Fakultät für Mathematik und Physik
Albert-Ludwigs-Universität Freiburg
Physikalisches Institut

Quantum Efficiency
Seminar und Colloquium

TJAART KRÜGER

Department of Physics and Astronomy
University Amsterdam

Regulation of solar energy absorption in plants on the single molecule level

Photosynthesis is the major solar energy storing process on earth. Understanding the molecular mechanisms underlying the efficient storage of the system is be crucial for future solar energy storage devices[1]. The natural photosynthetic apparatus consists of a set of membrane-associated pigment-proteins structures that drive the essential reactions. Two ultrafast processes are at the basis of the high efficiency: excitation energy transfer in a light-harvesting antenna and trans-membrane charge separation in the photosynthetic reaction. One of the fascinating aspects of natural photosynthesis is that the system is self-protected against damage due to over-illumination. One important mechanism is the quenching of harmful chlorophyll triplets by carotenoids; a second mechanism switches the light-harvesting antenna between a “light” and a “dark” state. In the former the antenna is fully functional; in the latter the absorbed excitation energy is rapidly converted into heat.

Single-molecule spectroscopy (SMS) is an experimental approach which uniquely allows exploration of the nature of the molecular processes that underlie these proposed functional changes in LHCs by eliminating the obscuring effects of ensemble techniques. I will illustrate how this technique can be employed to show that switching between the “light” and “dark” states can be environmentally controlled, giving strong evidence for a highly sensitive and effective regulatory mechanism – i.e., a bio-switch[2]. As such, the intrinsic disorder of a light-harvesting complex is modulated by its local environment to yield a specific function[3]. It will be demonstrated how the quantum nature of the different functional states can be characterised by combining SMS with a disordered-exciton – Redfield model[4].

1. G. D. Scholes, G. R. Fleming, A. Olaya-Castro, and R. van Grondelle, Lessons From Nature About Solar Light Harvesting, *Nature Chemistry*, 3, 763-774, 2011.
2. T. P. J. Krüger, E. Wientjes, R. Croce, and R. van Grondelle, Conformational Switching Explains the Intrinsic Multifunctionality of Plant Light-Harvesting Complexes. *Proceedings of the National Academy of Sciences of the USA*, 108:13516-13521, 2011.
3. T. P. J. Krüger, C. Ilioaia, M. P. Johnson, A. V. Ruban, E. Papagiannakis, P. Horton, R. van Grondelle, Controlled Disorder in Plant Light-Harvesting Complex II Explains its Photoprotective Role, *Biophysical Journal*, 102, 2669–2676, 2012.
4. T. P. J. Krüger, V. I. Novoderezhkin, C. Ilioaia, and R. van Grondelle, Fluorescence Spectral Dynamics of Single LHCII Trimers, *Biophysical Journal*, 98:3093–3101, 2010.

Date: **Tuesday, June 26th, 2012 15:45 pm**
Location: **Lecture Hall 1, Hermann-Herder-Str. 3, Freiburg**

Contact: Andreas Buchleitner, Institute of Physics, Quantum Optics and Statistics
T +49 761 203 5821 F +49 761 203 5967 E buchleitner_office@physik.uni-freiburg.de
www.physik.uni-freiburg.de