



NITheP & Quantum Research Group cordially invites you to a seminar by:

**Dr. Tjaart Krüger**

*University of Pretoria, Department of Physics*

Date: Friday, 26<sup>th</sup> April 2013

Time: 11h15 -12h15

Venue: NITheP Seminar Room, H-Block, 3<sup>rd</sup>Floor

## **Modulating Quantum Processes in Photosynthesis on the Single-Molecule Level**

Quantum processes are at the basis of the amazingly high efficiency of light harvesting in photosynthetic organisms. Recently, evidence has been found that quantum coherence also plays a role in the very complex apparatuses that are responsible for efficient light harvesting in various organisms. However, these intriguing features will offer no biological significance without vital photoprotective mechanisms. Such self-protection against damage due to over-illumination is one of the most surprising aspects of natural photosynthesis. In one important mechanism the light-harvesting antenna switches 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.

I will illustrate how, using single-molecule fluorescence spectroscopy, switching between the “light” and “dark” states can be environmentally controlled<sup>1,2</sup>, giving strong evidence of a highly sensitive and effective regulatory mechanism – i.e., a bio-switch<sup>3</sup>. This experimental approach uniquely allows exploration of the nature of the molecular processes that underlie the functional changes in light-harvesting antennae. It will also be demonstrated how the quantum nature of the different functional states can be characterised by combining this experimental approach with Redfield modeling of disordered exciton states<sup>4</sup>.

1. T. P. J. Krüger, C. Ilioaia, M. P. Johnson, A. V. Ruban, E. Papagiannakis, P. Horton, and R. van Grondelle, Controlled Disorder in Plant Light-Harvesting Complex II Explains its Photoprotective Role, *Biophysical Journal* 102: 2669–2676, 2012.
2. L. Valkunas, J. Chmeliov, T. P. J. Krüger, C. Ilioaia, and R. van Grondelle, How Photosynthetic Proteins Switch. *The Journal of Physical Chemistry Letters* 3:2779–2784, 2012.
3. 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.
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.