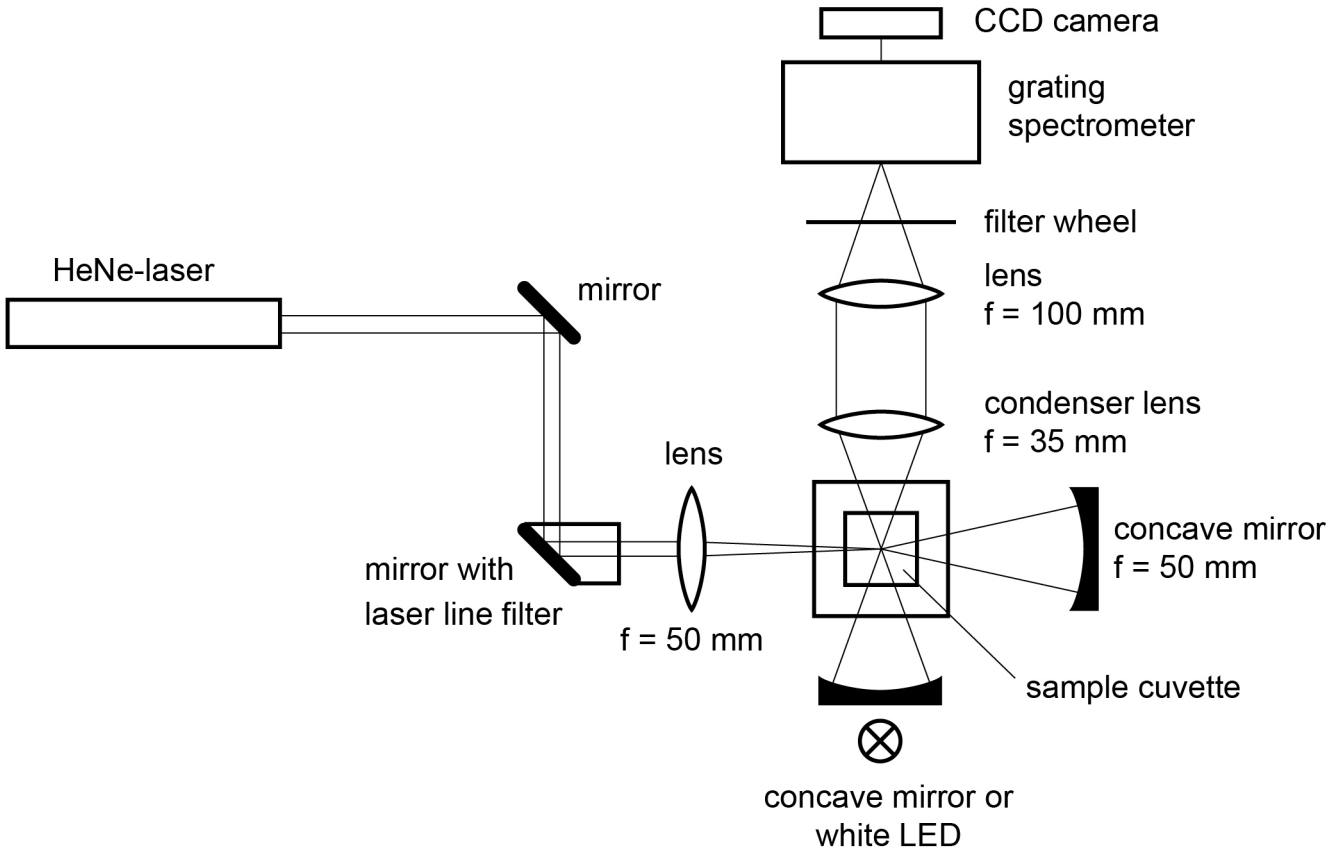
Under no circumstances may the laser beam hit your eyes, risk of blindness!

The first deflection mirror in front of the laser should be adjusted as little as possible, or if possible not at all. Risk of laser hitting your eyes!

Never adjust the slit width of the spectrometer! Do not touch the filters in the filter wheel.

It is recommended to run an overview measurement before starting the actual measurement.

VI. Experimental setup



Filter wheel (read from the top):
1: Stokes filter
2: Antistokes filter
3: neutral grey filter
4: entrance slit closed
5: reference Antistokes filter
6: reference Stokes filter

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