

CPP 27: INTERNAL SYMPOSIUM Optical Spectroscopy II

Time: Thursday 14:30–17:00

Location: H40

Invited Talk

CPP 27.1 Thu 14:30 H40

Controlling intermolecular interactions in organic semiconductors — ●LAURA HERZ — University of Oxford, Clarendon Laboratory, Parks Road, Oxford OX1 3PU

Conjugated polymers and molecules have emerged over the last decade as cheap and flexible alternatives to existing inorganic semiconductor technology. Light-emitting displays based on these materials are now at commercial standards with several products on the market, with transistors and photovoltaics being at the research and development stage. This talk will summarize our recent research into the mechanisms governing the femtosecond dynamics of electronic processes at the interface formed between two organic semiconductor components. We have examined the Coulombic interactions at the interface in a blend of two copolymers with intramolecular charge-transfer character and optimized band offsets for photoinduced charge generation. Through a combination of both time-resolved measurements of photoluminescence, and quantum-chemical modeling of the heterojunction, we demonstrate that the relative molecular orientation at the heterojunction can lead to either a repulsive barrier or an attractive interaction. For the latter case, charge transfer across the heterojunction may occur, but is followed by rapid relaxation into a coulombically bound state (exciplex) across the interface. I will follow on to show that electronic delocalization across more than one conjugated polymer chain may be tailored effectively through supramolecular self-assembly strategies, as for example shielding of chains with insulating macrocycles, or complexation with inert macromolecules.

CPP 27.2 Thu 15:00 H40

A real time, real space approach for calculating 2D spectra in heterogeneous systems — ●BEN BRÜGGEMANN^{1,2}, PÄR KJELLBERG¹, and TONU PULLERITS¹ — ¹Department of Chemical Physics, Lund University, Sweden — ²Institut für Physik, Humboldt-Universität zu Berlin

A non-perturbative approach is used to calculate nonlinear spectra using a multi-exciton density matrix theory. All interaction orders are reproduced simultaneously, but analog to the experiment they can be distinguished by the different phase matching directions. This is possible due to the summation of the polarizations for a number of randomly placed molecules, but since orientational averaging and energetic disorder can be included at the same time the additional computational effort is moderate. The method is applied to the FMO complex to calculate 2D frequency resolved spectra, which show good agreements with experimental data [1]. The advantage of the presented method is that the intensity dependence of the 2D spectrum can be investigated, as well as the signal from higher order phase matched directions. [1] T. Brixner et al. Nature 434, 625 (2005).

CPP 27.3 Thu 15:15 H40

Proteins under pressure: spectroscopic determination of compressibilities — ●JOHANNES WIEDERSICH¹, VLADIMIR PONKRATOV¹, MARK SOMOZA¹, JANE VANDERKOF², and JOSEF FRIEDRICH¹ — ¹Lehrstuhl für Physik Weihenstephan, Physikdepartment, TU München — ²Department of Biochemistry and Biophysics, University of Pennsylvania, Philadelphia, Pennsylvania

By means of optical spectroscopy we determine the local compressibility of proteins. At low temperatures the pressure shift of optical spectra can be precisely determined employing hole burning techniques. The values for the compressibility of ubiquitin and Zn horseradish peroxidase obtained at low temperatures are compared with those from high pressure experiments at ambient temperature. The results of both experiments show the same compressibility, indicating that the compressibility of proteins is the same whether the protein is surrounded by liquid at ambient conditions or whether it is frozen at low temperatures. In both cases the observed values are typical for solids.

Invited Talk

CPP 27.4 Thu 15:30 H40

Coherent control of single spins in diamond — ●FEDOR JELEZKO and JÖRG WRACHTRUP — 3. Physikalisches Institut, Universität Stuttgart

Defects in diamond may have a large impact on solid state quantum physics in general and quantum information processing and communication in particular. This contribution will highlight recent results on

the nitrogen-vacancy center (NV). Experiments on optical detection and manipulation of single electron spins will be reviewed. The experimental background of optical detection of single quantum systems in solids will be introduced. Well established single electron and nuclear spin measurement of NV defect is a key step in solid-state quantum information processing. Another important application of single spin manipulation is of more fundamental character. Experiments with single spins are suitable for experimental test of quantum mechanics. Projective measurements of single spins can be used as a test of the quantum Zeno effect and Bell's inequalities.

