# NON–PHOTOCHEMICAL QUENCHING IN PHOTOSYNTHETIC ANTENNA

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Over billions of years of evolution, various photosynthetic organisms have developed different photosynthetic apparatus. Despite their vast diversity, all these apparatus are designed in a very similar way: the so-called light-harvesting antenna is composed of pigment molecules usually bound to a protein scaffold. The mutual arrangement of these pigment-protein complexes, as well as their spectroscopic properties, ensures optimal absorption of the incoming photons and can lead to extremely efficient (up to ∼99%) delivery of the generated electronic excitations to a reaction center [1]. Despite the ever–growing knowledge about the structural organization of these complexes and excitation energy transfer dynamics in photosystem II, specific molecular mechanisms responsible for such high efficiency of excitation energy transfer are still not fully understood. To explain fluorescence measurements, fluctuating light–harvesting antenna model was formulated, which takes into account the continuous spatial rearrangement of the pigment-protein complexes within the photosynthetic membrane [2].

This work aims to expand the previously suggested fluctuating light–harvesting antenna model, introducing constant excitation generation and dissipation parameters depicting constant illumination conditions and molecular relaxation. The time evolution of the excitation in such a system can be described by a diffusion equation

$$\frac{\partial}{\partial t}p(\mathbf{r},t|R) = D\nabla_d^2 p(\mathbf{r},t|R) + G - k_{\mathrm{dis}}p(\mathbf{r},t|R)\,, \tag{1}$$

with the initial condition $p(\mathbf{r},t=0|R)=\delta(\mathbf{r})$ and boundary condition given by $p(\mathbf{r},t|R)_{|\mathbf{r}|=R}=0$. Here $p(\mathbf{r},t|R)$ is the density of the survived excitation at the time moment $t$, parametrically depending on $R$, the distance to the reaction center; $D$ is the diffusion constant; $\nabla_d^2$ is the Laplacian in a $d$ - dimensional system; $d$ represents the effective dimensionality of the antenna during the transfer of excitation energy. An average steady fluorescence quantum yield $\langle \mathrm{F}_{st}(Dc^{2/d})\rangle_x$ was obtained by taking into account the average concentration of excitation traps, $c$. Numerical solutions demonstrated that with the same number of excitation traps, the intensity of the steady fluorescence decreases faster in systems with higher dimensionality (Fig. 1).

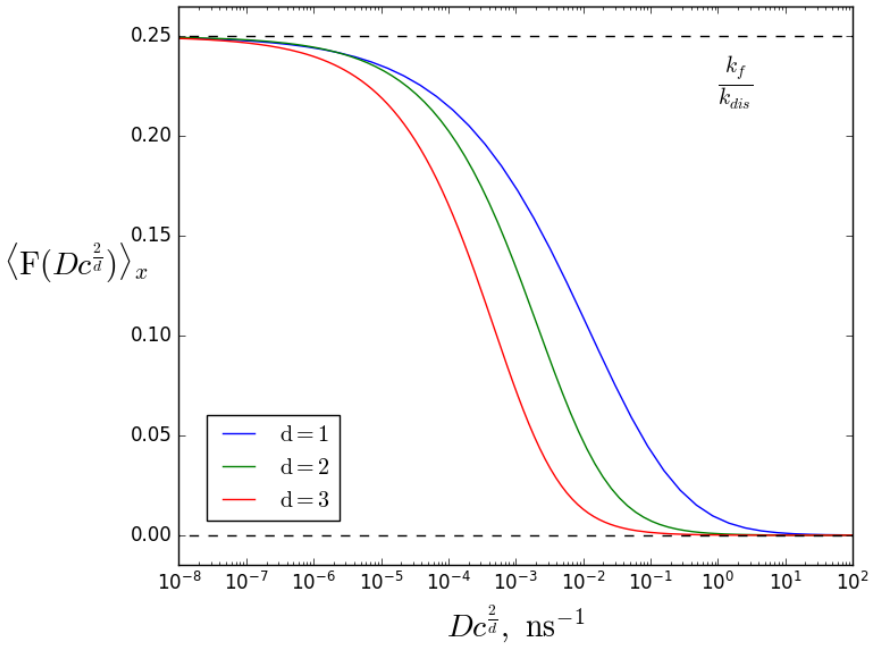


Fig. 1. Steady fluorescence quantum yield in various dimensions.

[1] Blankenship, R. E. Molecular Mechanisms of Photosynthesis; Blackwell Science: Oxford, 2002.
[2] J. Chmeliov, G. Trinkunas, H. van Amerongen, and L. Valkunas, Light harvesting in a fluctuating antenna, Journal of the American Chemical Society, 2014, 136, 8963–8972.