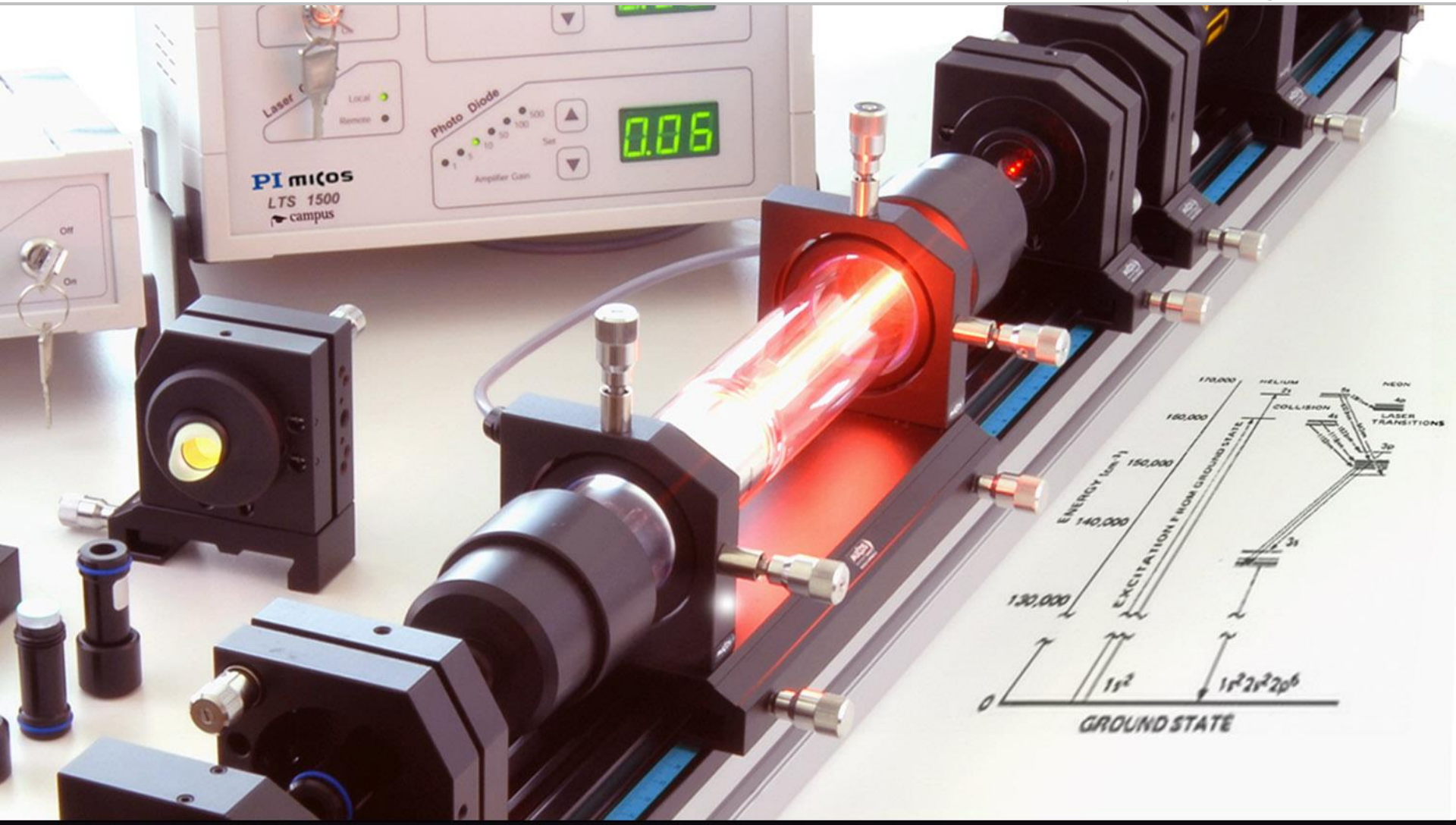
PI mikos



campus EDUCATIONAL LASER AND PHYSICS SYSTEMS

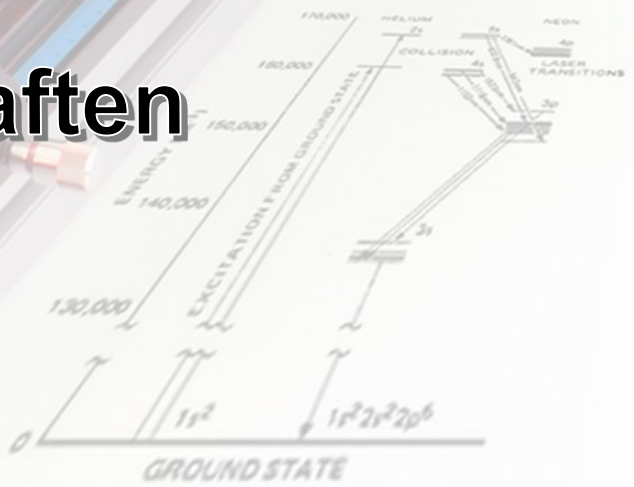
Innovative Lehrmittel 2015 in Berlin // Referent: Dr. Jürgen Gallus

Das Unternehmen PI miCos GmbH

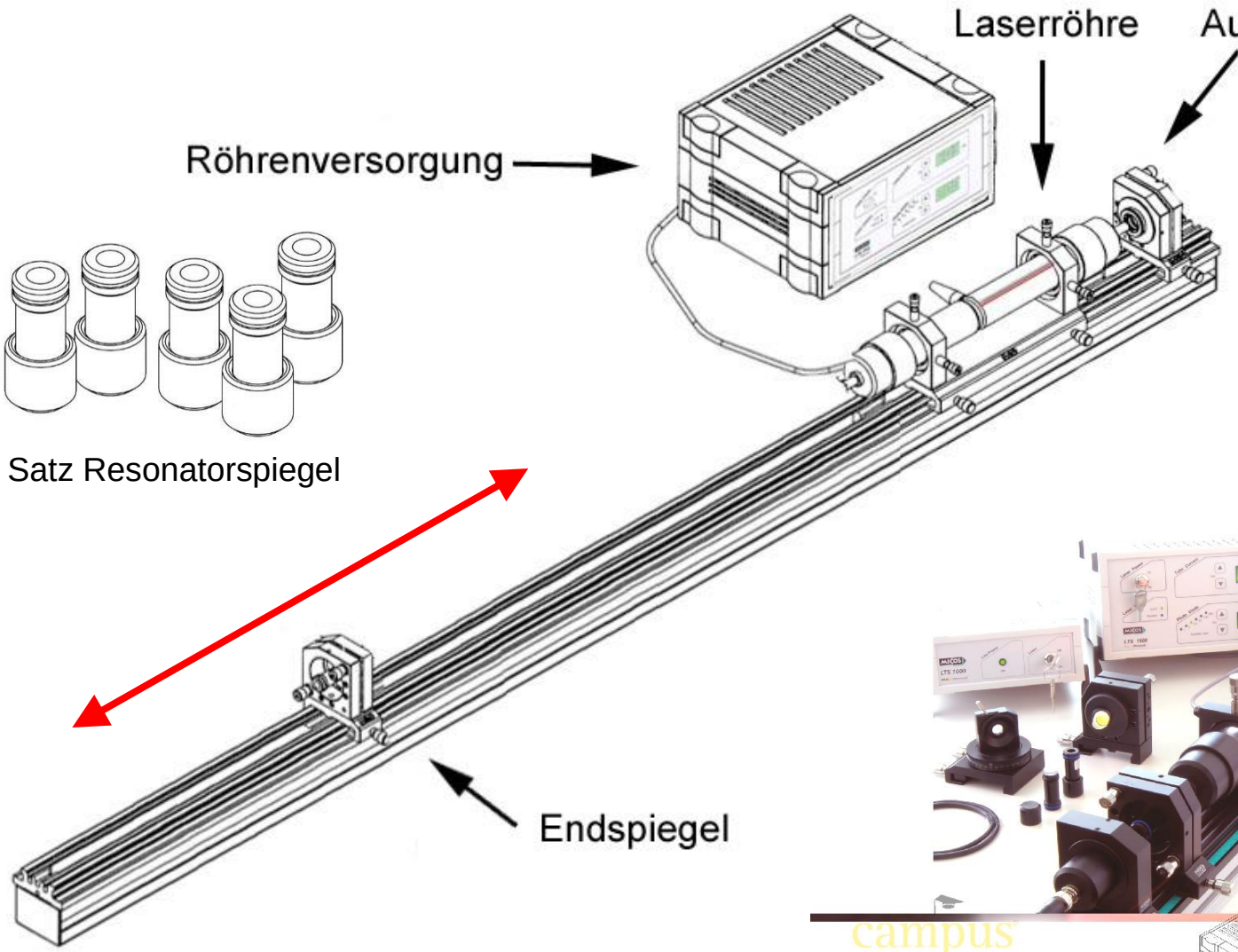
- Firmengründung der miCos GmbH 1990 von Lucius Amelung
- Seit 2011 Tochter der Physik-Instrumente (PI)
- Sitz des Unternehmens in Eschbach bei Freiburg, ca. 100 Mitarbeiter

