1 Theoretical aspects

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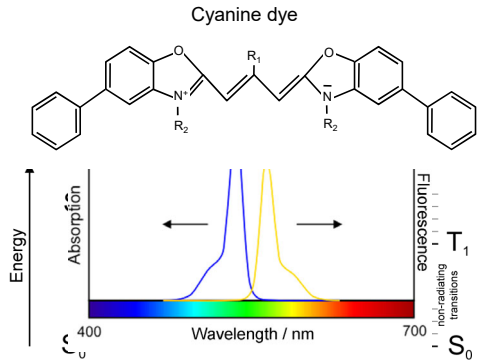
1.3 Light scattering and emission by particles

1.3.1 Localized Plasmons – Mie scattering
1.3.1 Far- and near-field of a radiating (point-) dipole
1.3.2 Fluorescence of molecules
1.3.3 Fluorescence Quenching and Enhancement
1.3.4 Stimulated Emission

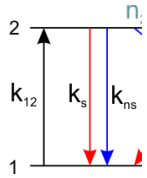
Absorption and Emission of Light by Molecules

Cyanine dye



Absorption- and Emission Rates

Simplified Sch



Absorption rate

$$R_{abs} = k_{12} \cdot n_1 = (\sigma \cdot I / h\nu) \cdot n_1$$

Emission rate

$$R_{em} = k_S \cdot n_2$$

Boundary conditions

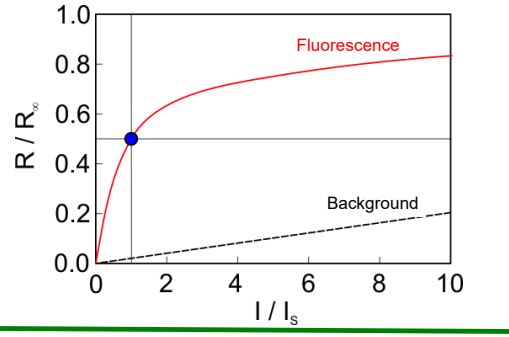
$$n_1 + n_2 + n_3 = 1$$
$$\dot{n}_1 = \dot{n}_2 = \dot{n}_3 = 0$$

Rate equations

$$\dot{n}_1 = -k_{12} n_1 + (k_s + k_{ns}) n_2 + k_{31} n_3$$
$$\dot{n}_2 = k_{12} n_1 - (k_s + k_{ns} + k_{23}) n_2$$
$$\dot{n}_3 = k_{23} n_2 - k_{31} n_3$$

Saturation

$$R_{em} = R_\infty \frac{I / I_S}{1 + I / I_S} \quad \text{with} \quad \begin{cases} R_\infty = \dfrac{k_s}{k_{23} + k_{31}} \cdot k_{31} \\ I_S = \dfrac{h\nu}{\sigma} \cdot \dfrac{k_{23} + k_s + k_{ns}}{k_{23} + k_{31}} \cdot k_{31} \end{cases}$$



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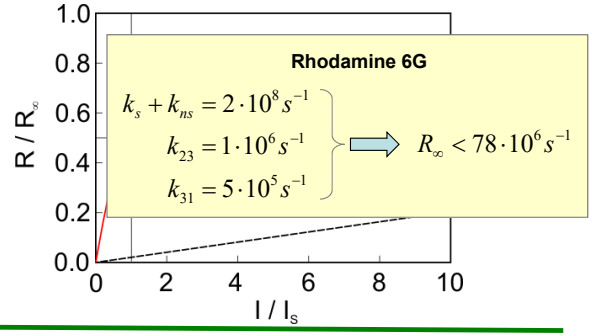

Rhodamine 6G

$$\left.\begin{aligned} k_s + k_{ns} &= 2 \cdot 10^8 \, s^{-1} \\ k_{23} &= 1 \cdot 10^6 \, s^{-1} \\ k_{31} &= 5 \cdot 10^5 \, s^{-1} \end{aligned}\right\} \Rightarrow R_\infty < 78 \cdot 10^6 \, s^{-1}$$