Module
Light Harvesting Processes

Part I. Tutorials
March 5-6, 2015
Room PNS, 5.1.00.001, University of Bayreuth

Part II. Conference
March 8-12, 2015
Banz Monastery

Part III. Seminar
March 19, 2015
Room PNS, 5.1.00.001, University of Bayreuth

SS 2015
(Joint module of ENB and GRK)
“Light Harvesting Processes” is a conference module in SS 2015 within the Elite Study Program “Macromolecular Science” and GRK 1640. The courses cover aspects in biology, chemistry and physics of photosynthesis, natural and synthetic light harvesting materials and solar cells. The module consists of three parts. The students are expected to attend all three parts; I. Tutorials, II. Conference and III. Seminar.

I. Tutorials

March 5-6, 2015, Room PNS, 5.1.00.001, University of Bayreuth

The tutorials will be held by:

A). Prof. Dr. Matthias Ullmann, Computational Biochemistry, UBT

05.03.2015; 09:00 – 11:00

"Charge and Energy Transfer in Photosynthesis"

In photosynthesis, light energy is used to drive chemical synthesis of carbohydrates. The overall process can be subdivided into several steps: light harvesting, electron and proton transfer, ATP synthesis, and finally the chemical synthesis of carbohydrates. All these processes are carried out by proteins. In this tutorial, the basic principles of these different processes will be introduced. The tutorial will focus on how protein structures achieve their function in the cellular context by tuning properties of bound cofactors such as chlorophylls or hemes. The structural basis of the different charge and energy transfer mechanisms in plants and photosynthetic bacteria will be discussed.

B). Dr. Richard Hildner, Experimental Physics IV, UBT

05.03.2015; 13:00 – 15:00

“Photophysics of organic macromolecules and (supra-) molecular aggregates”

In this tutorial we will discuss the photophysical properties of functional organic macromolecules that find application for light-energy conversion. After a brief introduction/reminder of the properties of individual molecules, we will discuss the interaction mechanisms between molecules upon aggregation and the influence of these interactions on the electronically excited states. We will consider how the relative strength of intermolecular interactions determine the nature of energy transport (incoherent – coherent) within molecular aggregates. Finally, we will briefly discuss one example, photosynthetic light-harvesting complexes (i.e. biological supramolecular aggregates) that elegantly exploit these different regimes of energy transport to achieve nearly perfect transport efficiencies.

Press event for the 2nd funding period of GRK 1640 (GRK students only)
March 6, 2015 at 09:00 am, Room PNS, 5.1.00.001, UBT

Press foto with GRK students, GRK PIs, and guest lecturers (Vanden Bout, Eisele, Cogdell)
C). Prof. Dr. David Vanden Bout, University of Texas at Austin, USA
06.03.2015; 09:15 – 11:15

“Single Molecule Spectroscopy for Studying Conjugated Polymers”

Conjugated polymers (CPs) have found broad applications in optoelectronic devices. By their nature, CP chains are usually thought of as multichromophore systems with the potential for many absorption and emission sites along the polymer chain. Optical excitation leads to energy that can potentially move between these sites in a complex energy transfer mechanism that is determined by structure, dynamics, and chemical defects. Like any heterogeneous systems, the complex structures and resultant properties in CPs are often obscured in ordinary ensemble measurements of bulk states. The fundamental molecular information however has become accessible via the unprecedentedly effective technique of single molecule spectroscopy (SMS). For instance, the conformation of single chains and the relationship of conformation-spectrum have been probed with SMS fluorescence excitation polarization experiments. Methods to probe the electronic landscape through SMS methods will be discussed. These will include polarization spectroscopy, emission and excitation spectra, as well as time-resolved, blinking, and antibunching experiments. In addition, we will look at the dynamics of triplet/singlet states and the interactions between excitons and polarons. Further information on molecular interactions and electronic coupling between chromophore sites can be gained by preparing and investigating CP aggregates. Methods to examine energy transfer and H/J aggregate coupling in these systems will be discussed.

D). Dr. Dörthe M. Eisele, Chemistry Department and Center for Innovation & Discovery, City College of New York of City University of New York (CUNY), USA
06.03.2015; 13:15 – 15:15

Inspired by Nature: Supra-molecular Aggregates

Gaining a fundamental understanding for Nature’s highly efficient photosynthetic complexes in its full complexity holds the exciting potential for new materials and design principles for the construction of highly efficient and robust light-harvesting devices. Nature’s masterpieces consist of molecular subunits that self-assemble by weak non-covalent interactions into soft supra-molecular structures, which are then densely packed into super-structures: such hierarchical assembly is a generic motif of Nature’s highly efficient light-harvesting systems. A key to our ability to mimic natural photosynthesis and to tune material properties for efficient artificial light-harvesting applications is a basic understanding of the role of each step: from (a) the light absorption, to (b) the excitation energy transfer to (c) the electron transfer including the final charge separation. While photosynthetic organisms have been extensively studied over the last decades, those fundamental processes are not yet well understood. In particular, the interplay of the organism’s functional units still remains an open question. This tutorial will discuss the complex interaction of the different functional units and the material properties that are critical to the system’s efficiency. One of the most challenging aspects of studying such self-assembled nanoscale systems is that due to the self-assembly process the ensemble often may show significant
inhomogeneity in morphological, structural, and optical properties. We will discuss strategies to characterize and study biological and synthetic supramolecular complexes on the nanoscale by comprehensively combining methods that allow examination of both the ensemble and the individual object.

II. Conference on „Light Harvesting Processes”

March 8-12, 2015, Banz Monastery

This conference gives insight into the complex processes involved in photosynthesis. Additionally this meeting will give ideas and inspirations to understand and mimic synthetically some of the steps involved in the above process. Closely related technological phenomena are synthetic light harvesting and photovoltaics, which are also part of the conference contributions. Additionally, theoretical aspects of the above topics are dealt with. Aim of the conference is to bring together scientists from different areas such as biology, chemistry, physics and technology, working in the field of light-harvesting processes, photovoltaics and related subjects. The meeting will provide a platform for interdisciplinary communication and the exchange of ideas.

The confirmed invited speakers include:
- Greg Engel (Chicago, USA)
- Stephen Forrest (Michigan, USA)
- Laura Herz (Oxford, United Kingdom)
- Markus Motzkus (Heidelberg, Germany)
- Dieter Neher (Potsdam, Germany)
- Ivan Scheblykin (Lund, Sweden)
- David Vanden Bout (Texas, USA)

The homepage of the conference is: http://www.LHP-bayreuth.de

III. Seminar on the scientific topics covered in the conference

March 19, 2015, Room PNS, 5.1.00.001, UBT

The participating students should form interdisciplinary groups with 2 students per group. Each group will select one main topic of the conference and will prepare a seminar of about 30 minutes presenting the basics, different stages of the scientific development as well as highlights. The seminar language is English.

Please consult Prof. M. Thelakkat for any queries regarding the topics and division of groups.