Module M030

Light Harvesting Processes

Part I. Tutorials
April 5, 2013
Room: S 84, University of Bayreuth

Part II. Conference
April 7-11, 2013
Kloster Banz

Part III. Seminar
April 22, 2013
Room PNS, 5.1.00.001, University of Bayreuth

SS 2013

(This is a joint module for ENB and GRK)

"Light Harvesting Processes" is a conference module in SS 2013 within the Elite Study Programme “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 the three parts; *I: Tutorials, II. Conference* and *III. Seminar.*

I. Tutorials

April 5, 2013**, Lecture hall: S84, NW II, UBT**

The tutorials will be held by:

A). Prof. Masahiro Irie, Rikkyo University, Tokyo

05.04.2012; 09:00 – 11:00 am

“Photochromism of Diarylethene Single Molecules and Single Crystals”

Photochromism is defined as a reversible transformation of a chemical species between two isomers having different absorption spectra induced in one or both directions by photoirradiation. Although vast numbers of photochromic molecules have been so far reported, molecules which exhibit thermally irreversible photochromic reactivity are limited. A new class of thermally irreversible photochromic molecules is a “diarylethene” family. The diarylethenes are derivatives of stilbene. When phenyl rings of stilbene are replaced with five membered heterocyclic rings with low aromatic stabilization energy, both open- and closed-ring isomers become thermally stable and coloration/decoloration cycles can be repeated more than 10,000 times. Chemical bond rearrangement during the photoisomerization induces electronic as well as geometrical structure changes of the diarylethenes. Single-molecule fluorescence photoswitching based on the electronic structure changes can be applied to ultrahigh density (Tbits/inch^2) optical memory and super-resolution fluorescence imaging. On the other hand, the geometrical structure changes in the single crystalline phase can be applied to light-driven actuators. In this lecture, fluorescence photoswitching at the single-molecule level and light-driven bending of rod-like crystals will be presented.

References

1. M. Irie, *Chem.Rev.* **2000,** 100, 1685
2. F. Terao, M. Morimoto, M. Irie, *Ang.Chem. Int.Ed.*, **2012,** 51, 901

B). Prof. Richard Cogdell, Glasgow University, Glasgow

05.04.2012; 11:00 am – 13:00 pm

“The Primary reactions of purple bacterial photosynthesis: a light driven battery?”

The structure of the light harvesting and reaction centre pigment protein complexes that catalyse the primary reactions in purple photosynthetic bacteria have been determined by X-ray crystallography (1-3). This lecture will describe both their structures and how they cooperate to absorb solar energy and separate charge across the photosynthetic membrane (4). If you take a step back and look at these reactions in

a more general context then they resemble a solar battery. This concept will be developed and related to novels ideas of how to make solar fuels.

References

1. Deisenhofer et al. (1984) J. Mol. Biol. 180, 385-398
2. McDermott et a. (1995) Nature 374, 517-521
3. Roszak et al. (2003) Science 302, 1969-1972
4. Cogdell et al. (2007) Quart. Revs. Biophys. 39, 227-324

C). Prof. Dr. Jürgen Köhler, Experimental Physics IV, Bayreuth

05.04.2012; 14:00 pm – 16:00 pm

"Light-Harvesting Processes"

Starting with the quantum mechanical premise that electrons are indistinguishable, we will develop expressions for the interaction mechanisms between molecular building blocks that lie at the heart of any energy transfer process - Coulomb and exchange interaction - and how these determine the efficiency of this process. Next we will consider how the relative strength of the intermolecular coupling with respect to intramolecular forces will influence the character of the energy transfer process (coherent vs. incoherent). Finally we will touch upon a very special case - Förster energy transfer - and evaluate the preconditions that have to be fulfilled for this rather simple description of energy transfer. The tutorial will be presented in form of a lecture.

References:

1. Basics about (molecular) excitons: R.S. Knox, (1963). Theory of excitons. Academic Press, New York; A.S. Davydov, (1971). Theory of molecular excitons. Plenum, New York.

2. Connection between molecular excitons and elementary excitations: G.D. Scholes and G. Rumbles, Nature Materials **5** (2006) 683.

3.Limitations of FRET: S.E. Braslavsky et al.... G.D. Scholes, Photochem. Photobiol. Sci. **7** (2008) 1444.

II. Conference on „Light Harvesting Processes”

April 7- 11, 2013, 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:

- David Beljonne (Mons, Belgium)
- Tobias Brixner (Würzburg, Germany)
- Don Bryant (Pennsylvania, USA)
- Max Crossley (Sydney, Australia)
- Dirk Guldi (Erlangen, Germany)
- Masahiro Irie (Tokyo, Japan)
- Jain McCulloch (London, United Kingdom)
- Alexandra Olaya-Castro (London, United Kingdom)
- Villy Sundström (Lund, Sweden)

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

III. Seminar on the scientific topics covered in the conference on 22.04.2013 at Room PNS, 5.1.00.001

The participating students should build interdisciplinary groups consisting of 2 students per group. Each group will select one main topic of the conference and will prepare a presentation including the basics, different stages of the scientific development as well as highlights. A seminar in English for about 30 minutes will be given by each group.

Please consult Prof. M. Thelakkat (ENB) or Prof. S. Kümmel (GRK) for any queries.

Recommended: A lecture module, "Organic Solar Cells" takes place on 4th April at PNS Seminar room from 9 am to 18 pm. All ENB and GRK students are also invited. This module will be recognized as one of the current topics module for the ENB students and as one of the lecture modules for GRK students!