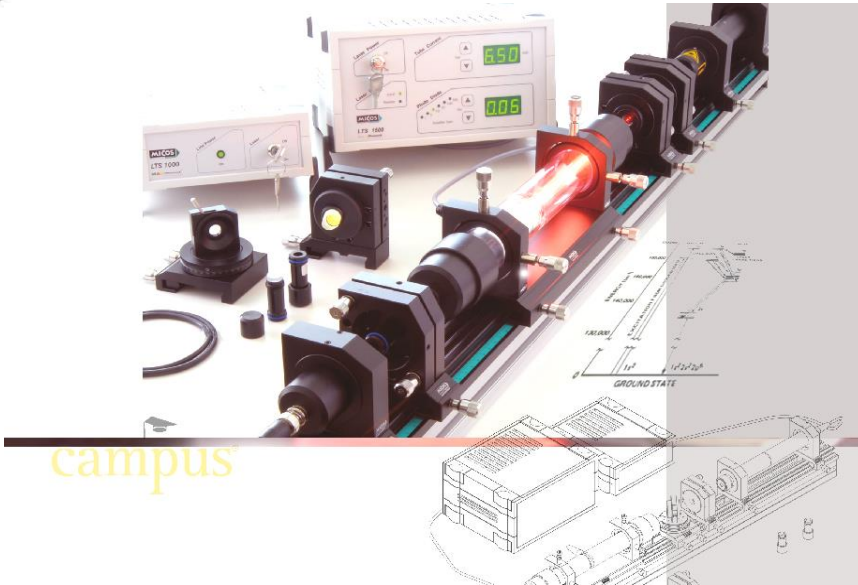
Versuche mit dem Helium-Neon-Laser

- Laser-Resonator
- Spektrale Eigenschaften
- Lasermoden



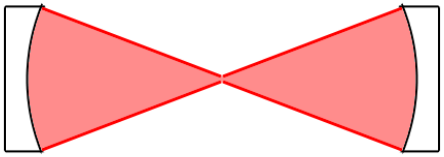
Offener variierbarer Resonator



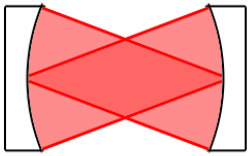


Optische Resonatoren

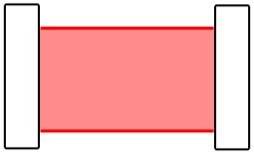
a) konzentrisch



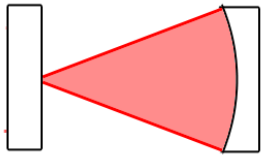
b) konfokal



c) planar

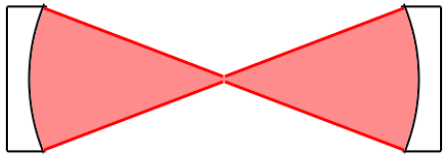


d) hemisphärisch

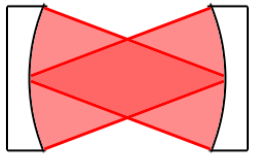


Optische Resonatoren

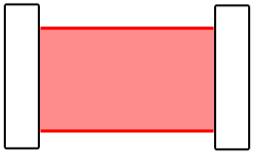
a) konzentrisch



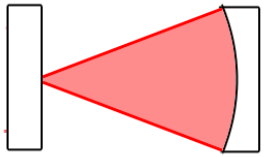
b) konfokal

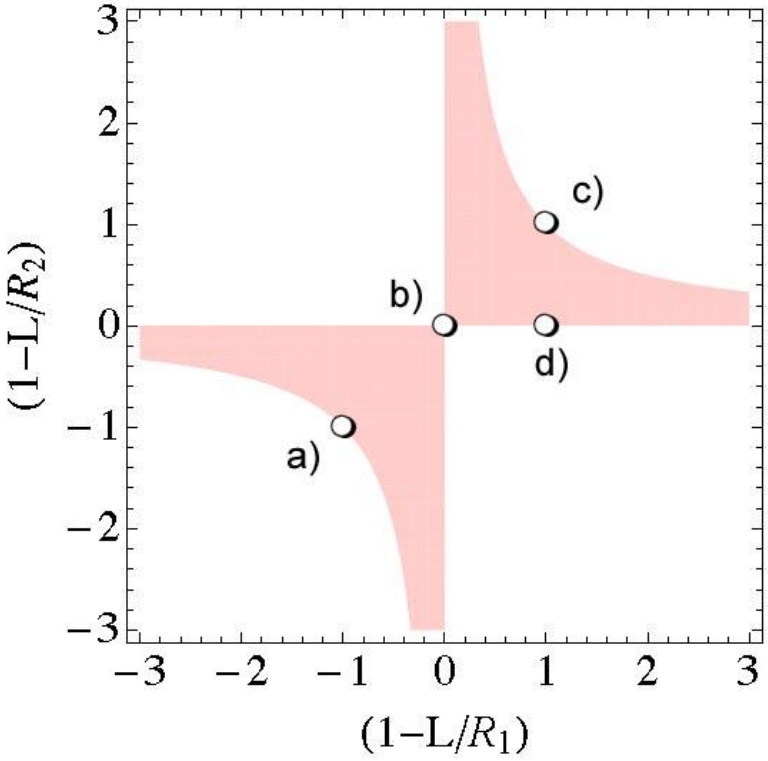


c) planar



d) hemisphärisch



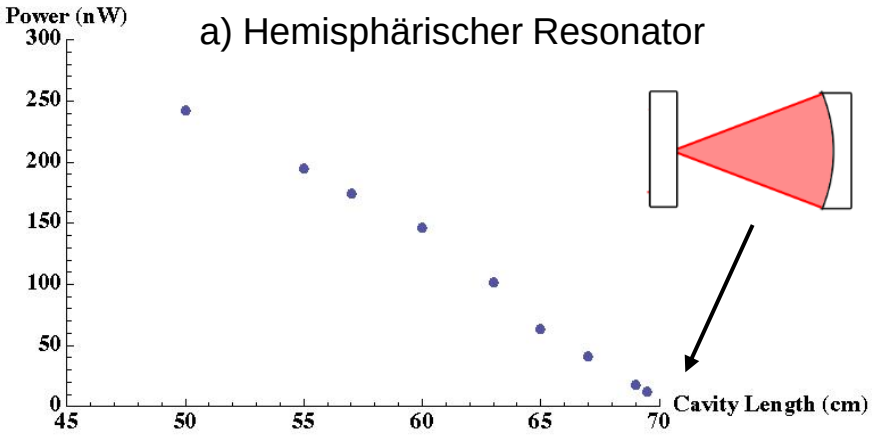


Resonatorparameter: $g_i = 1\text{-}L/R_i$

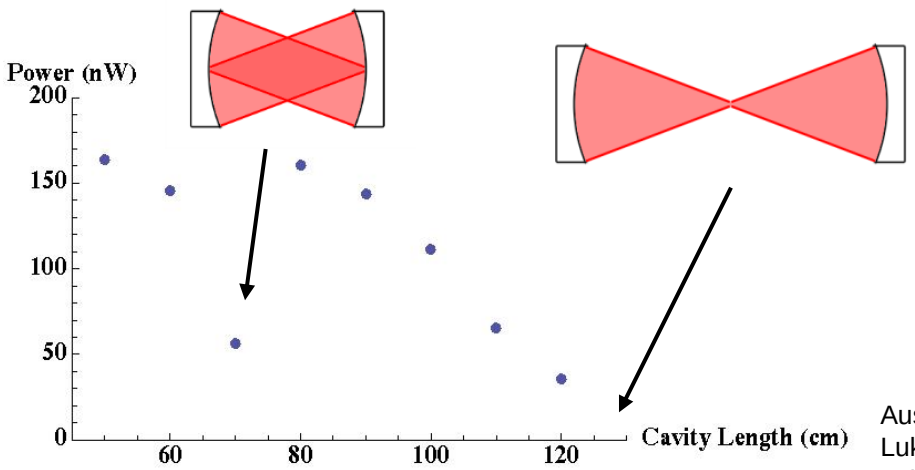
Stabilitätskriterium: $0 < g_1\, g_2 < 1$

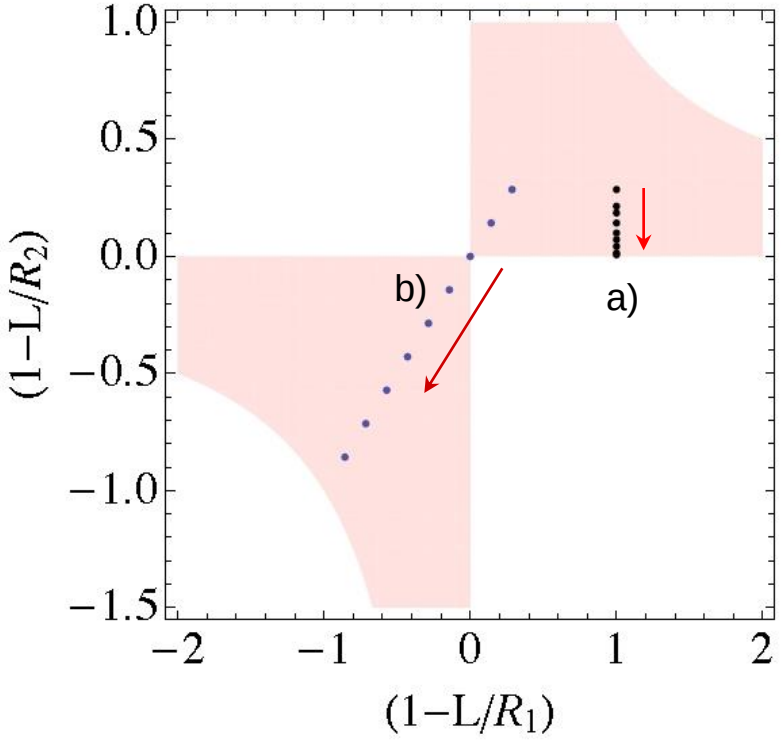
Messungen an Optischen Resonatoren

a) Hemisphärischer Resonator



b) Konfokaler / Konzentrischer Resonator



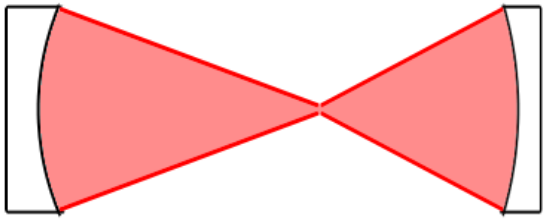


↑ = Verlängerung des Resonators

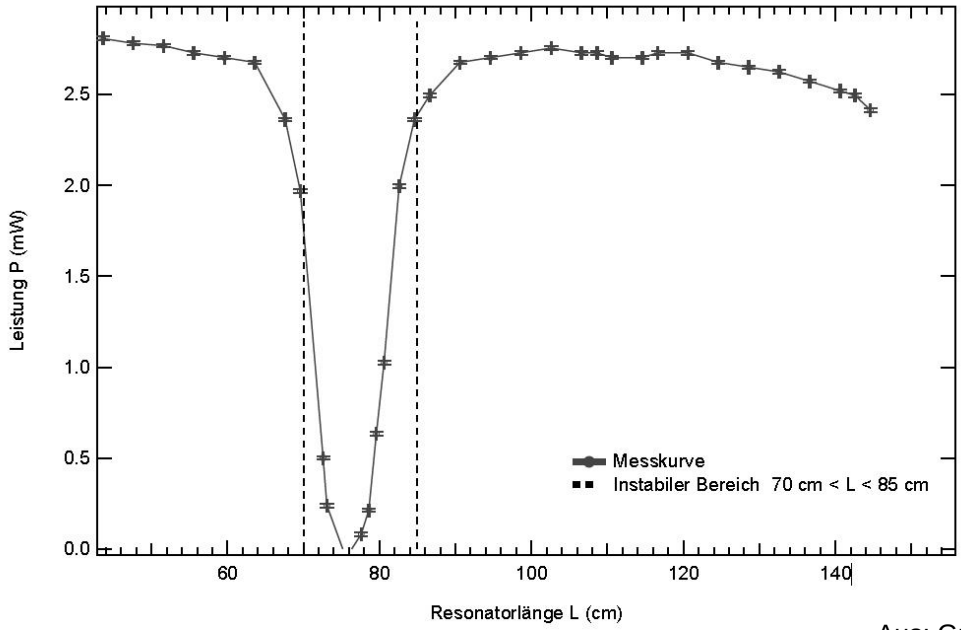
Aus: The Experimental He-Ne Laser
Lukas Kuczynski, Alec Jackson
Laboratory Report 2012

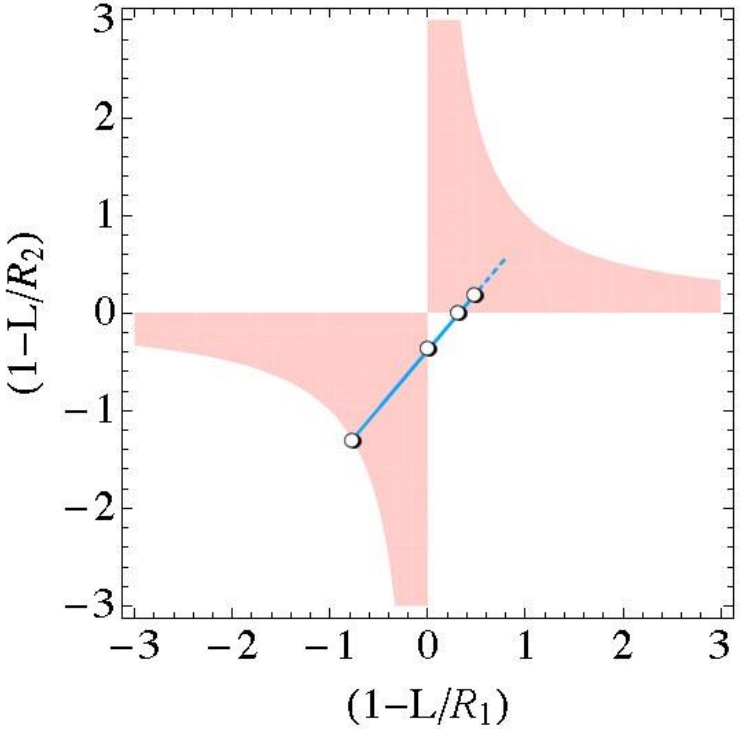
University of Colorado Boulder

Asymmetrischer Resonator



R_1 = 850mm R_2 = 700mm

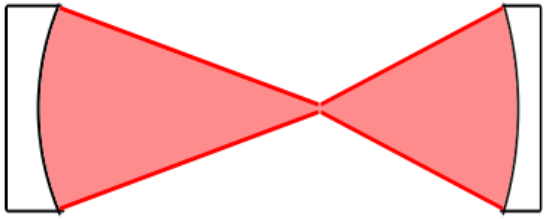




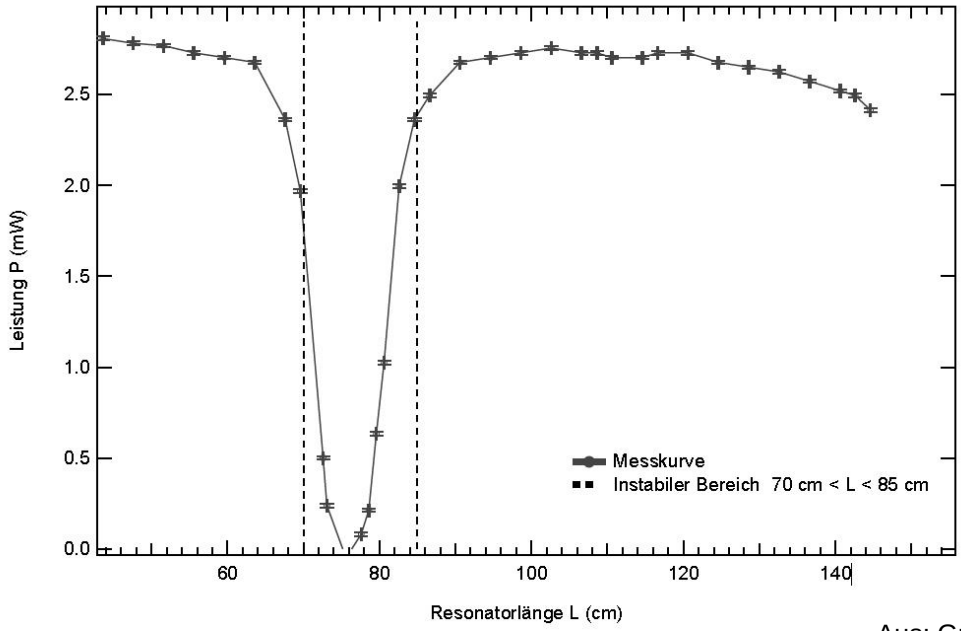
Aus: Grundlagen des He-Ne-Lasers
Jan Kehlbeck
Bachelor-Arbeit 2012

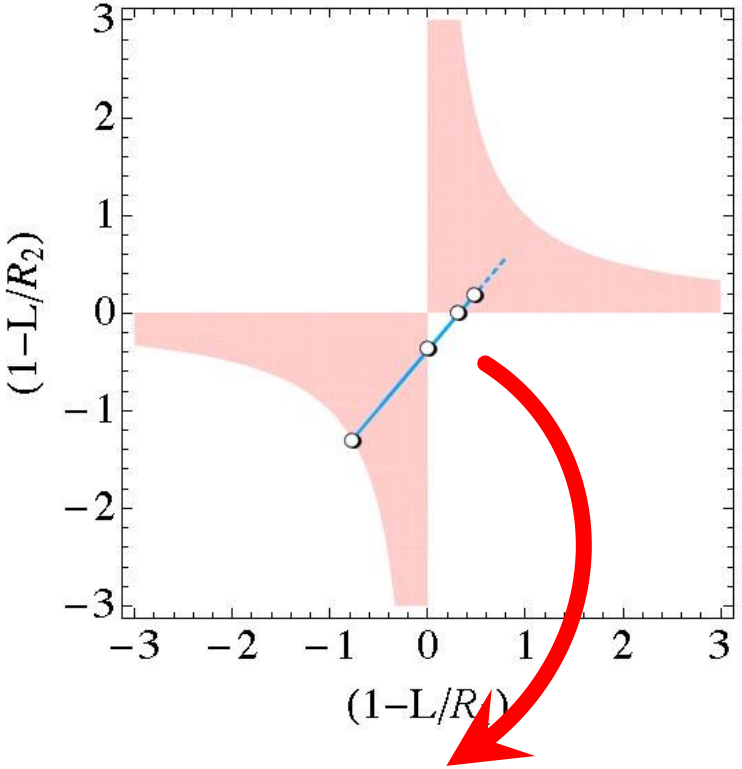
PHYSIKA Physikalische Praktika der Universität Bremen

Asymmetrischer Resonator



R_1 = 850mm R_2 = 700mm





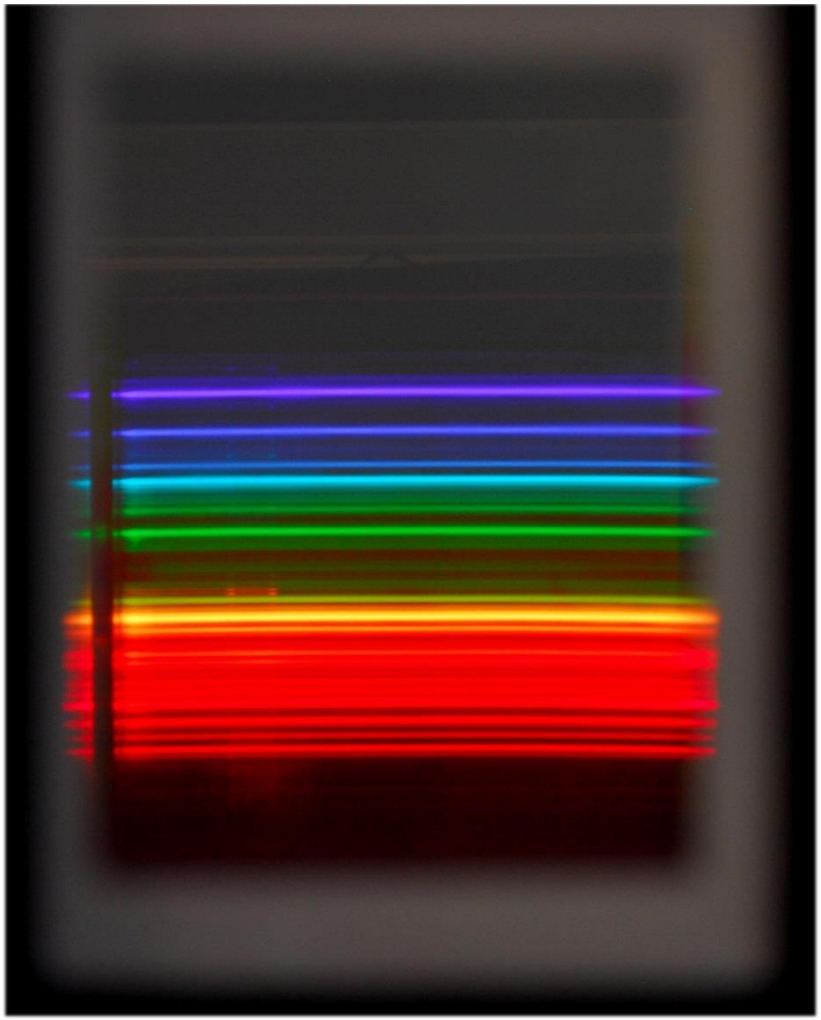
Stabilitätskriterium nicht erfüllt:

