Lectures and Seminars of the CUI course programme in the SoSe2016

CUI Main Lecture

Lecture	Lecturers	Start	Time	Place
Microfluidics	Prof. M. Trebbin	05.04.16	Tuesdays 14:45-16:15	Hörsaal AP*

Lectures

Lecture	Lecturers	Start	Time	Place
Modern X-Ray Physics – Scattering and imaging	Prof. G. Grübel Prof. W. Wurth Dr. S. Roth	05.04.16	Tuesdays 12:45-14:15	Hörsaal AP*
Ultrafast Optical Physics II	Prof. F. Kärtner Dr. N. Chang	08.04.16	Fridays 08:30-10:00	SemRm 1*
Condensed matter and ultra-cold atoms	Prof. L. Mathey	04.04.16	Mondays 16:00-17:30	Hörsaal AP*
Out-of-equilibrium statistics and theory of quantum transport	Prof. M. Thorwart	05.04.16	Tuesdays 10:15-11:45	SemRm 5*
Biomedical Physics II	Prof. A. R. Pearson Dr. Yorke Dr. Schulz	15.04.16 22.04.16 29.04.16 06.05.16 13.05.16 27.05.16 03.06.16 10.06.16 17.06.16 24.06.16	16:00-18:00	SemRm5*§
Topological condensed-matter systems	Prof. M. Thorwart Dr. T. Poßke	07.04.16	Thursdays 10:15-11:45	SemRm 1*
Structural biochemistry	Prof. C. Betzel Dr. M. Perbandt Dr. F. Buck Dr. T. Hackl Prof. Wieland	08.04.16	Fridays 10:00-11:30	Hörsaal C FBC

Lectures organised by IMPRS-UFAST†

Lecture	Lecturers	Start	Time	Place
Virus derived, structurally modified bio-nanoparticles: Modular scaffolds for designing improved vaccines and new materials	Prof. H. Netter Prof. D. Eggert	04.04.16 - 06.04.16	09:00-12:30	CFEL, SemRm II (ground floor)
Time-dependent density-functional theory and Many-Body Techniques	Prof. A. Rubio	11.07.16 - 13.07.16	09:00-12:30	CFEL, SemRm II (ground floor)

Seminars

Seminar	Lecturers	Start	Time	Place
Special topics on nanochemistry	Prof. H. Weller	04.04.16	Mondays 16:30-18:00	SemRm 261 IPhCh**
Physics of nanostructures	Dr. G. Meier Dr. K. Buth Prof. U. Merkt	04.04.16	Mondays 14:15-15:45	Bibliothek AP*
Quantum dynamics of out-of-equilibrium nanosystems	Prof. M. Thorwart	05.04.16	Tuesdays 14:00-15:30	SemRm 6*
Many-body theory of ultracold atoms and solid state systems	Prof. L. Mathey	06.04.16	Wednesdays 14:00-15:30	ZOQ SemRm, (Bld. 90) Bahrenfeld
Molecular physics	Prof. J. Küpper	07.04.16	Thursdays 10:00-11:30	SemRm II CFEL (Bld. 99) Bahrenfeld
Many-body systems and quantum statistical methods	Prof. M. Potthoff	06.04.16	Wednesdays 14:15-15:45	SemRm 2*
Theory of solid-state physics	Prof. A. Lichtenstein Prof. D. Pfannkuche Prof. M. Potthoff Prof. M. Thorwart	06.04.16	Wednesdays 16:00-17:30	SemRm 3*

Abbreviations:

SemRm = Seminar room
Bld. = Building
CFEL = Center for Free-Electron Laser Science
IPhCh = Institut für Physikalische Chemie
IMPRS-UFAST = International Max Planck Research School for Ultrafast Imaging and Structural Dynamics
ZOQ = Zentrum für Optische Quantentechnologien
AP = Angewandte Physik (Jungiusstraße 9, 20355 Hamburg)
DESY = Deutsches Elektronen-Synchrotron
FBC = Fachbereich Chemie (Martin-Luther-King-Platz 6, 20146 Hamburg)

Remarks on "Place":

*The event does take place at the department of Physics of the University of Hamburg (Jungiusstraße 9 or 11, 20355 Hamburg). See also the webpage of the Department of Physics of the University of Hamburg: www.physik.uni-hamburg.de.

