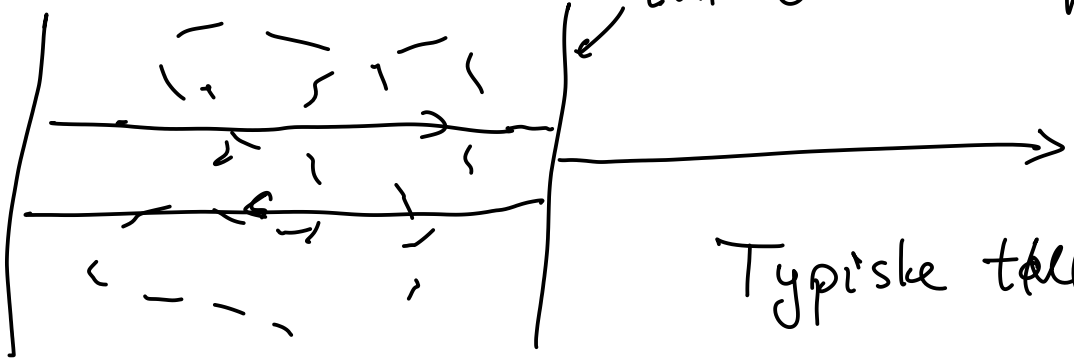
Lasere

Emisjonsrate: $w_{fi} = \frac{2\pi}{\hbar} |\underbrace{\langle B, n_{ka}+1 | H_{emis} | A, n_{ka}\rangle}|^2 \delta(\,)$

$i e \sqrt{\frac{\hbar (n_{ka}+1)}{2\varepsilon_0 \omega_k}}\, \omega_{AB}\, \vec{\varepsilon}_{ka}\, \vec{r}_{BA}\, e^{i\omega t}$

$w_{fi} = (\,)\ (n_{ka}+1)$



Speil Speil

Typiske tall:

Total spontan em.

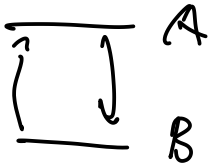
$\Gamma_{sp} = 10^7\ s^{-1}$

Stimulert: $n\,\Gamma_{st}$ $\Gamma_{st} = 1\ s^{-1}$

Stim. em. viktig for $n_s \Gamma_{st} = \Gamma_{sp}$

$n = n_s$ $n_s = \frac{\Gamma_{sp}}{\Gamma_{st}} = 10^7$

Absorpsjon: $w_{abs} \sim n_{ka}$



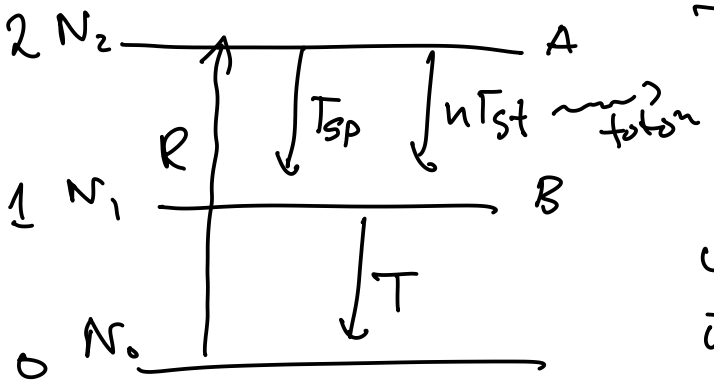
Em: $N_A \cdot \underbrace{w_{fi}}_{n+1}$ Abs $N_B \cdot \underbrace{w_{abs}}_{n}$

For at em > abs $\Rightarrow N_A > N_B$

Termisk likevekt — populasjonsinversjon

$$P_A = \frac{e^{-E_A/T}}{e^{-E_A/T} + e^{-E_B/T}} \qquad P_B = \frac{e^{-E_B/T}}{Z} \qquad P_B > P_A$$

Enkel modell:



$T \gg T_{sp}, nT_{st}$ $\qquad N_2 > N_1$

$\underbrace{N_0 \cdot R}_{\text{inn i 2}} = \underbrace{N_2(T_{sp} + nT_{st})}_{\text{ut av 2}}$

↑ Stasjonær tilstand

Forenkling: $N_0 \approx N$ = antall atomer.

To ukjente: N_2 atomer i 2.