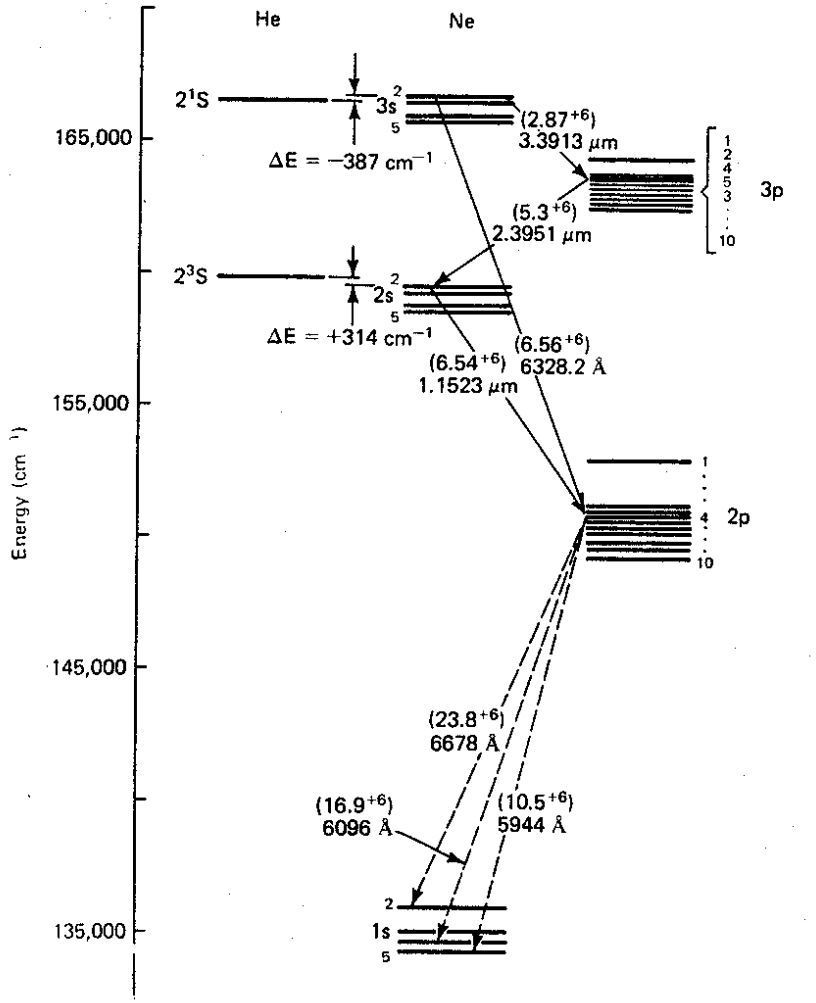
$g_1 g_2 < 0$!

Aus: Grundlagen des He-Ne-Lasers
Jan Kehlbeck
Bachelor-Arbeit 2012

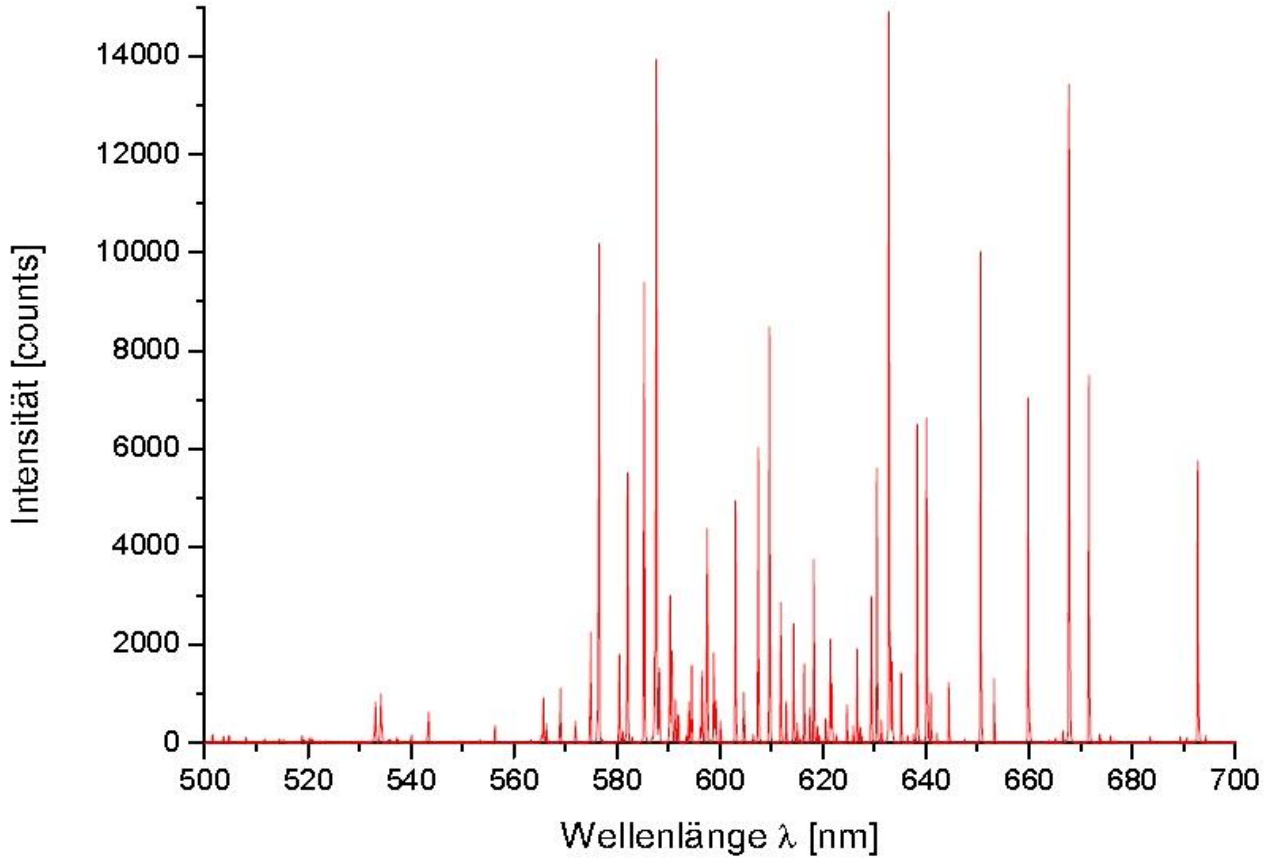
PHYSIKA Physikalische Praktika der Universität Bremen

He-Ne-Fluoreszenzspektrum qualitativ





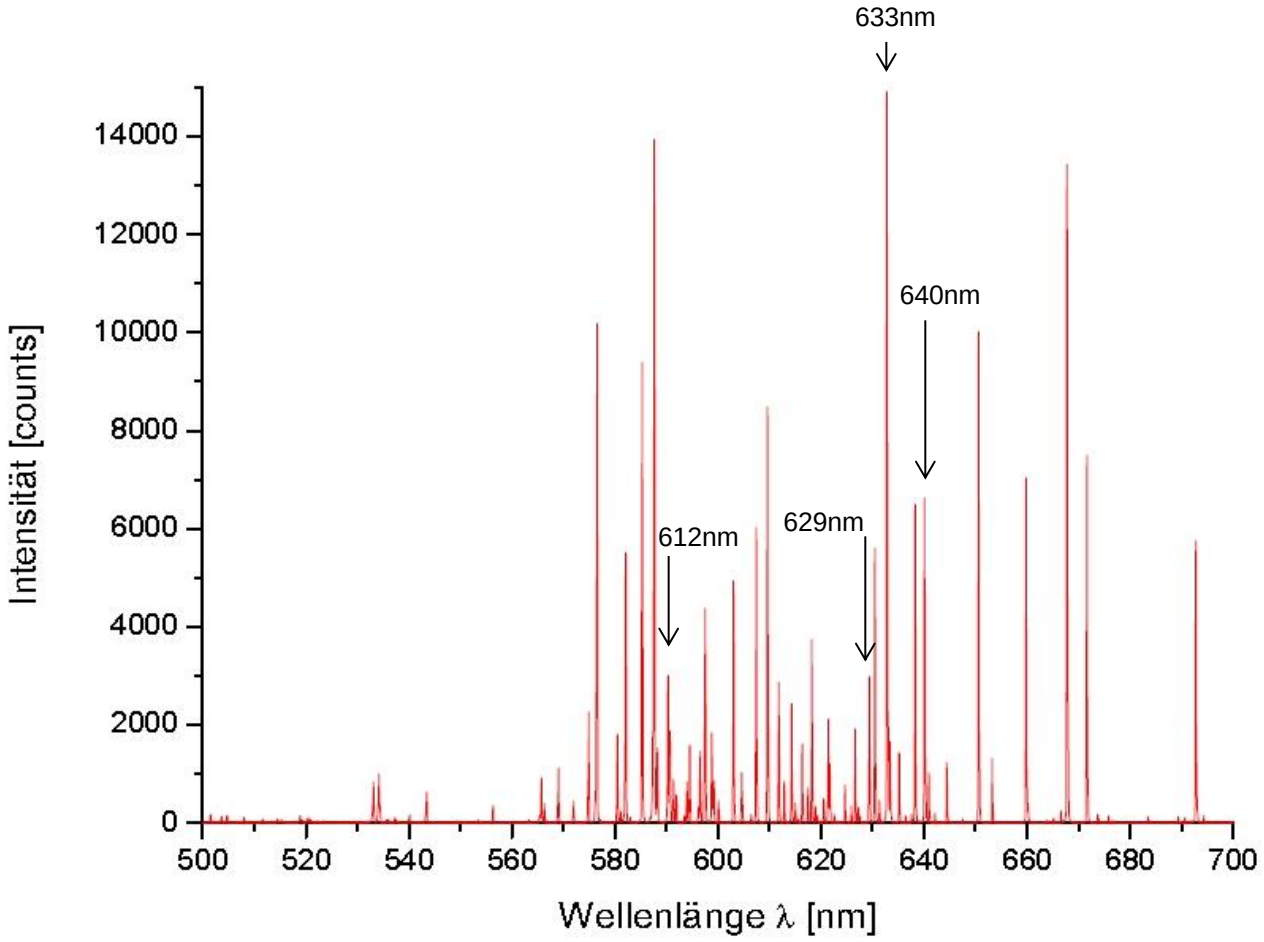
He-Ne-Fluoreszenzspektrum quantitativ



Aus: He-Ne-Laser
Fabian Ganss, Robert Schmidt
Laborprotokoll 2008

TECHNISCHE UNIVERSITÄT CHEMNITZ

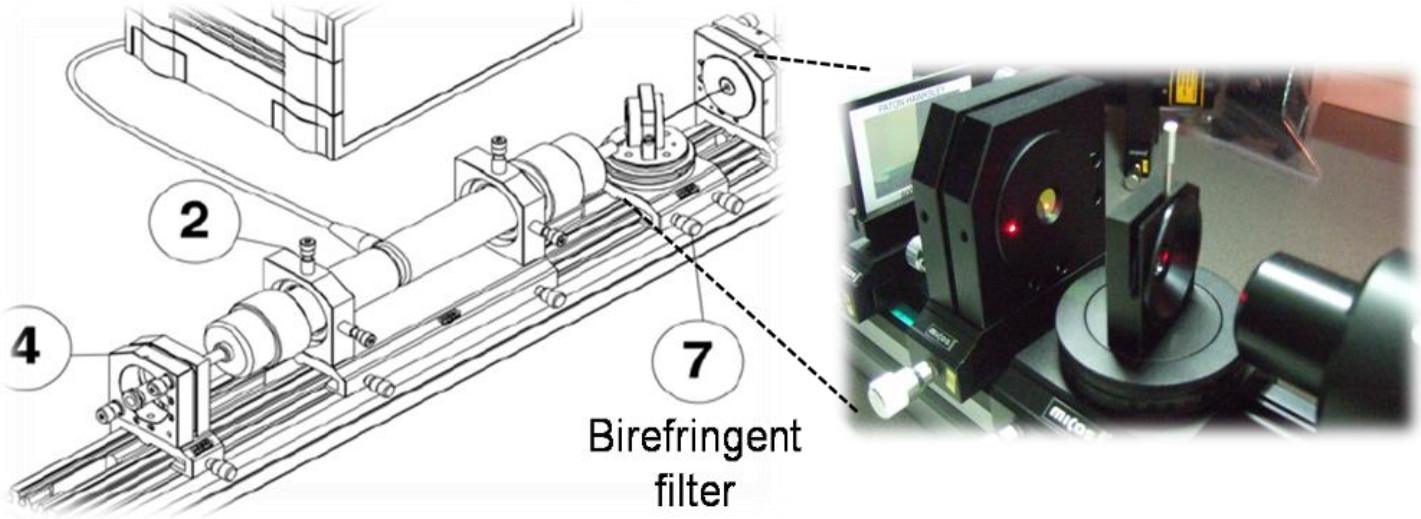
He-Ne-Fluoreszenzspektrum quantitativ



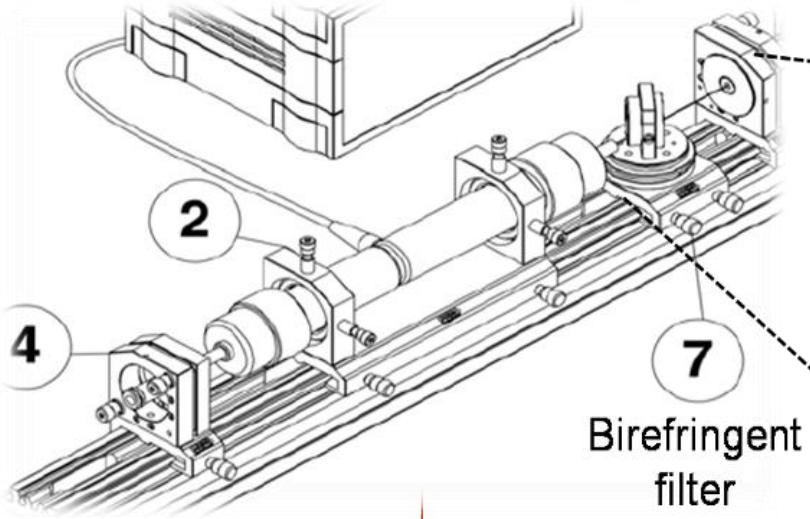
Aus: He-Ne-Laser
Fabian Ganss, Robert Schmidt
Laborprotokoll 2008

