

SCIENTIFIC AND METHOD MODULES

Module name	Quantum Coherent Structures – Unconventional Superconductivity
Number	2015-A3
Aims	This module deals with macroscopic coherent quantum states such as superfluids, superconductors or Bose-Einstein condensates that hold great promise for applications such as frictionless, dissipationless transport or ultralow threshold lasers, if brought to room temperature. It also elucidates the role of spins (“spintronics”), topological band structures, and light-matter interactions (nanophotonics) in nanoscience. The field is partly a challenge in materials physics, partly a challenge in theoretical understanding. The fundamentals of the field and several practical examples will be considered.
Basics	Recommended knowledge: thematic modules T1, T3 Required knowledge: quantum mechanics, solid-state devices, quantum dots and nanoparticles, electron transport, dielectric structures, excitons
Contents	Superconductivity, unconventional superconductivity with topological order, surface states, Majorana fermions, topological insulators, Bose-Einstein condensates (“conventional” condensates of atoms [atom laser, vortices], polariton condensates in microcavities at higher temperatures [GaAs, CdTe, ZnO, GaN], magnon condensates), superfluidity.
Methods	Transport measurements, band structure of topological insulators and superconductors, topological invariants, Majorana exchange statistics, angular-resolved spectroscopy, high pressure physics
Type	Two-day block course/ yearly recurrence with modification
Date (month/year)	30 September to 1 October 2015
Time	See programm: http://www.buildmona.de/training/modules/2015-A3/
Work load	15 hours presence/ 45 hours self-study
Examination	Poster presentation about a self-chosen topic about “Quantum Coherent Structures” (own research or from literature) and discussion (oral) in front of the poster with the organizer(s)
Credit points	2
Responsible scientists	Grundmann, Rosenow
International guest lecturers	T. Ihn (ETH Zurich, Switzerland), M. Houzet (CEA Grenoble, France), P. Törmä (Aalto Univ., Finland), F. Kuemmeth, (Univ. of Copenhagen, Denmark), A. Beukman (TU Delft, The Netherlands), G. Malpuech (CNRS, France), F. Laussy (Univ. Antónoma de Madrid, Spain)
Industrial partners	
Recommendations for literature, e-learning	International Series of Monographs on Physics 116, Bose-Einstein Condensation, Lev Pitaevskii and Sandro Stringari, Oxford Science Publications, Clarendon Press Oxford 2003

BuildMoNa Module 2015-A3
Quantum Coherent Structures – Unconventional Superconductivity
Wednesday, 30 September to Thursday, 1 October 2015

Universität Leipzig, 04103 Leipzig, Linnéstr. 5,
Lecture Hall for Theoretical Physics

Preliminary Agenda

Wednesday, 30 September 2015

- 14:00 Welcome address
- 14:10 Prof. Dr. Piet Brouwer
Freie Universität Berlin, Germany
Majorana wires
- 15:00 Prof. Dr. Thomas Ihn
ETH Zurich, Switzerland
Magnetotransport in the topological insulator candidate InAs/GaSb
- 15:50 *Coffee break (Aula)*
- 16:20 Dr. Manuel Houzet
CEA Grenoble, France
Multi-terminal Josephson junctions as topological materials
- 17:10 Prof. Päivi Törmä
Aalto University, Finland
Superfluidity in topologically nontrivial flat bands
- 19:00 Dinner

Thursday, 1 October 2015

- 9:00 Prof. Dr. Ferdinand Kuemmeth
University of Copenhagen, Denmark
Transport spectroscopy of semiconductor-superconductor quantum devices

- 9:50 Ir. Arjan Beukman
TU Delft, The Netherlands
Experimental studies of InAs/GaSb heterostructures as a 2D topological insulator
- 10:40 *Coffee break (Aula)*
- 11:10 Prof. Guillaume Malpuech
Institut Pascal, CNRS Aubière, France
Spin-orbit coupling in photonic systems: From Optical Spin Hall Effect to Z topological insulator
- 12:00 Prof. Fabrice Laussy
Universidad Autónoma de Madrid, Spain
Superconductivity: The sandwich mechanism
- 12:50 *Lunch (Aula)*
- 14:50 Dr. Mikhail Erements
Max-Planck-Institut für Chemie, Mainz, Germany
Superconductivity at 200K
- 15:40 *Coffee break (Aula)*
- 16:10 Dr. Christoph Brüne
Universität Würzburg
Transport and induced superconductivity in the topological surface and edge states of HgTe
- 17:00 Group photo shooting (in front of main building)
- 17:30 Poster Session
- 18:30 *Fingerfood*