SemRm 1 and 2 = Seminar room (1. Floor, right staircase)

SemRm 6 = Seminar room (3. Floor, left staircase)

**The event does take place at the Institut für Physikalische Chemie of the University of Hamburg (Grindelallee 117, 20146 Hamburg). See also the webpage of the Department of Chemistry of UHH: http://www.chemie.uni-hamburg.de/pc/index.html.

§The meeting on April, 22, 2016, is organised by Skype.

†These courses have the format of block-courses. Besides, the attendance to these lectures is limited to a specific number (typically 15). Importantly, the priority is given to the fellows of the IMPR-UFAST School. Hence, if you like to attend one of the courses, please, send first an e-mail to Dr. Julia Quante (julia.quante@mpsd.mpg.de). She will inform you about availability and changes in the course programme.

Abstract: CUI Main Lecture

Microfluidics: Microfluidics enables the precise control of fluids on the nanoliter scale by designing, manufacturing, and formulating miniaturized systems ("Lab on a Chip"). These miniaturized devices take advantage the physical and chemical phenomena on the small scale, such as micro- and nanochannels, for fundamental scientific investigations as well as specialized industrial applications. Selected examples include:

- Chemical and biological micro/nanoreactors for chemical synthesis, biosynthesis, high-throughput synthesis, combinatorial chemistry and safer synthesis
- Micro/nanofabrication technologies (in silicon, plastics, glass and other materials) including laser micro/nanofabrication, photochemistry, micro/nanophotolithography, micro/nanomachining etc.
- Micro/nanomechanics and engineering in chip-based systems (MEMS and NEMS)
- Fluidics, fluids for micro/nanosystems, their mobilization and control
- Medical diagnostics and screening, point-of-care clinical analyses, disease detection, drug delivery, and implantable devices
- Micro and nano total analytical systems (µTAS, nTAS), their components and applications
- Reduction of wastes, and increases in efficiency, reliability and performance (decreases in power and reagent consumption, time and cost)

Hence, this research field is attractive for a variety of disciplines including: chemistry, physics, nanoscience, biology, bioengineering, electronics, clinical/medical science, chemical engineering and materials science - across both academic and industrial sectors.

This lecture is an introduction to this multidisciplinary field ranging from the historical background to modern perspectives and application examples. Along the way we will cover the theoretical and practical fundamentals including the physics of miniaturization, fluid mechanics of microflows, electrical and thermal phenomena and an introduction to microfabrication.

It is the goal of this course to convey the fundamental concepts and methods which are relevant for the creation and work with microfluidic systems.

Abstracts: Lectures

Modern X-Ray Physics – Scattering and imaging: This course (4+2 hours weekly) will provide an introduction into the methods of modern X-ray physics. It covers the hard x-ray regime with the focus on scattering applications. Knowledge on soft X-ray applications, covered by the precursor course (Methoden moderner Roentgenphysik I) is helpful, but not a prerequisite.
The program will include: Basics of modern X-ray physics (sources, refraction+reflection, kinematical scattering theory and its applications, introduction into small-angle, anomalous and coherent scattering). Basics of modern x-ray applications in biology, surface and interface science and soft matter research are also discussed.
The program will include a site visit to the DESY Photon Science facilities.

Ultrafast Optical Physics II: The content of the course is the following:

- Linear and nonlinear pulse propagation: Optical solitons and pulse compression.
- Laser dynamics: Single-mode, multi-mode, Q-switching, mode locking.
- Pulse characterization: Autocorrelation, FROG, SPIDER and 2DSI
- Noise in mode-locked lasers and frequency combs
- Laser amplifiers and parametric amplifiers and oscillators.
- Soft and hard X-ray sources including attosecond pulse generation
- Nonlinear polarizations in matter: the perturbative expansion approach.
- Ultrafast Fourier-transform spectroscopy: 2 and more dimensions
- From GHz to the ultraviolet: investigating transient states of matter with light
- More ways to see: Raman, CARS & fluorescence - also good for imaging
- High-harmonic generation and its applications
- Ultrafast X-ray science: femtosecond molecular movies w/ atomic resolution

Condensed matter and ultra-cold atoms: We explore the physics of condensates of ultra-cold atoms and related ordered states, such as superconducting states. We describe their properties first within a mean-field description, and then establish the formalism of path integrals, effective actions and spontaneous symmetry breaking. We study Landau theory to describe continuous phase transitions, and introduce and apply the concept of the renormalization group to capture the critical behaviour.