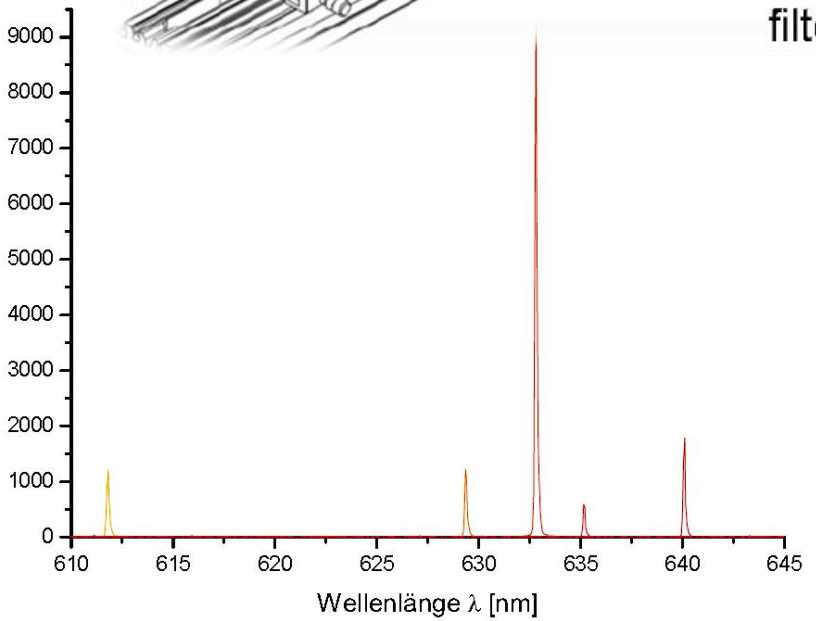
TECHNISCHE UNIVERSITÄT CHEMNITZ

Abstimmung der Wellenlänge: Doppelbrechendes Filter



Abstimmung der Wellenlänge: Doppelbrechendes Filter

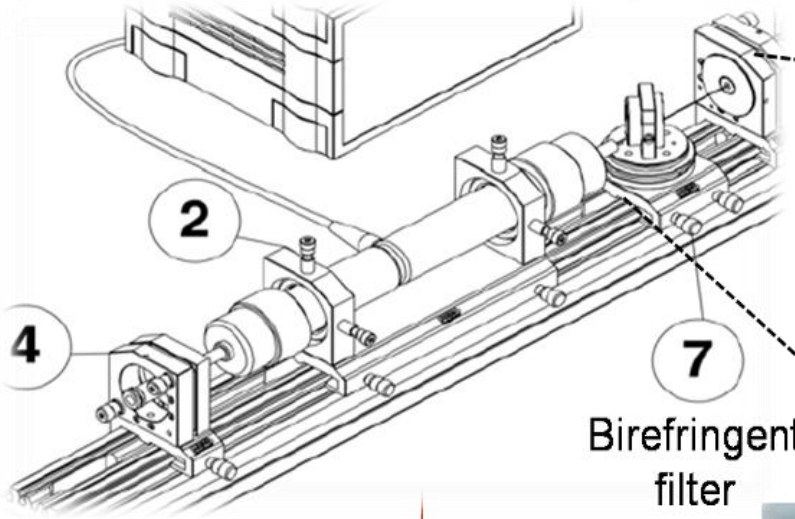


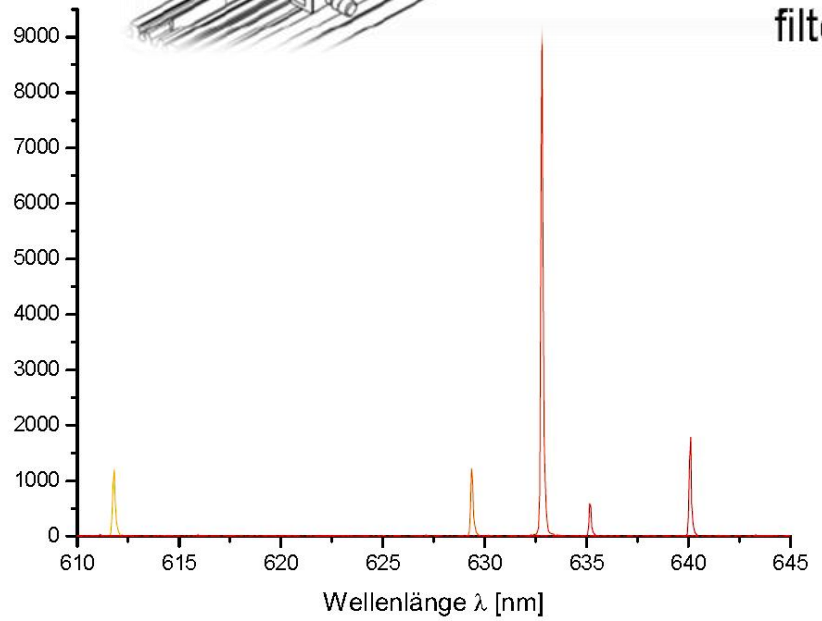


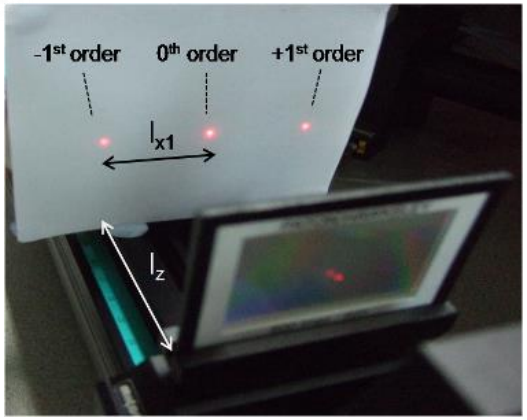
Aus: He-Ne-Laser
Fabian Ganss, Robert Schmidt
Laborprotokoll 2008

TECHNISCHE UNIVERSITÄT CHEMNITZ

Abstimmung der Wellenlänge: Doppelbrechendes Filter







Beugungs-gleichung

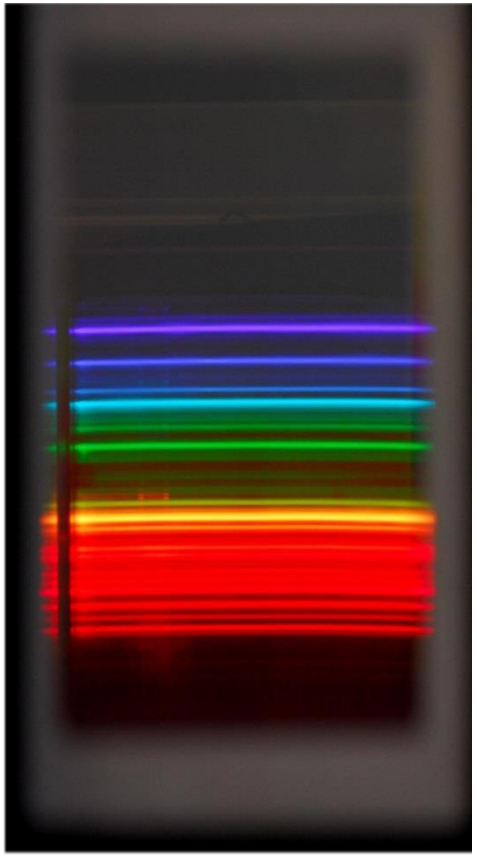
$$\lambda = \frac{d \sin \theta_m}{m}$$

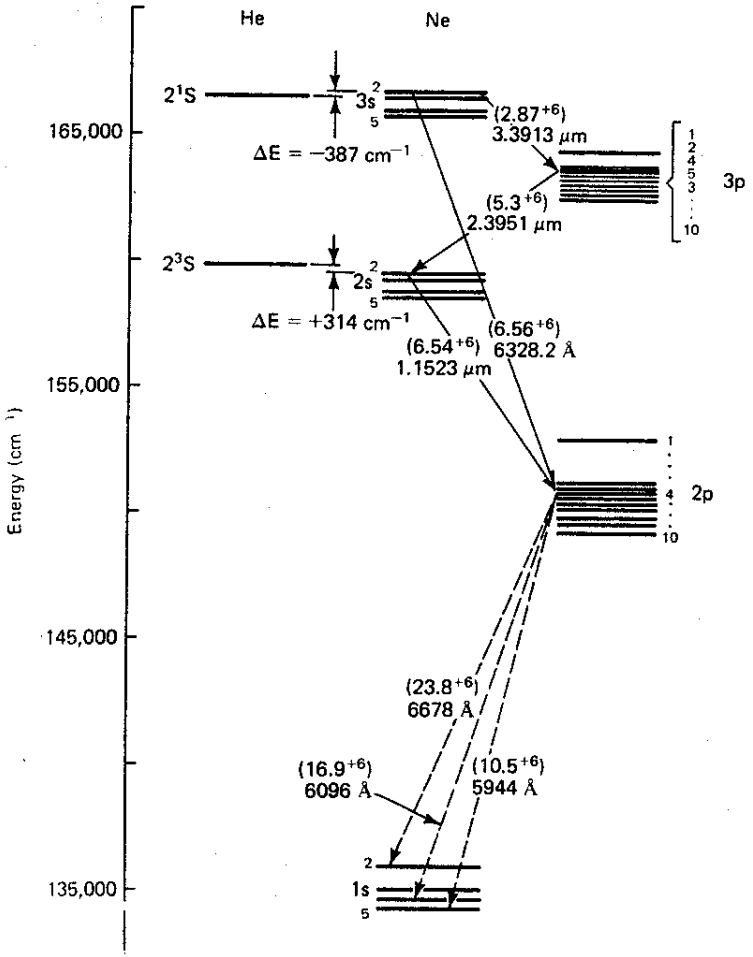
Aus: Laser System Design and Alignment
Wee Yongjun, Singapore
Laboratory Report