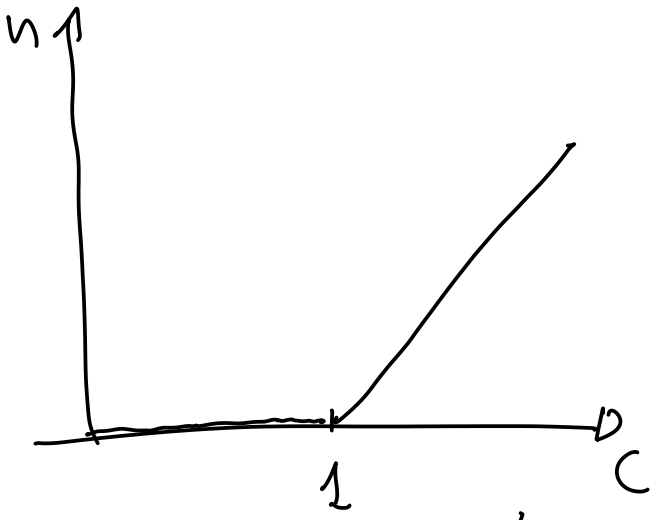
n antall fotoner

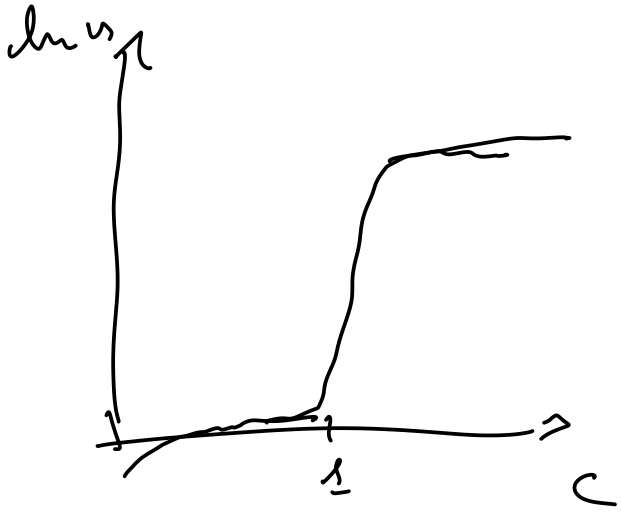
Fotoner: $N_2 T_{st}(n+1) = T_{cav} \cdot n$

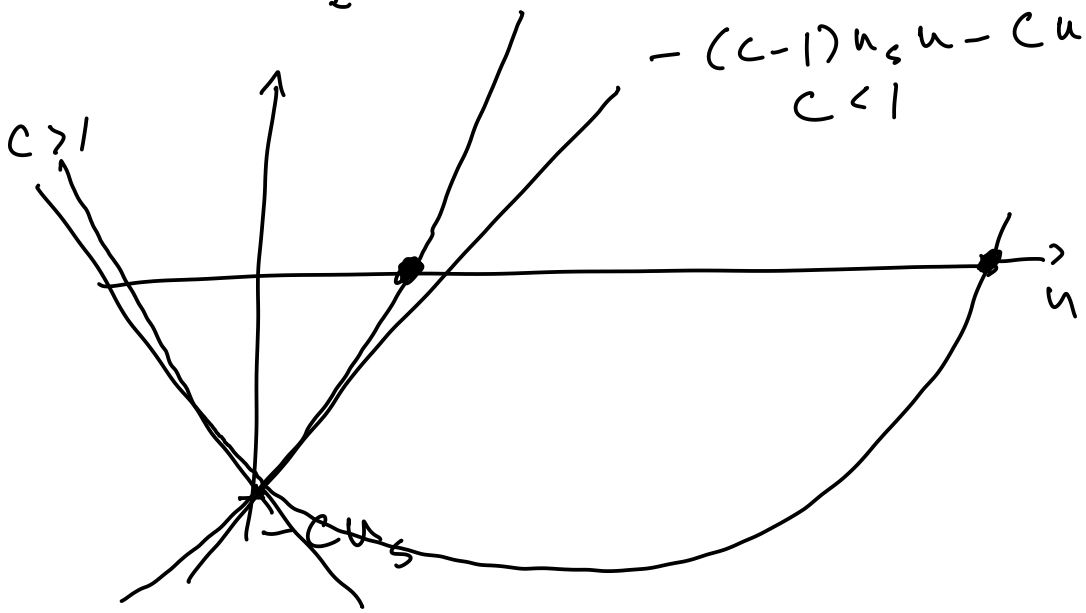
$$\Rightarrow f(n) = n^2 - (C-1) n_s n - C n_s = 0$$

$$C = \frac{N R T_{st}}{T_{sp} T_{cav}} \qquad n_s = \frac{T_{sp}}{T_{st}}$$

$$n = \frac{1}{2}(c-1)n_s + \frac{1}{2}\sqrt{(c-1)^2 n_s^2 + 4 c n_s} \qquad n_s = 10^7$$







$$f(n) = n^2 - (c-1)n_s n - c n_s$$