Emission und Absorption eines Photons

$\langle B; (n-1)(\vec{k},\kappa) | a_\alpha(\vec{k},t) | A; n(\vec{k},\kappa)\rangle \sim \sqrt{n_n(\vec{k},\kappa)}$ Absorption

$\langle B; (n+1)(\vec{k},\kappa) | a^+_\alpha(\vec{k},t) | A; n(\vec{k},\kappa)\rangle \sim \sqrt{(n+1)(\vec{k},\kappa)}$ Emission

Spontane Emission

Übergangsrate:

$$R_{A\to B+\gamma(\vec{k},\kappa)} = \frac{2\pi}{\hbar^2}\,\delta\left(\frac{E_B - E_A}{\hbar} + \omega_k\right)\frac{e^2}{m^2}\,\frac{\hbar}{2\varepsilon_0\omega_k}$$
$$\cdot \left| \sum_i \langle B | e^{-i\vec{k}\cdot\vec{x}_i}\, \vec{p}_i \cdot \vec{\varepsilon}^{\,*}_\alpha(\vec{k}) | A\rangle \right|^2$$

Totale Zerfallsrate:

$$R_{A\to B+\gamma} = \frac{1}{2j_A+1} \sum_{m_{j_A}} \sum_{m_{j_B}} \int \frac{d^3k}{(2\pi)^3} \sum_\alpha R_{A\to B+\gamma(\vec{k},\kappa)}$$

für H-Atom

$$R_{A\to B+\gamma} = \frac{1}{2j_A+1} \sum_{m_{j_A}\cdot m_{j_B}} \frac{e^2}{4\pi\varepsilon_0\hbar c}\,\frac{4}{3}\,\frac{|\omega_{BA}|^3}{c^2}\,X^2_{BA}$$

mit $X^2_{BA} = |\langle B|x_i|A\rangle|\,|\langle B|x_i|A\rangle|$