NANYANG TECHNOLOGICAL UNIVERSITY

Konkurrierende Prozesse

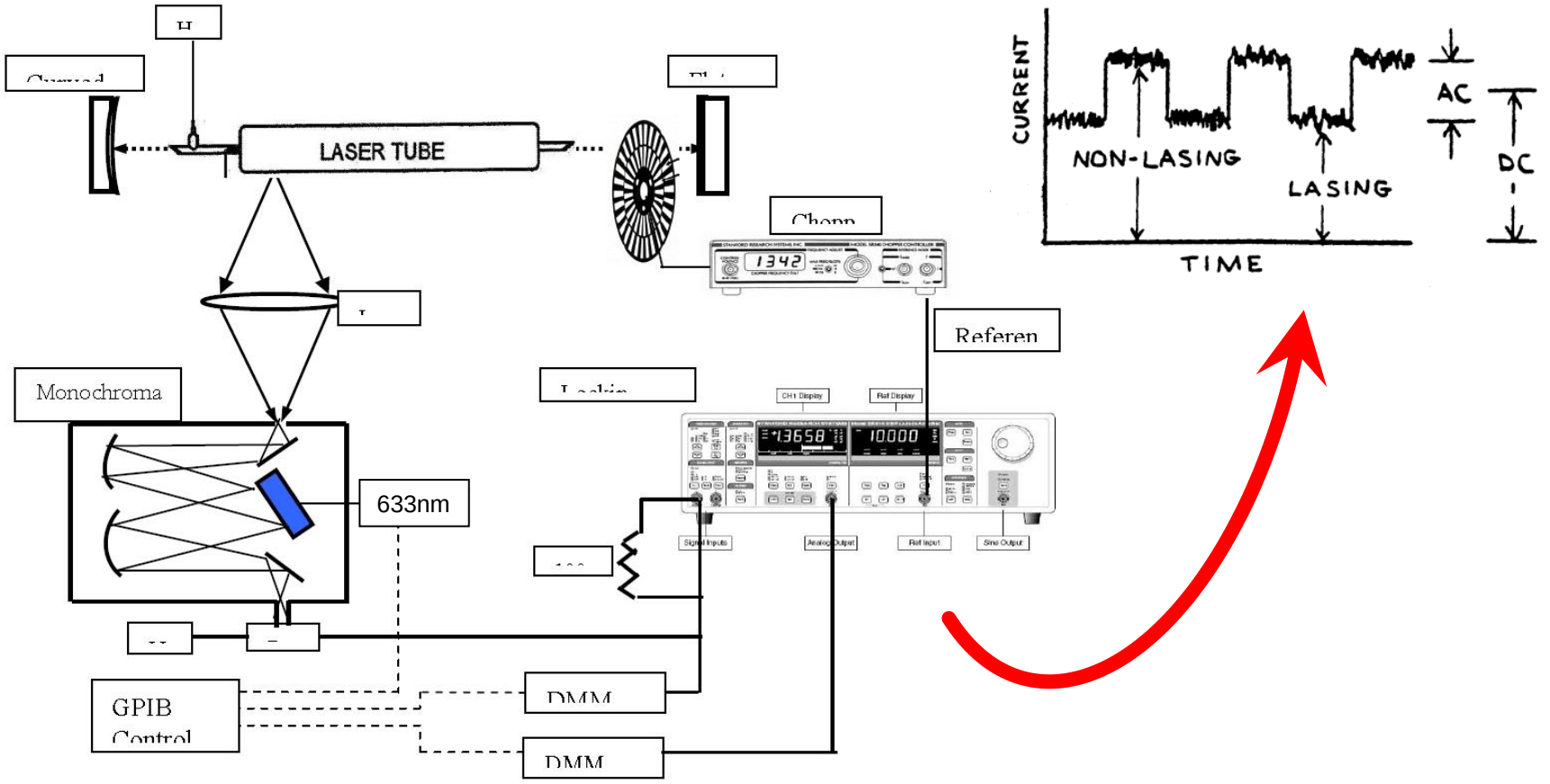
Spontane Emission





Stimulierte Emission

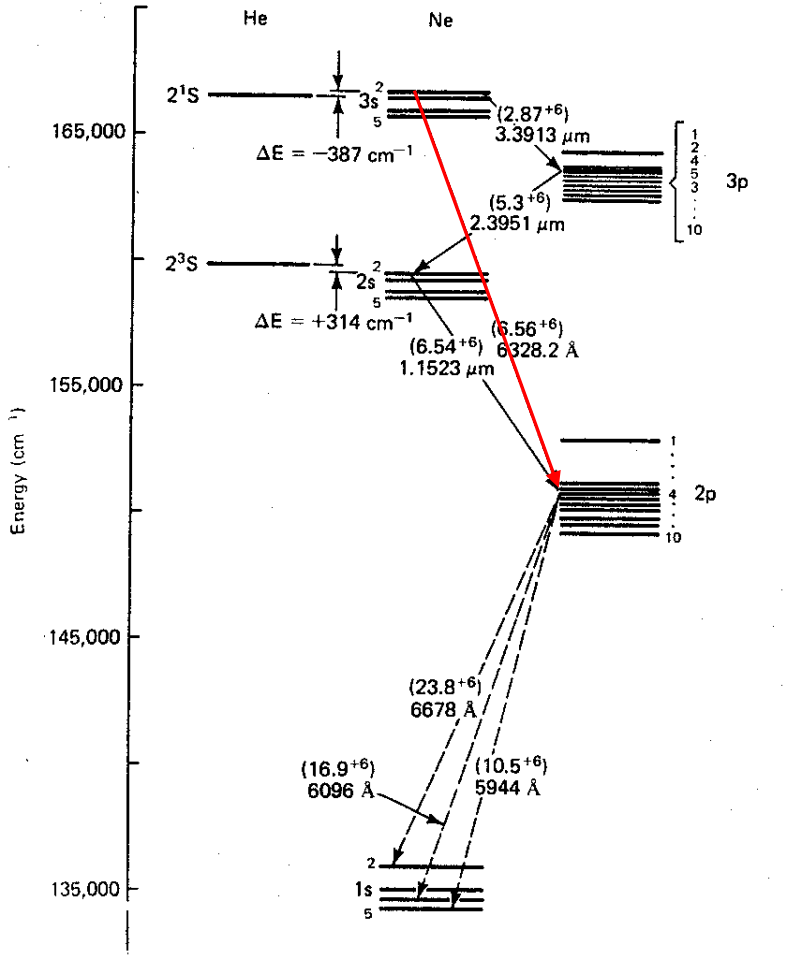
Spontane vs. Stimulierte Emission



Aus: Experiment O-2
„The Atomic Physics of a Laser Plasma"
Department of Physics, Stanford University