Biomedical Physics II:
Lecture topics:

- Physical models, building blocks of biology, estimates/rules of thumb, length and time-scales in biological systems, structure of life, multicellularity and differentiation.
- Biological time, clocks & oscillators, cell cycle, thermal energy scale, diffusion, rate equations and dynamics
- Electrostatics, pH, salty solutions, protein folding, interactions, crowding, packing
- Membranes, compartmentalization, structure, transport, communication, potentials, cell signaling and neurotransmission
- Energy in biology, mass/energy budget, non-equilibrium systems, free energy, entropy, metabolic control enzymes, feedback and regulation, bioenergetics
- Cytoskeleton, translational and rotary motors, thermal ratchets, processive motors, construction and destruction in biological systems
- Probing and perturbing biology – biophysical tools and chemical probes

Topological condensed-matter systems: "Topology" is one of the hot keywords in modern condensed matter physics, which you possible have already encountered in seminar talks without sufficient background information. In this lecture, you learn the concepts of topology applied to the theory of condensed matter from the start and reach a level of knowledge that can save you a lot of time and can give you considerable advantage during your masters

thesis.
After an introduction into the mathematical subject topology, we treat physical systems connected to the keywords anyons, Majorana fermions, topological quantum computing, anti-unitary classification of Hamiltonians (the tenfold way), topological classification of band structures (quantum spin Hall effect, topological insulators, topological superconductors).
Most of these topics are content of ongoing research. The lecture is mostly concerned about theory. However, a general understanding of the concepts of topology is also of continuously increasing importance in experimental condensed matter physics.

Structural biochemistry: The students will be introduced in structural biology and the analysis of interactions between biological macromolecules. In the lecture methods like protein crystallization, crystallography, nuclear magnetic resonance spectroscopy (NMR), electron microscopy, small angle X-ray scattering and mass spectroscopy will be addressed. The course language will be preferably German.

Abstracts: Lectures organized by IMPRS-UFAST

Virus derived, structurally modified bio-nanoparticles: Modular scaffolds for designing improved vaccines and new materials: The modular organisation of virus-derived bio-nanoparticles (B-NPs) and the self-assembly competence of recombinant, modified B-NP subunits allows the design of B-NPs used for different applications such as the engineering of superior vaccination tools, vectors for gene therapy, and scaffolds for the development of new bio-materials. For the rationale design of recombinant B-NPs, the relationship between introduced biochemical modifications and structural constraints have to be understood to generate optimised biomedical devices.
Within the course, we will discuss strategies to generate biochemically modified B-NPs for the development of superior vaccination tools and templated nano-probes for medical imaging. Different types of B-NPs distinguished by size, shape and composition will be introduced, the impact of the biochemical modifications such as changes of disulphide bonding and glycan density will be discussed in relation to the biophysical characteristics of the B-NPs and their biological functionality. Furthermore state of the art microscopic techniques that allow the 2D and 3D characterization of differently structured bio-nanoparticles will be discussed.

Time-dependent density-functional theory and Many-Body Techniques: Spectroscopies are the tools used to study the microscopic structure of matter. The experimental results obtained with these tools can only be interpreted correctly with the help of accurate theoretical methods, capable of simulating the microscopic behaviour of matter subject to external perturbations. A number of spectroscopic methods address electronic excited states (e.g. optical absorption spectroscopy, photo-electron emission spectroscopy, etc.), and hence the need of first principles theoretical methods capable of addressing the excited state many-electron problem. Time-dependent density-functional theory /TDDFT) is one of such methods.
The scientists that approach the TDDFT filed face difficulties in grasping its many aspects of Many-Body Techniques (MBT). We also believe that a focus course on these techniques is extremely helpful for young graduate students, post-docs and even older scientists that are envisaging a project for which TDDFT/MPT is the tool of choice.