CPP 27.5 Thu 16:00 H40

Optical Spectroscopy On Nanoparticles in a Linear Paul Trap

— ●ALEXANDER KUHLLICKE, STEFAN SCHIETINGER, and OLIVER BENSON — AG Nano-Optik, Institut für Physik, Humboldt-Universität zu Berlin Hausvogteiplatz 5-7, 10117 Berlin

Linear radio frequency ion traps, so-called Paul traps, are widely-used tools for high-resolution spectroscopy on atom ions and have also been utilized for the trapping of micrometer-sized particles. We have narrowed the gap between these size regimes by trapping single nanoparticles with sizes down to 20 nm within a linear Paul trap. This opens a way to investigate nanoparticles without the interaction with supporting surfaces. We observed ion chains and Coulomb-crystals within the trap and performed spectroscopy on trapped dye-doped particles and N-V centers in diamonds. Future experiments aim at the spectroscopy on mesoscopic quantum emitters.

CPP 27.6 Thu 16:15 H40

Resonant Energy Transfer Monitoring Self-Assembly of

Functionalized Dye Molecules on Semiconductor Nanocrystals

— ●THOMAS BLAUDECK^{1,2}, MOHAMED ABDEL-MOTTALEB², EDUARD ZENKEVICH³, ALEXANDER SHULGA³, and CHRISTIAN VON BORCZYSKOWSKI² — ¹POM, TU Chemnitz, 09107 Chemnitz, Germany — ²OSMP, TU Chemnitz, 09107 Chemnitz, Germany — ³Institute of Molecular and Atomic Physics, National Academy of Science, Minsk 220072, Belarus

Targeted generation of multichromophoric aggregates comprising inorganic (NCs) and organic (dye molecules) parts encounters growing interest in biology, medicine, and molecular electronics. We report on the properties of such aggregates designed from pyridyl-substituted free-base porphyrin dye molecules and CdSe NCs, formed via spontaneous self-assembly and monitored by steady-state and time-resolved spectroscopy. The results clearly identify an excitation energy transfer from the NC to the dye molecules and are discussed in the framework of Stern-Volmer quenching and Förster resonant energy transfer (FRET) theory. The results are generalized on the self-assembling formation of antenna arrays comprising NCs and other classes of molecules.

Invited Talk

CPP 27.7 Thu 16:30 H40

Optical spectroscopy on single carbon nanotubes — ●ACHIM

HARTSCHUH¹, HUIHONG QIAN¹, TOBIAS GOKUS¹, MATHIAS STEINER², and ALFRED MEIXNER² — ¹Department Chemie und Biochemie and CeNS, LMU Muenchen, Germany — ²Institut fuer Physikalische und Theoretische Chemie, Universitaet Tuebingen, Germany

Semiconducting single-walled carbon nanotubes (SWNTs) are photoluminescent quasi-one-dimensional quantum wires with great promise for applications in photonics, nanoelectronics and optical sensing. Light emission from SWNTs is dominated by excitonic recombination with a low quantum yield of typically 10e-3 for embedded nanotubes. Recent measurements on single nanotubes using confocal Raman and photoluminescence microscopy revealed variations of both emission energies and excited-state lifetimes from nanotube to nanotube [1, 2]. Lifetime variations appear to result from defect mediated non-radiative transitions to non-luminescent states while energetic variations can be attributed to fluctuations in the dielectric environment of the nanotube. Since nanotubes consist of surface atoms only, dielectric screening and thus the emission energy of excitonic states are highly susceptible to the local environment making them ideally suited as nanoscale optical sensors (see e.g. [3]).

[1] A. Hartschuh et al., Science 301, 1293 (2003). [2] A. Hagen et al., Phys. Rev. Lett. 95, 197401 (2005). [3] D. A. Heller et al., Science

311, 508 (2006).

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