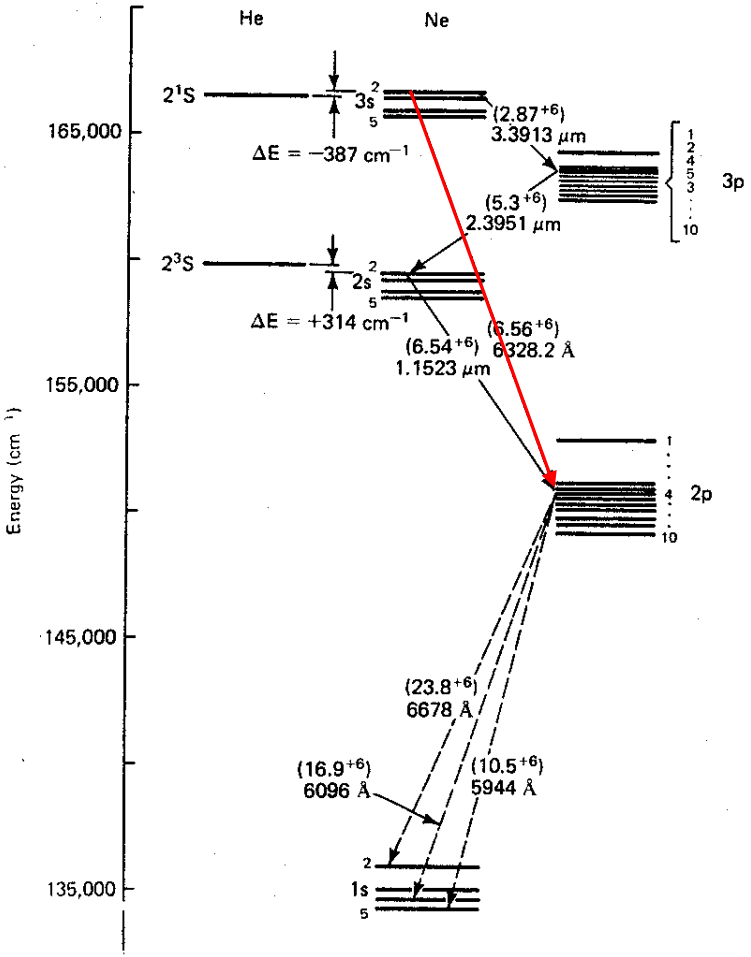
Spontane vs. Stimulierte Emission

Laser aus → Fluoreszenz 100%

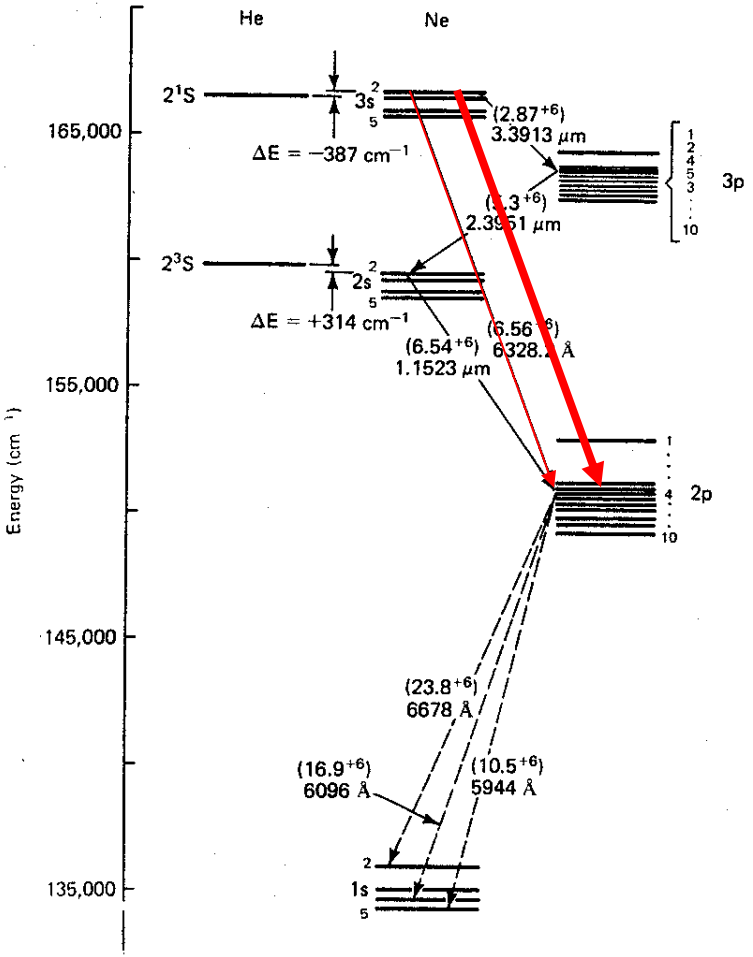


Spontane vs. Stimulierte Emission

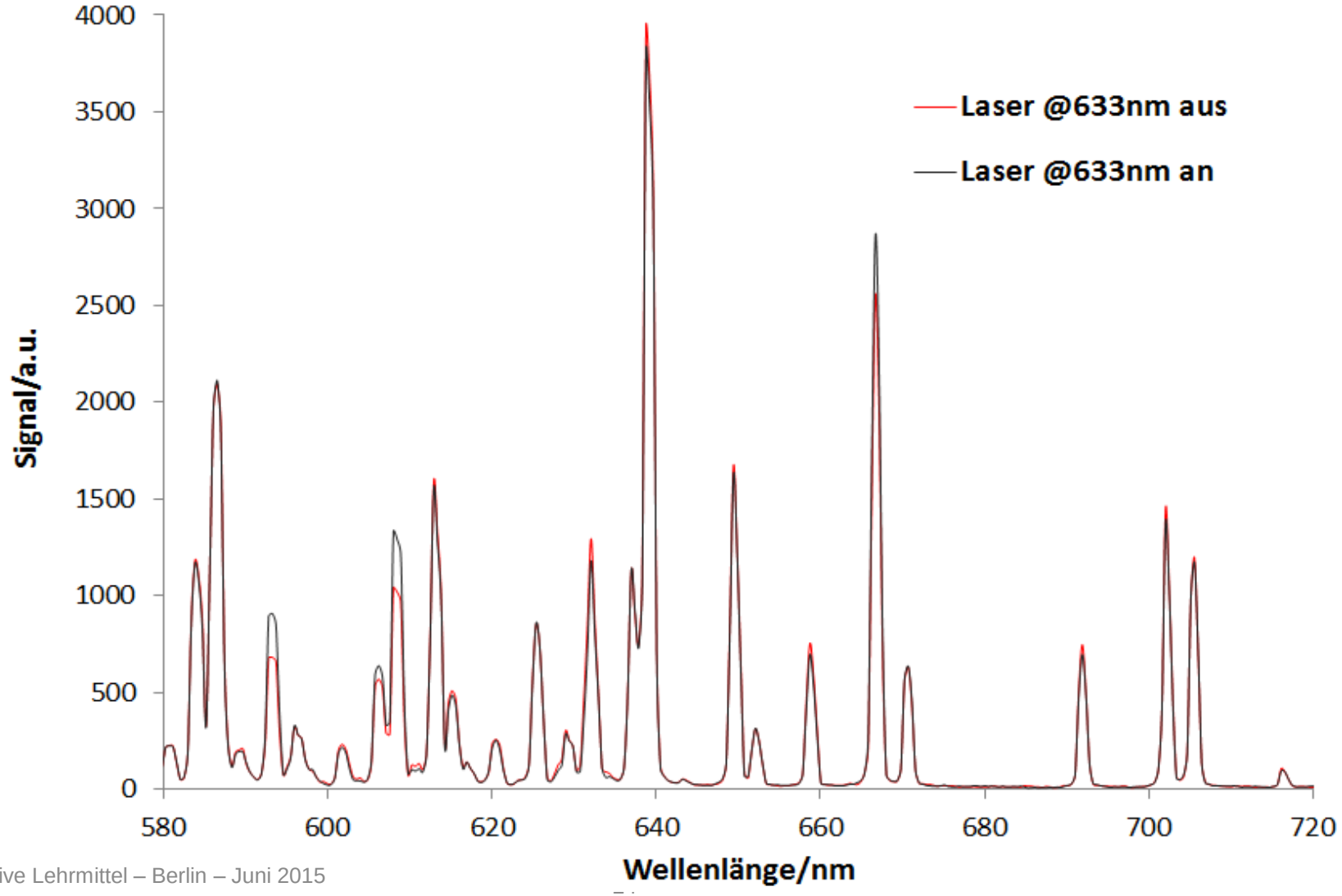
Laser aus → Fluoreszenz 100%



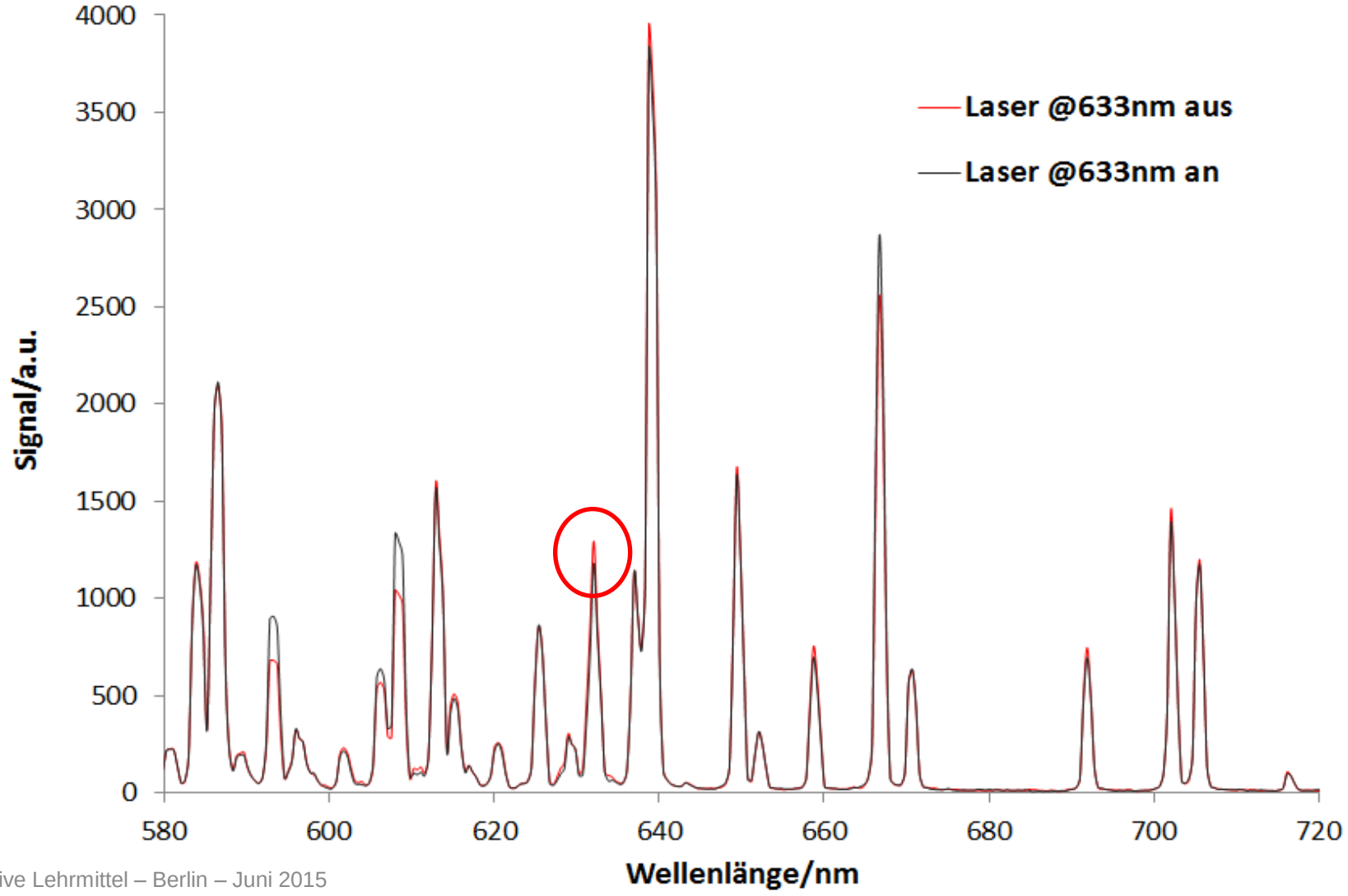
Laser an → Fluoreszenz reduziert



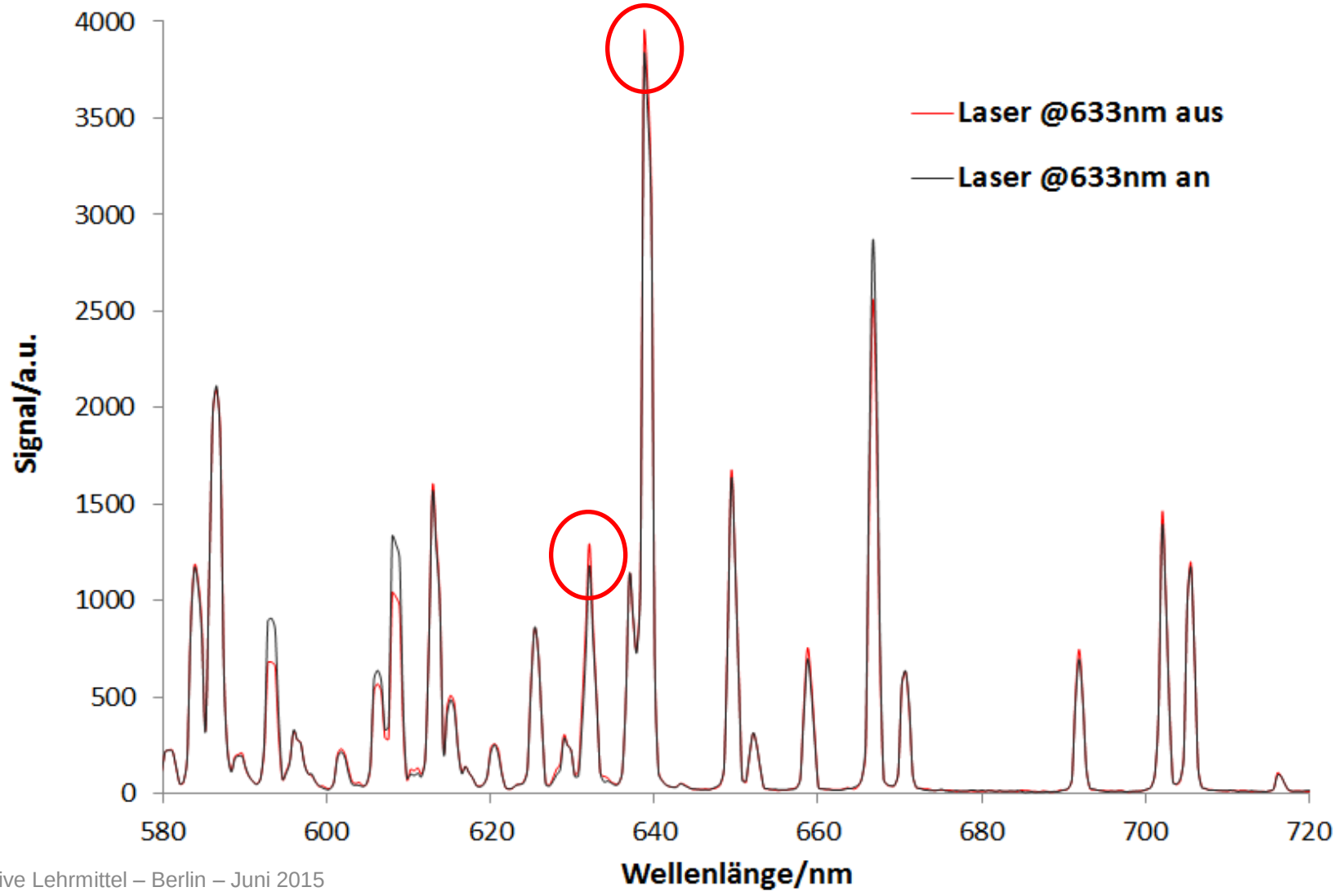
Spontane vs. Stimulierte Emission



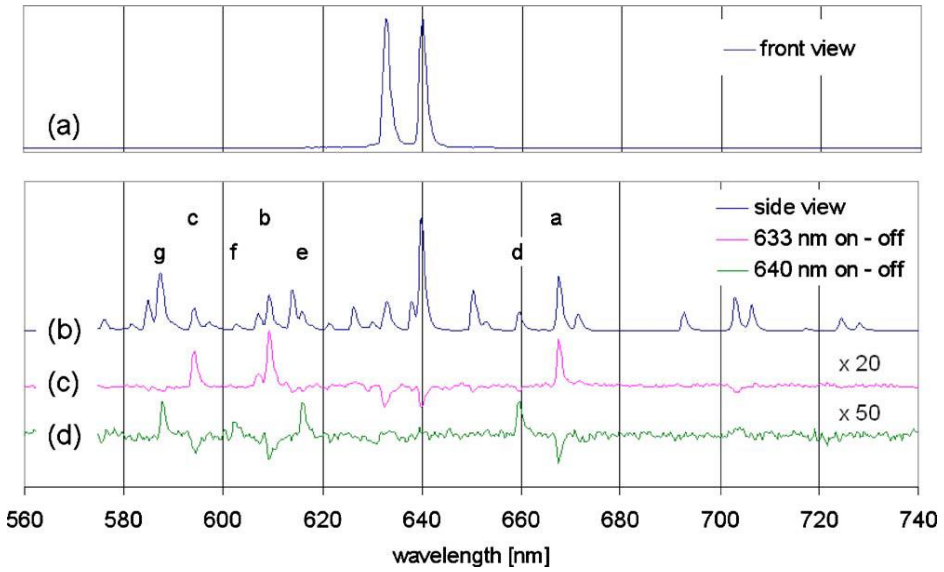
Spontane vs. Stimulierte Emission

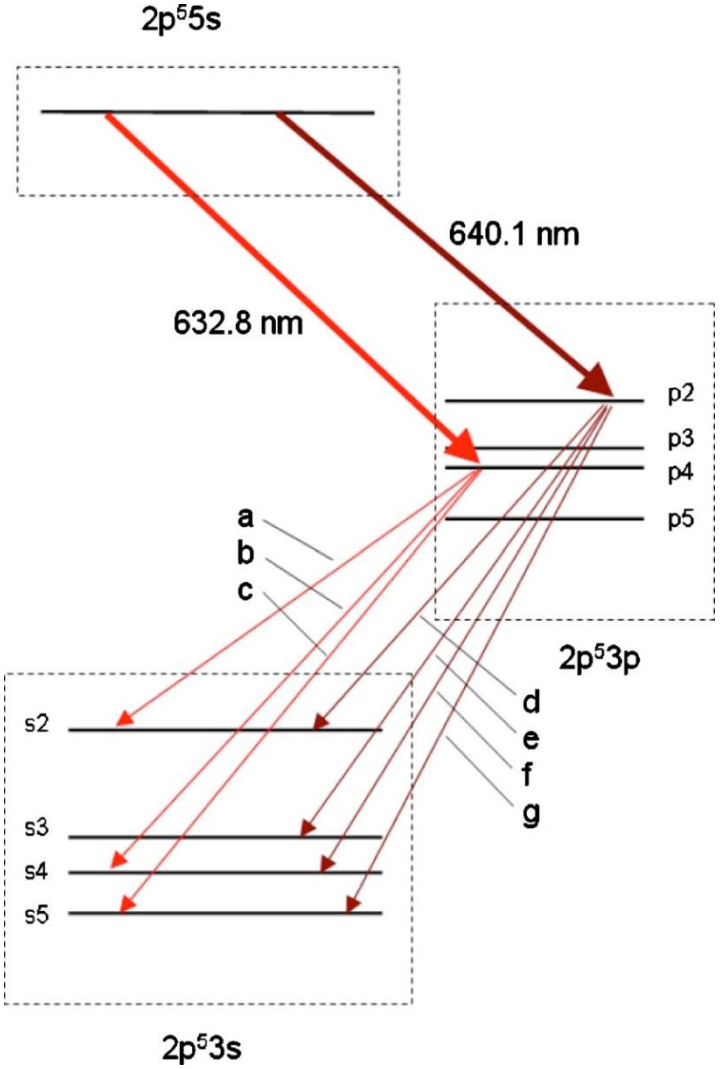


Spontane vs. Stimulierte Emission



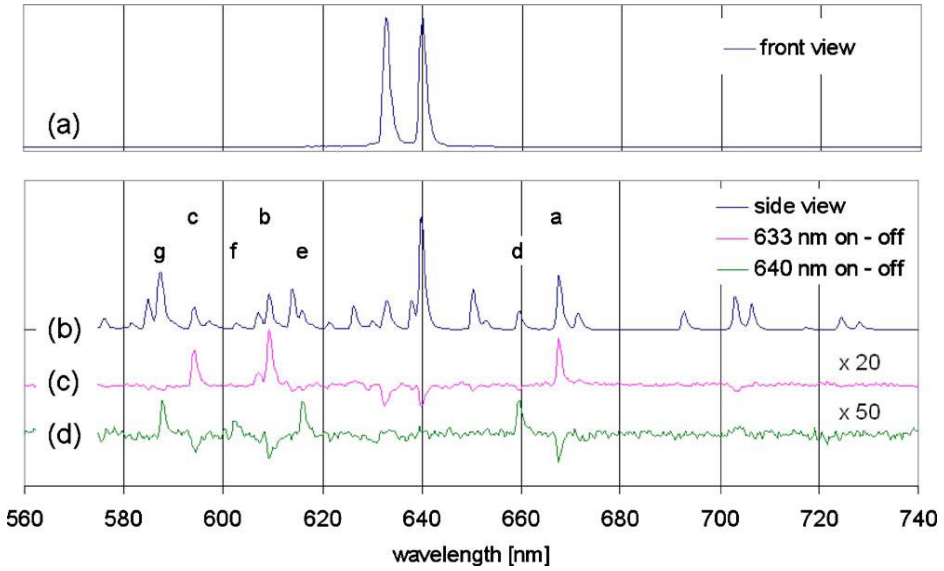
Verstärkung von Fluoreszenzlinien

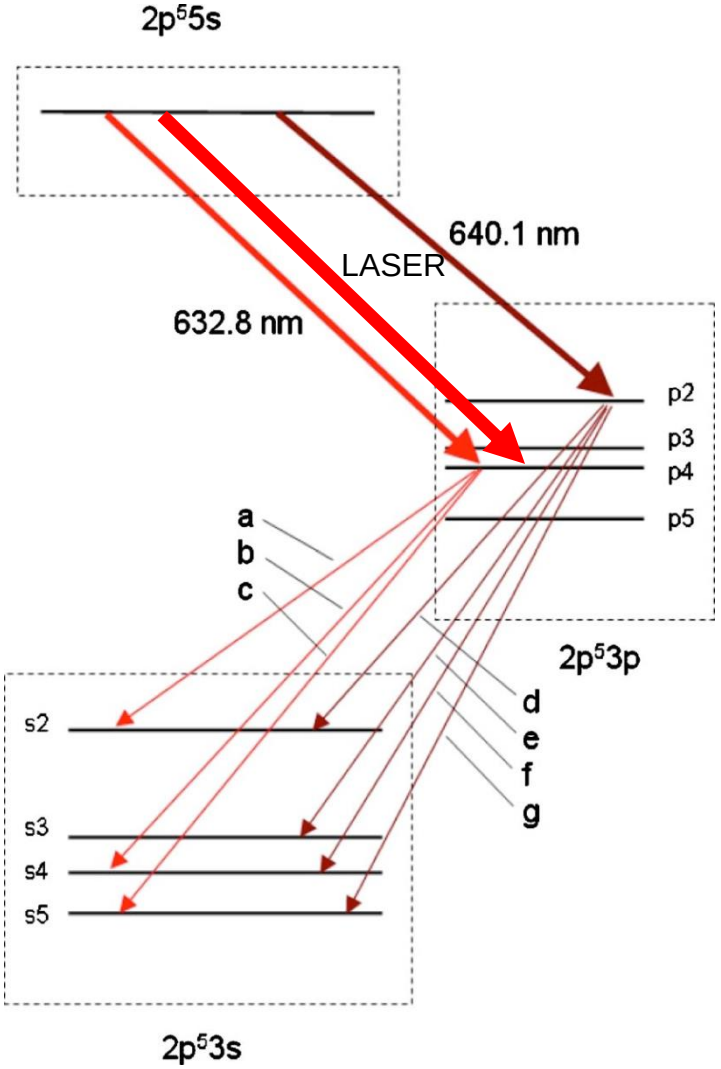




Jes Henningsen
"Teaching laser physics by experiments"
Am. J. Phys. **79** (1), January 2011

