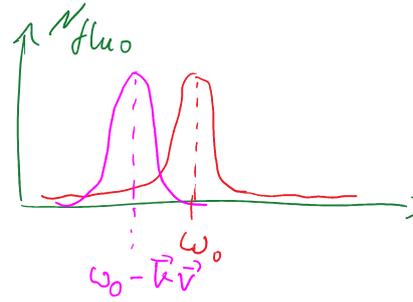
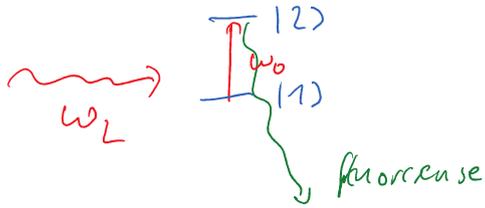


Doppler-free laser spectroscopy

Mittwoch, 11. Januar 2023 16:19

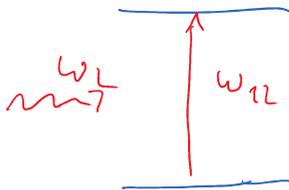
Doppler effect



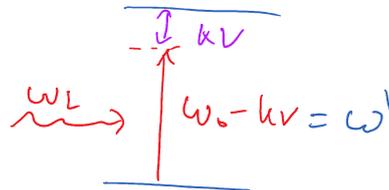
\vec{k} wave vector of the light

$$|\vec{k}| = k = \frac{\omega_L}{c} = \frac{2\pi}{\lambda_L}$$

at rest



with Doppler $\vec{k} \cdot \vec{v} \neq 0$



$$\omega' = \omega - kv$$

$$\delta = \text{detuning} = \omega - \omega_0$$

$$(8.2) \quad \frac{\delta}{\omega_0} = \frac{v}{c}$$

$$\delta = kv$$

$$k = \frac{\omega_L}{c}$$

$$\Rightarrow \delta = \frac{\omega_L}{c} \cdot v \Leftrightarrow \frac{\delta}{\omega} = \frac{v}{c} \equiv (8.2)$$

