SYAD 1: SAMOP Dissertation Prize

Time: Tuesday 10:45–12:45 Location: Audimax

Invited Talk SYAD 1.1 Tue 10:45 Audimax

Attosecond-fast electron dynamics in graphene and graphene-based interfaces — •Christian Heide — Friedrich-Alexander Universität Erlangen-Nürnberg, D-91058 Erlangen

'How fast can one turn on a current?' is an important question behind boosting up the speed of electronics. Graphene is a promising material for light-field-driven electronics. Under the influence of a strong optical field, intraband motions and interband transitions in graphene are intricately coupled. In the extreme case, this leads to Landau-Zener transitions from the valence to the conduction band. In the reciprocal space, the momentum of an electron changes due to acceleration by the electric field. When the electron passes the Dirac point, where both bands are strongly coupled, the wave function of the electron is coherently split into a superposition of the two band states. After half an optical cycle of about 1.3 femtoseconds, these parts of the wave function meet again and interfere, turning on a current. Within my dissertation, we have measured this current and demonstrated that its amplitude and phase is controllable by the waveform of the laser pulse.

Furthermore, we show that graphene, grown on silicon carbide exhibits charge transfer from one material to another within 300 attoseconds. The reason for the extremely short charge transfer time is the combination of the materials used: the atomically thin graphene with excited electrons directly at the interface and the extended semiconductor, which is ideally suited to capture excited electrons.

Both results are important steps towards light-field-driven electronics.

Invited Talk SYAD 1.2 Tue 11:15 Audimax

About the interference of many particles — •Christoph Dittel — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Straße 3, 79104 Freiburg, Germany

In the coherent evolution of systems of identical particles – as nowadays routinely dealt with in photonics as well as in cold atom experiments – the superposition principle is to be applied not only to individual particles, but also to many-particle paths, provided the particles are to some degree indistinguishable and thus lack independent individuality. While such many-particle coherence properties are often referred to as essential features of multi-component quantum systems (including applications such as quantum computing architectures), their implications for the dynamics and counting statistics of many particle quantum systems have so far received only limited attention. Yet, many particle interference can give rise, e.g., to the suppression of numerous many-particle transmission amplitudes, as a distinctive feature of strictly indistinguishable as compared to partially distinguishable particles. We will give a general theory of such suppression of many-particle transmission events. Furthermore, since partial distinguishability of sets of identical particles conveys which-path information – now on the level of many-particle paths – to the environment, the systematic analysis of many-particle coherence properties paves the way for a decoherence theory of many-particle quantum systems. A cornerstone of such theory is the generalization of wave-particle duality for many-particle systems, which we will formulate, and illustrate in experimentally relevant contexts.

Invited Talk SYAD 1.3 Tue 11:45 Audimax

Supersolid Arrays of Dipolar Quantum Droplets — •Fabian Böttcher — 5. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart

The observation of a supersolid – a paradoxical state of matter characterized by the coexistence of crystalline order and superfluidity – has been a challenge since its first prediction in the 1950s. Initial experimental and theoretical investigations focused mainly on solid helium where supersolidity still remains elusive. In recent years, ultracold atomic gases have provided a new experimental approach and have allowed the observation of supersolidity in dipolar quantum gases.

Already classical magnetic ferrofluids can show many interesting phenomena, such as self-organization and spontaneous symmetry breaking. Ultracold dipolar quantum gases bring these phenomena into the quantum world. In dipolar quantum gasses, the constituent particles can interact via the short-range contact interaction and the long-range and anisotropic dipole-dipole interaction. The precise interplay of these two interactions in combination with the intrinsic quantum fluctuations leads to the emergence of liquid-like quantum droplets. Confining these quantum droplets leads to their fragmentation into arrays of multiple droplets, realizing a purely self-organized supersolid state of matter. Experimentally, we prove the supersolid nature of these droplet arrays by observing their characteristic periodic density modulation, their global phase coherence and the superfluid dynamics of low-energy excitation modes.

Invited Talk SYAD 1.4 Tue 12:15 Audimax

Quantum Logic Spectroscopy of Highly Charged Ions — •Peter Micke — QUEST Institute for Experimental Quantum Metrology, Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig, Germany