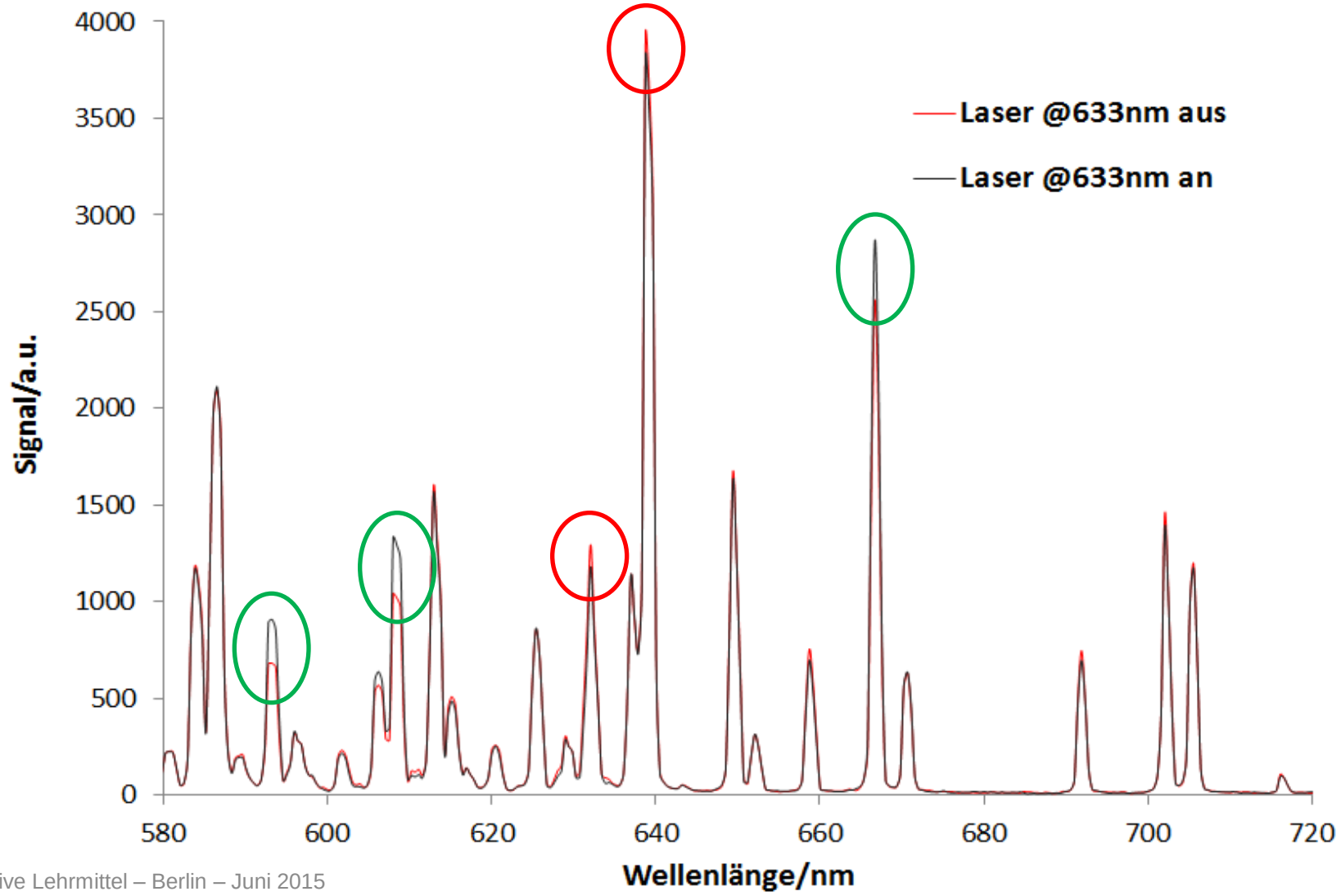
Verstärkung von Fluoreszenzlinien



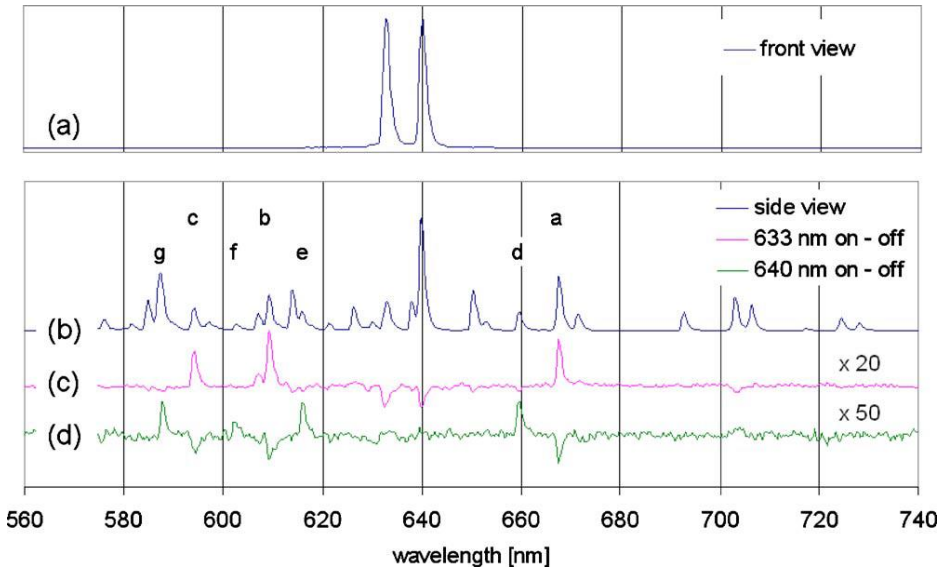


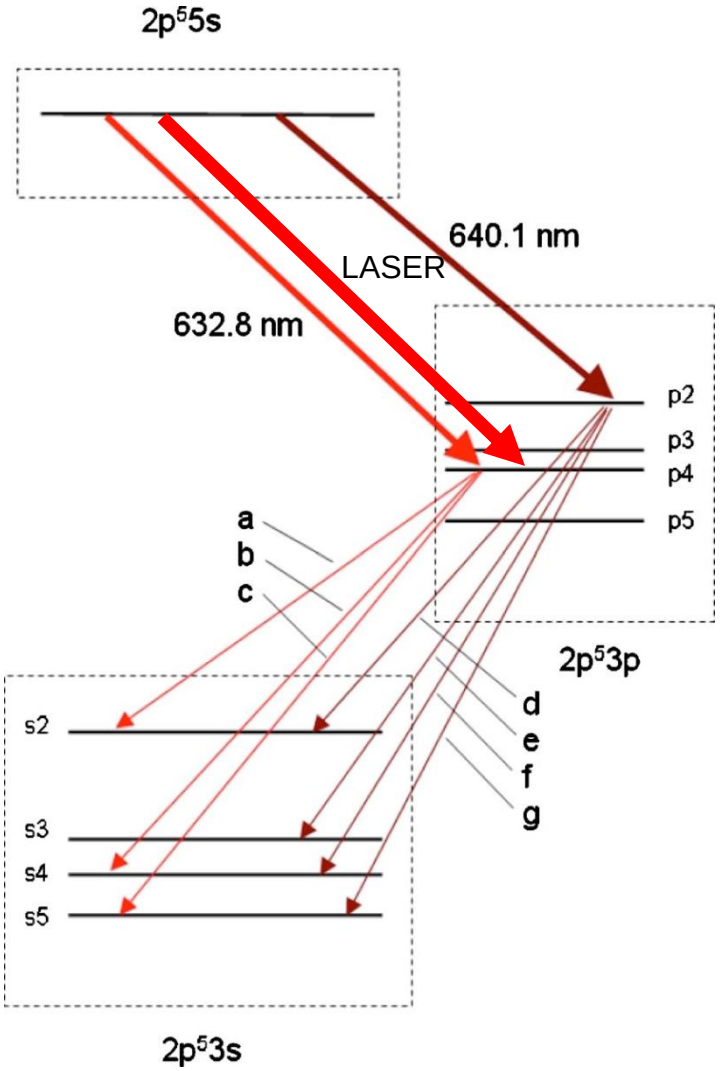
Jes Henningsen
"Teaching laser physics by experiments"
Am. J. Phys. **79** (1), January 2011

Spontane vs. Stimulierte Emission



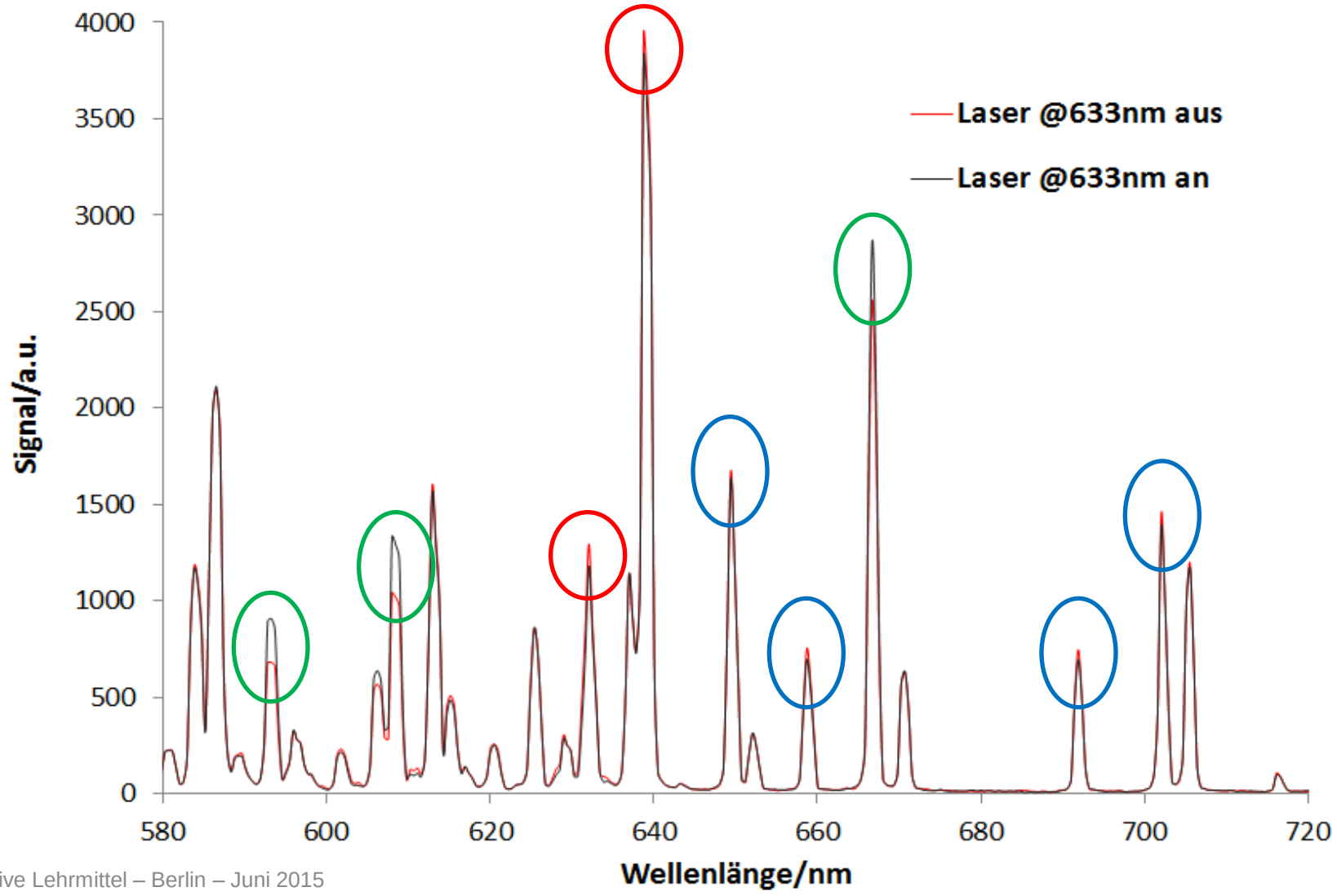
Verstärkung von Fluoreszenzlinien



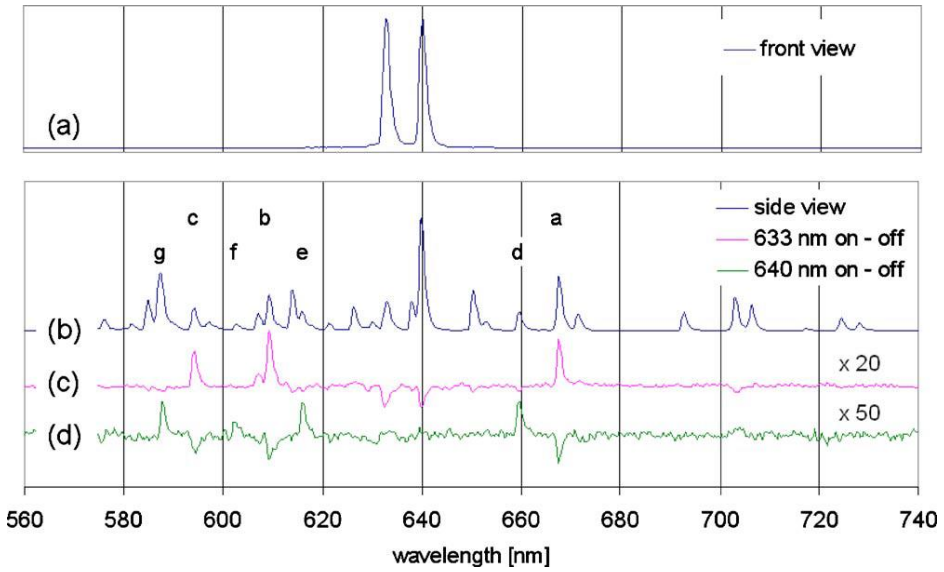


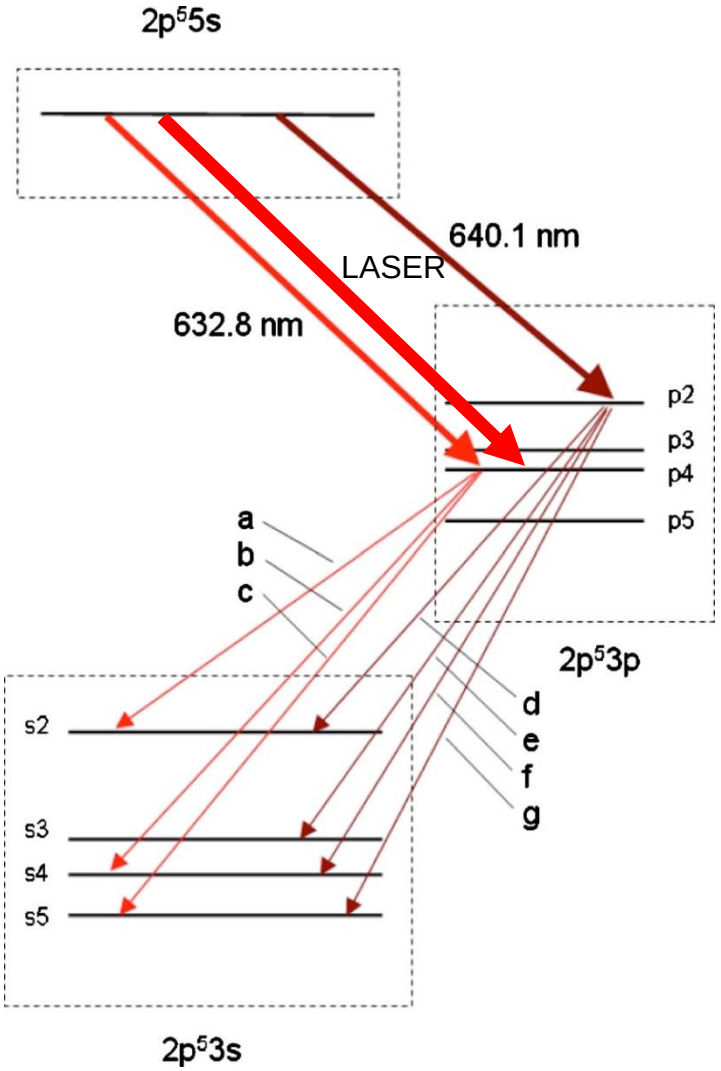
Jes Henningsen
"Teaching laser physics by experiments"
Am. J. Phys. **79** (1), January 2011