Abstracts: Seminars

Physics of nanostructures: The Seminar is on topics in micro- and nanometer-scale science and technology. Studies range from thin films to micro- and nanostructures and include squares, circles, nanowires, and even more complex micro- and nanoscale geometries. The focus of the seminar is on magnetic nanostructures. Ferromagnetic nanostructures are ideal systems to tailor physical properties of the single object via material parameters, layer sequences, and lithographical processes. Magnetization dynamics on the nanosecond and subnanosecond time scale in ferromagnetic micro- and nanostructures are in the focus of interest in frequency space as well as in real space. E.g., broadband ferromagnetic-resonance measurements obtained by vector-network analyzer spectroscopy are discussed in the presentations of the seminar. Transmission x-ray microscopy with a spatial resolution down to 10 nanometers and a temporal resolution below 100 picoseconds is important to give access to magnetization dynamics on its genuine time- and length scale. Complexity created by periodic arrangement of well-understood building blocks plays not only an important role in biochemistry, photonics, and engineering but is also of increasing importance for magnetism on the nanoscale. Magnetic interactions can be engineered to yield one-, two-, and three-dimensional crystal-like structures that show new intriguing properties that are discussed in the seminar „Physics of nanosctructures“.

Quantum dynamics of out-of-equilibrium nanosystems: The seminar addresses the non-equilibrium quantum dynamics of systems, which interact with quantum mechanical fluctuations produced from some external environment. They typically lead to decoherence and relaxation phenomena, before a stationary state in the statistical sense is eventually reached. By the framework of open quantum systems, a vast number of physical systems and effects are described, ranging from excitonic energy transfer in biomolecular light-harvesting complexes, to quantum mechanical charge, spin and heat non-equilibrium transport, to activation phenomena in pumped quantum systems, to cooperative effects in ultracold quantum gases, to the dynamics of a ferromagnetic domain wall under the influence of a spin-polarized current, to name only those which are in the focus of our research group. During the seminar, selected topics of these fields will be discussed.

Many-body theory of ultra-cold atoms and solid-state systems: In this research-oriented seminar we discuss many-body effects in ultra-cold atoms and solid-state systems. Subjects include, for example, Bose-Einstein condensation, superconductivity and superfluidity, low-dimensional systems and fluctuating orders, renormalization group methods and many-body dynamics. Presentation subjects can be chosen from a wide range of fields, such as laser physics, solid state physics, quantum field theory, and atomic physics. The presentations can deal with fundamental questions or applied concepts, such as cooling and detecting methods, or technological aspects of ultra-cold atom systems or solid-state systems. Both experimentalists and theorists are very welcome, and a lively discussion is desired.

Molecular physics: This seminar provides a regular lecture series on modern topics in molecular physics. International experts provide introductions and in-depth discussions of state-of-the-art research in molecular and laser physics. Seminars are held in tutorial style, and questions during talks that help the audience to better follow the presentation are highly appreciated. Students will learn to follow research seminars, to extract useful information from seminars and related discussions, and how to articulate questions and comments.
Speakers typically visit CFEL for one or two days and are available for discussions of their and your work.

Many-body systems and quantum statistical methods: In Potthoff's group the physical properties of quantum systems consisting of a macroscopically large number of strongly interacting fermions are studied. These systems may show collective behaviour that cannot be understood on an independent-particle level. The field covers collective magnetism, correlation-driven metal-insulator transitions, high-temperature superconductivity and unconventional states of matter in general. We are interested in classical and quantum phase transitions in low-dimensional lattice systems and nanostructures, in elementary excitation spectra and in non-equilibrium phenomena. The employed methods range from field-theoretical techniques and exact diagonalization over (dynamical) mean-field theory and cluster techniques to (quantum) Monte-Carlo methods and density-matrix renormalization group. An important focus is on new methodical developments. For further information about the time schedule of the seminar, please, visit the following webpage http://theorie.physnet.uni-hamburg.de/group_vts/groupseminar.html

Theory of solid-state physics: Speakers of the I. Institute of Theoretical Physics or external scientific guests are invited to give a talk on a specific topic of cutting-edge research in the field of solid-state physics.
Further information concerning the speakers will be forwarded to the mailing list of the graduate school of CUI by its coordinator.