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Natural Sciences

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September 10th - 13th, 2018

Institute of Experimental Physics, Graz University of Technology

Plenary Lectures

PLENARY TALK-1 9:30-10:15 TUESDAY, SEP 11 HS P1

Applied Quantum Mechanics: Sensing with Monolithically Integrated Quantum Cascade Devices

Gottfried Strasser

Institute of Solid State Electronics, Technische Universität Wien, Vienna, Austria
Center for Micro- and Nanostructures, Technische Universität Wien, Vienna, Austria
gottfried.strasser@tuwien.ac.at

This talk aims to give a short introduction in the field of quantum devices with a strong focus on quantum cascade lasers (QCLs) and quantum cascade detectors (QCDs). Since the first proposal using intraband transitions in QWs to achieve lasing (Kazarinov and Suris in the seventies) and their first experimental realization at Bell Laboratories in the nineties intraband and interband cascade lasers have been intensively studied in terms of bandstructure engineering, cavity design and fabrication technology. Nowadays, QC lasers are compact and coherent light sources covering the spectral range from the mid-infrared to the terahertz region.

A bi-functional QC structure will be presented, that can be operated in two modes, as coherent light emitter as well as intraband detector, depending on the bias applied to the structure. Today, photonic devices are widely used in environmental and industrial process control and/or monitoring as well as medical and biochemical diagnostics. Conventional optical sensing setups include a light source, a light-analyte interaction region and a separate detector. We developed and improved a sensor concept based on a bi-functional quantum cascade heterostructure, for which the differentiation between laser and detector is eliminated. Apart from the fascinating physics of light-matter interaction, this enables mutual commutation of laser and detector, simplifies remote sensing setups and allows crucial miniaturization of sensing devices for further integration.

PLENARY TALK-2 10:30-11:15 TUESDAY, SEP 11 HS P1

Probing Quantum Linearity with Biomolecules and High Mass Nanoparticles

Markus Arndt

University of Vienna, Faculty of Physics, QNP Group, VCQ, Boltzmanngasse 5, A-1090 Vienna, Austria
Markus.arndt@univie.ac.at

Quantum physics is our best theory of nature, but important questions have remained: Why is quantum mechanics linear, allowing for superpositions of classically mutually exclusive states that we do not see on the macroscopic scale we live in? What is the role of complexity or gravity in the quantum-to-classical transition? Can we utilize non-classical superpositions for novel measurements?

Starting from text-book like matter-wave diffraction experiments we will analyze which beam splitter and configurations are needed to see de Broglie interference of massive and complex particles in the lab. We see that molecular matter waves can be delocalized in position and momentum, even when each molecule avails of a rich set of internal vibrational, rotational and conformational states with a variety of electronic and optical properties. Quantum coherence in the center of mass motion persists even at internal microcanonical temperatures of 500 - 1000 K. It even was seen for molecules as massive as 10'000 amu and even molecules that we eat every day can be delocalized.