$$v_{\text{typ}} \approx 300 \frac{\text{m}}{\text{s}} \text{ @ } "RT"$$

$$c = 3 \cdot 10^8 \frac{\text{m}}{\text{s}}$$

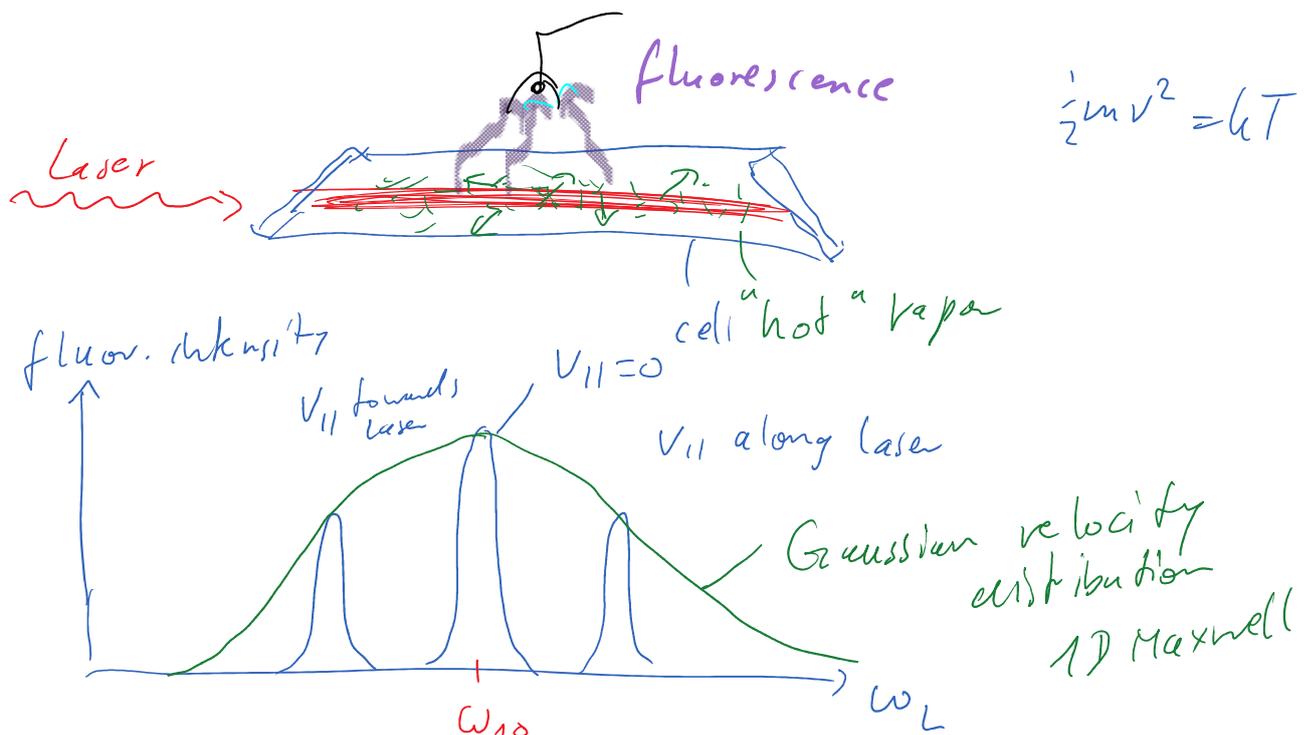
$$\frac{v}{c} \approx 10^{-5}$$

$$\text{if } \omega = 500 \text{ THz} \quad (\text{visible light})$$

$$\delta \approx 16 \text{ Hz}$$

Doppler shifts are huge compared to natural line widths (5 MHz for D Lines in Alkali's, 1 Hz for H (1s-2s 2 photon))

