L77-Spontaneous Emission

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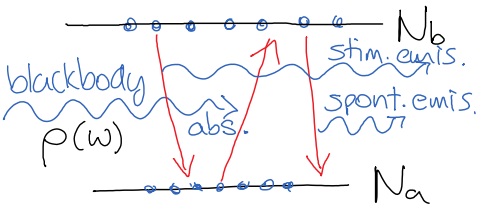
* Einstein's A, B coefficients

recall: $R_{b\to a} \equiv \frac{dP_{b\to a}}{dt} = \underbrace{\frac{\pi |g_{ab}|^2}{3\varepsilon_0 \hbar^2}}_{B} \rho(\omega_0)$



$B_{ab}\rho(\omega_0)N_a$ = rate of stimulated absorption

$B_{ba}\rho(\omega_0)N_b$ = rate of stimulated emission

$A_{ba}N_b$ = rate of spontaneous emission

detailed balance: assuming thermal equilibrium:

$$\dot{N}_b = -N_b A - N_b B_{ba}\rho(\omega_0) + N_a B_{ab}\rho(\omega_0) = 0$$

$$\rho(\omega_0) = \frac{A}{N_a/N_b B_{ab} - B_{ba}} = \frac{A}{e^{\frac{\hbar\omega_0}{kT}} B_{ab} - B_{ba}} = \frac{\hbar}{\pi^2 c^3} \frac{\omega_0^3}{e^{\frac{\hbar\omega_0}{kT}} - 1}$$

where $N_a \sim e^{-E_a/kT}$, $N_b \sim e^{-E_b/kT}$, using Blackbody distribution.

thus $B_{ab} = B_{ba} = \frac{\pi |g_{ab}|^2}{3\varepsilon_0 \hbar^2}$, $A = \frac{\hbar\omega^3}{\pi^2 c^3} \cdot B = \frac{\omega_0^3}{3\pi\varepsilon_0 \hbar c^3}$

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