Spontane vs. Stimulierte Emission



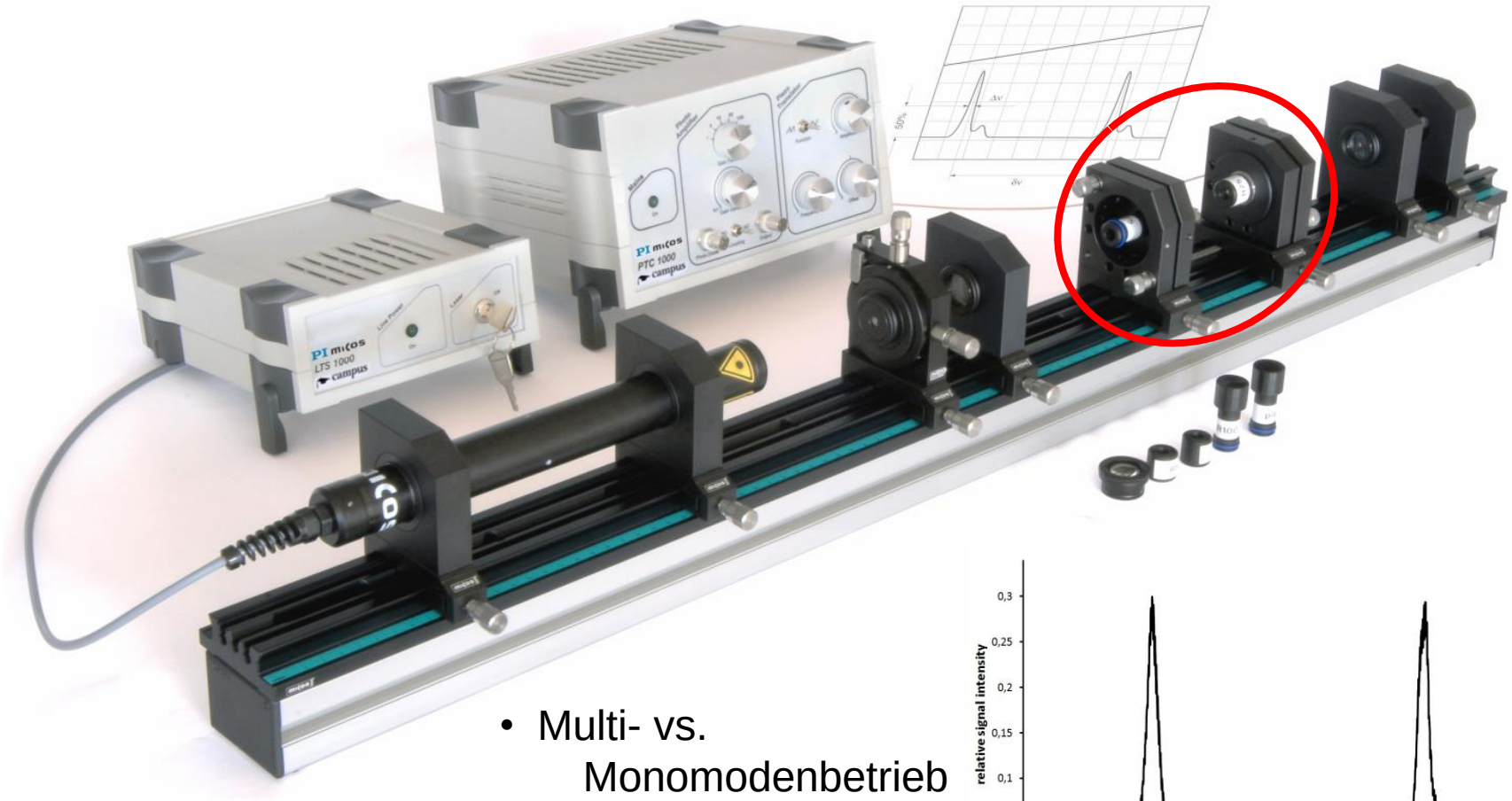
Verstärkung von Fluoreszenzlinien





Jes Henningsen
"Teaching laser physics by experiments"
Am. J. Phys. **79** (1), January 2011

Longitudinalmoden: Durchstimmbares Fabry-Perot-Etalon



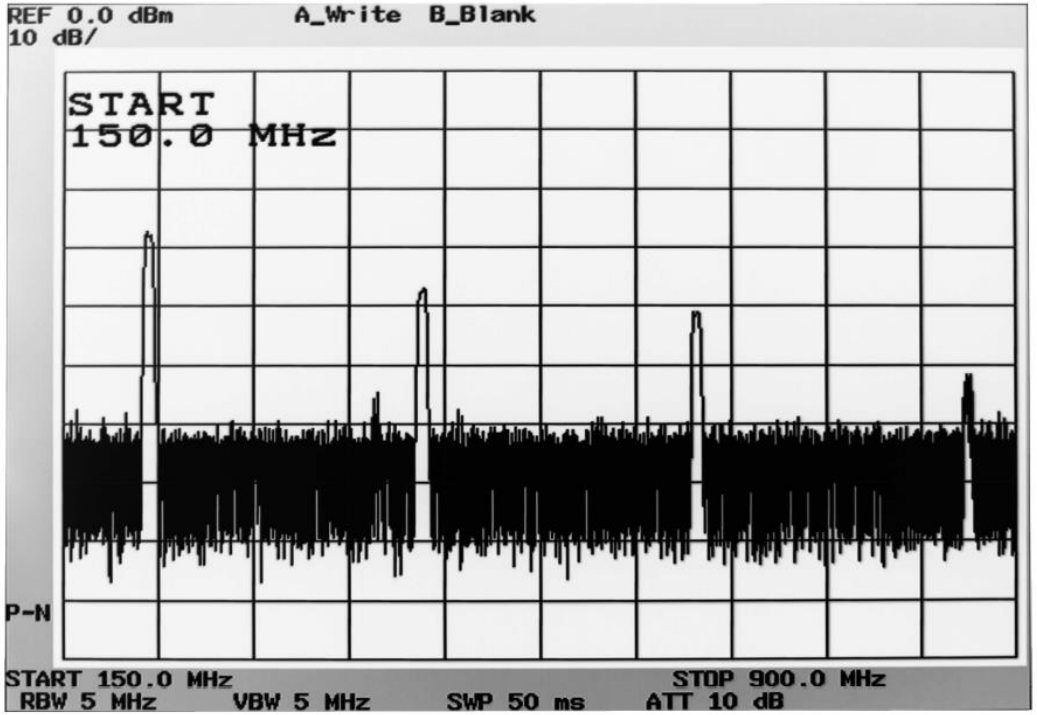
- Freier Spektralbereich
- Finesse

- Multi- vs. Monomodenbetrieb
- Bestimmung des Modenabstands

Longitudinalmoden: Spektrum-Analysator

Modenblende im Resonator:
TEM_{00}-Moden

$$\Delta\nu = \frac{c}{2L}\left(\Delta q\right)$$

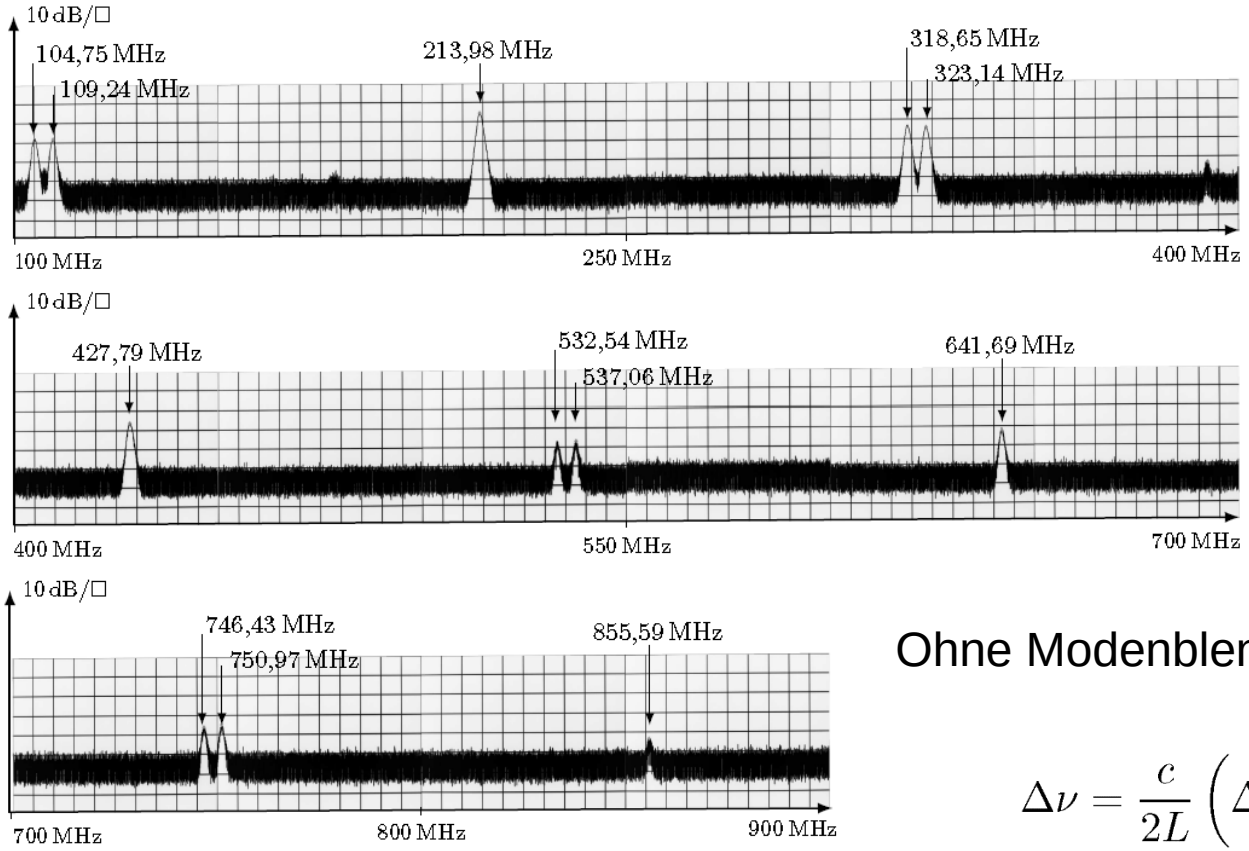


Messung der Schwebungsfrequenzen

Aus: Grundlagen des He-Ne-Lasers
Jan Kehlbeck
Bachelor-Arbeit 2012

PHYSIKA Physikalische Praktika der Universität Bremen

Longitudinalmoden: Spektrum-Analysator



Ohne Modenblende: TEM_{10}- bzw. TEM_{01}

$$\Delta\nu = \frac{c}{2L}\left(\Delta q + \frac{1}{2}(\Delta m + \Delta n)\right)$$

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Jan Kehlbeck
Bachelor-Arbeit 2012

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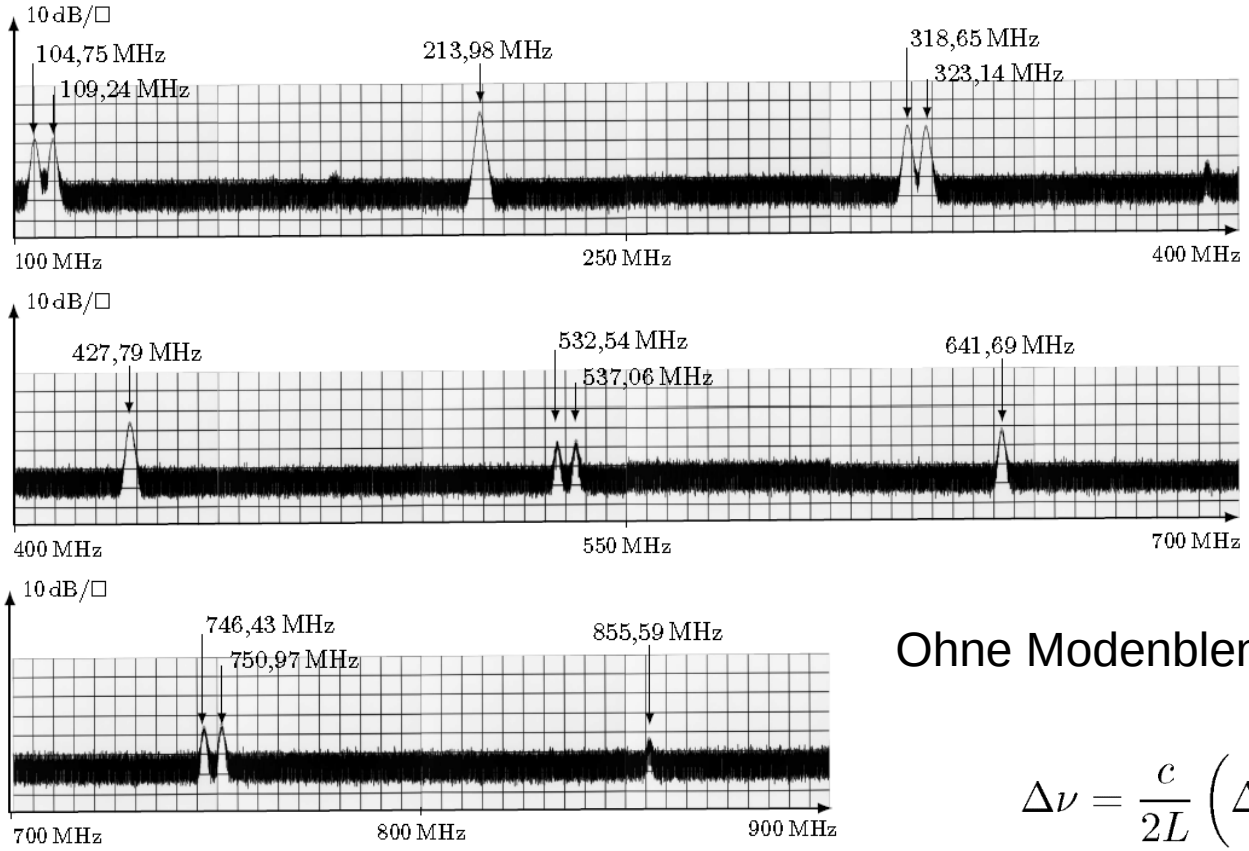
Longitudinalmoden: Spektrum-Analysator



Ohne Modenblende: TEM_{10}- bzw. TEM_{01}

$$\Delta\nu = \frac{c}{2L}\left(\Delta q + \frac{1}{2}(\Delta m + \Delta n)\right)$$

Herzlichen Dank für Ihre Aufmerksamkeit!