Typical signal of laser spectroscopy in a cell



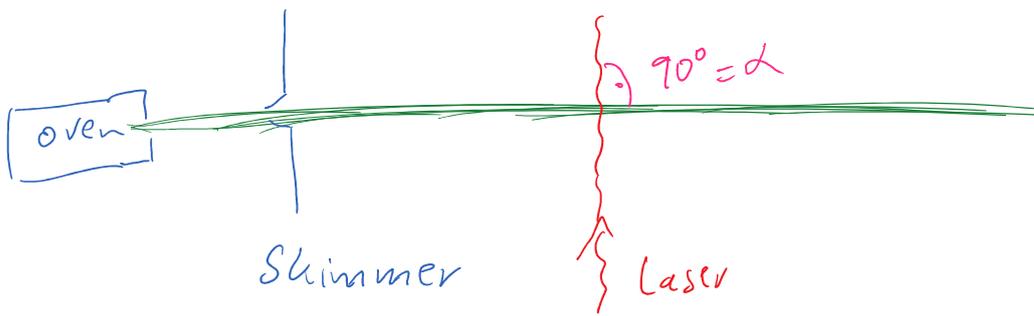
Result: Voigt profile

Result: Voigt profile

$$v(\omega) = \int g(\omega) \cdot l(\omega - \tau) d\tau$$

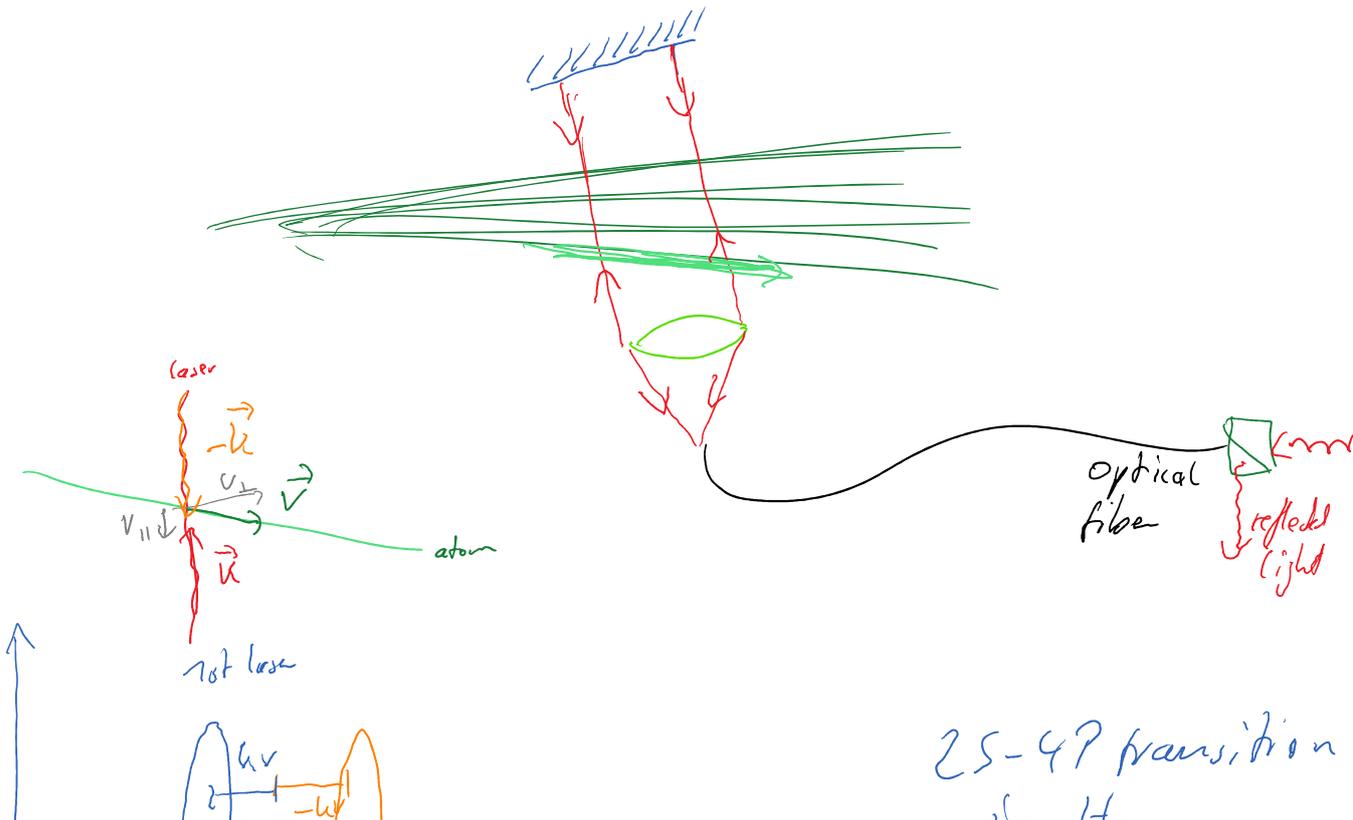
Beyond Doppler-limit

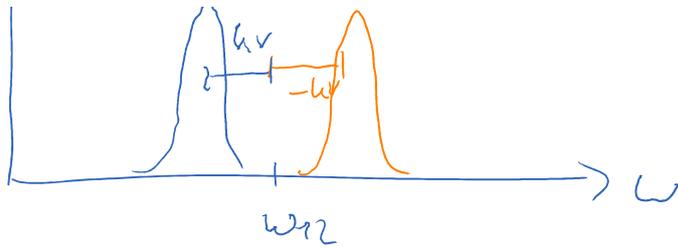
8.2. Crossed beam method



Problem: if $\alpha \neq 90^\circ \Rightarrow$ systematic shift

Solution: 2 lasers or 1 laser + Mirror





2S-4P transition
in H

New systematic: photon recoil

