LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

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Fachverband Didaktik der Physik

Normaler und anormaler Zeeman-Effekt im Praktikum

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Theorie:

$$H = \frac{\boldsymbol{p}^2}{2m} + V_\mathrm{C}(r) + \frac{1}{2m^2c^2}\boldsymbol{S}\cdot\boldsymbol{L}\frac{1}{r}\frac{\mathrm{d}V_\mathrm{C}(r)}{\mathrm{d}r} - \frac{e\,|\boldsymbol{B}|}{2mc}(J_\mathrm{z}+S_\mathrm{z})$$

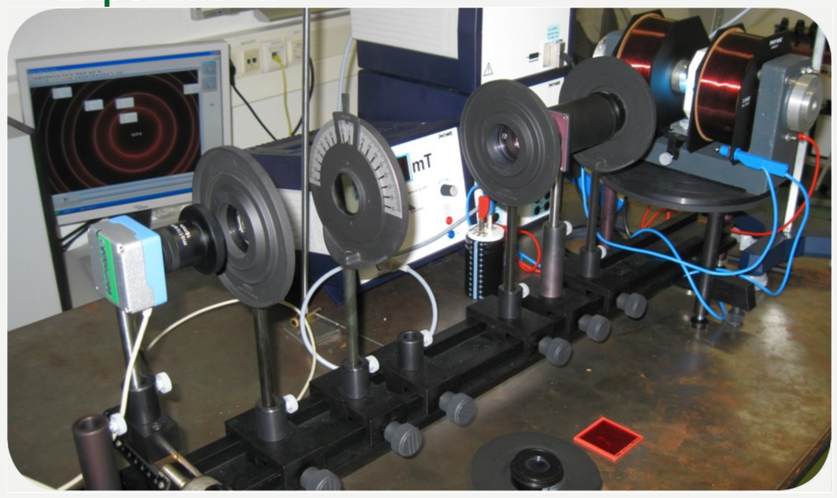
$$\Delta E = \langle J, M_J, L, S| - \frac{e\,|\boldsymbol{B}|}{2mc}(J_\mathrm{z}+S_\mathrm{z})\,|J, M_J, L, S\rangle$$

$$\Delta E = \left(1 + \frac{J(J+1)+S(S+1)-L(L+1)}{2J(J+1)}\right)\cdot\mu_\mathrm{B}\cdot M_J\cdot B$$

$$g_{1\to2} = (M'_J g'_J - M''_J g''_J)$$

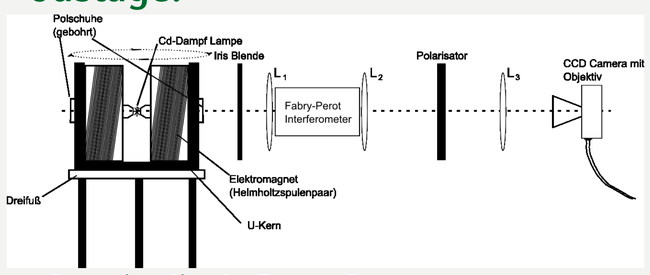
$$\Delta k = g_{1\to2}\frac{\mu_\mathrm{B}B}{hc}$$

Experiment:



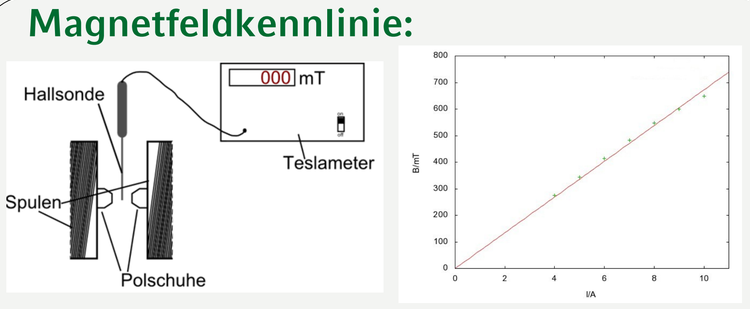
Teilversuche:

Justage:



Longitudinale Betrachtung

Magnetfeldkennlinie:

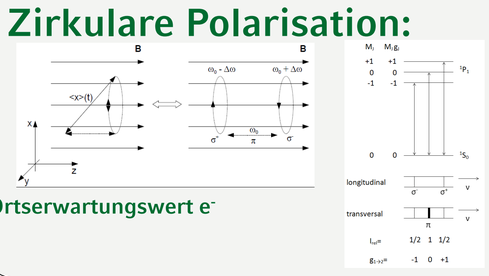


Cd-Spektrum:

- Rot, $\lambda = 643{,}85\,\mathrm{nm}$; Übergang: ${}^1D_2 \rightarrow {}^1P_1$ d.h. $S=0, L=2, J=2 \rightarrow S=0, L=1, J=1$
- Blau, $\lambda = 467{,}82\,\mathrm{nm}$; Übergang: ${}^3S_1 \rightarrow {}^3P_0$ d.h. $S=1, L=0, J=1 \rightarrow S=1, P=1, J=0$
- Grün, $\lambda = 508{,}59\,\mathrm{nm}$; Übergang: ${}^3S_1 \rightarrow {}^3P_2$ d.h. $S=1, L=0, J=1 \rightarrow S=1, L=1, J=2$

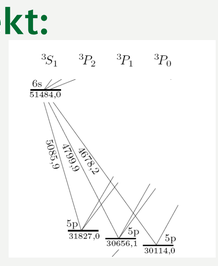
Vermessung des normalen Zeeman-Effekts:

Zirkulare Polarisation:



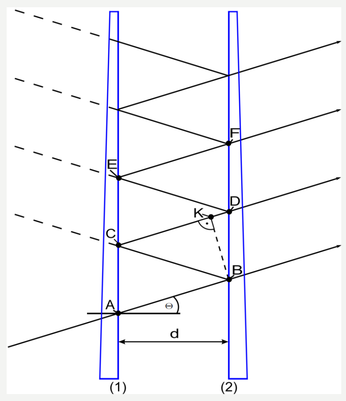
Ortserwartungswert e^-

Anormaler Zeeman-Effekt:

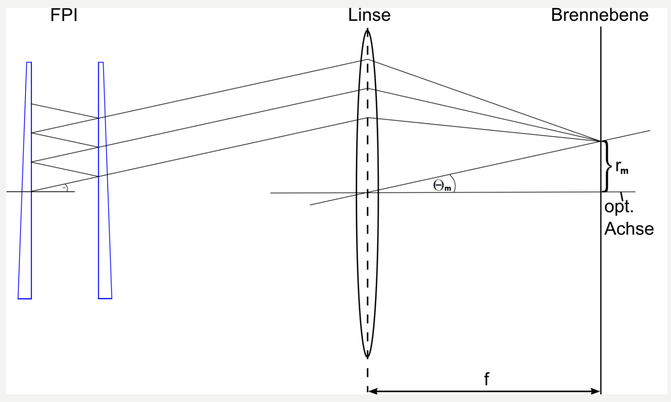


Bestimmung des Landé-Abstandsfaktor $g_{1\to2}$:

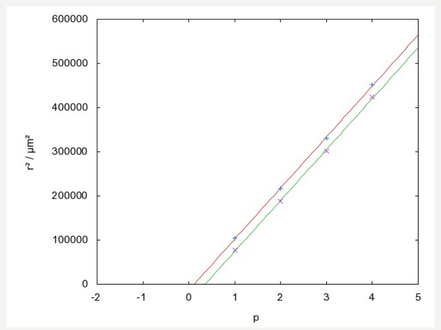
Fabry-Pérot-Interferometer

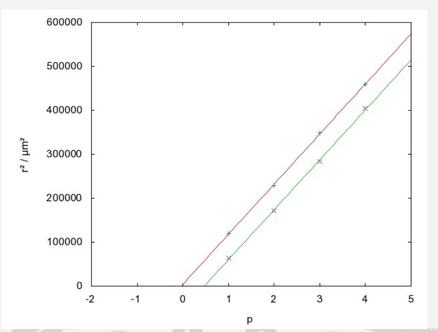


optische Abbildung



Quadrat des Radius r² gegen die Ringnummer p





Auswertung mit gnuplot/MATLAB/Octave

$$2\cdot d\cos\Theta_m = m\cdot\lambda$$

$$m = m_0 - (p-1)$$

$$m_0 = \frac{2d}{\lambda} = \frac{6\,\mathrm{mm}}{643{,}9\,\mathrm{nm}} = 9318$$

$$r_m = f\cdot\tan\Theta_m$$

$$r_m^2 = f^2(-\frac{m\lambda}{d}+2)$$

$$r_m^2 = f^2\left(-\frac{m_0-(p-1)}{d}\lambda+2\right)$$

$$\Delta p_0 = -2d\cdot\left(\tfrac{1}{\lambda^+}-\tfrac{1}{\lambda^-}\right)$$

$$\Rightarrow \quad \Delta p_0 = 2d\cdot\Delta k$$

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