A 55: Characterization and control of complex quantum systems SYQS 2 (with Q, MO, MS, MP, AGjDPG)

Time: Friday 14:00–16:00 Location: Audimax

Invited Talk A 55.1 Fri 14:00 Audimax

Charge transfer and quantum coherence in solar cells and artificial light harvesting systems — •Christoph Lienau — Carl von Ossietzky University, Institute of Physics, Oldenburg, Germany

In artificial light harvesting systems the conversion of light into electrical or chemical energy happens on the femtosecond time scale [1], and is thought to involve the incoherent jump of an electron from the optical absorber to an electron acceptor. Here we investigate the primary dynamics of the photoinduced electronic charge transfer process in two prototypical structures: (i) a carotene-porphyrin-fullerene triad, a prototypical elementary component for an artificial light harvesting system and (ii) a polymer:fullerene blend as a model system for an organic solar cell. Our approach [2] combines coherent femtosecond spectroscopy and first-principles quantum dynamics simulations. Our experimental and theoretical results provide strong evidence that the driving mechanism of the primary step within the current generation cycle is a quantum-correlated wavelike motion of electrons and nuclei on a timescale of few tens of femtoseconds. We furthermore highlight the fundamental role played by the flexible interface between the light-absorbing chromophore and the charge acceptor in triggering the coherent wavelike electron-hole splitting.

[1] C. J. Brabec et al., Chem. Phys. Lett. 340, 232 (2001). [2] C. A. Rozzi et al., 'Quantum coherence controls the charge separation in a prototypical artificial light-harvesting system', Nature Communications 4, 1602 (2013).

A 55.2 Fri 14:30 Audimax

Designing Disorder-Assisted Energy Transfer — •Mattia Walschaers[1,2], Roberto Mulet[1,3], and Andreas Buchleitner[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, D-79104 Freiburg, Germany — [2]Instituut voor Theoretische Fysica, KU Leuven, Celestijnenlaan 200D, B-3001 Heverlee, Belgium — [3]Complex Systems Group, Department of Theoretical Physics, University of Havana, Havana, Cuba

Common wisdom suggests that complex structures typically have a negative impact on quantum transport, due to localization phenomena and the strong fluctuations which they cause. We show that localization and strong fluctuations can also be used to the benefit of transport.

By controlling typical spectral properties of an ensemble of complex systems, we design localization properties. In doing so, we can build systems such that the energy transport is mainly governed by only two scattering resonances.

When, however, these resonances start to overlap considerably, the transfer efficiency decreases drastically. We explain that a suitable control of some average properties of the energy spectrum gives rise to a statistical repulsion between the two scattering resonances. Hereby we can avoid drastic losses of the transfer efficiency, rendering the transport mechanism very robust.

A 55.3 Fri 14:45 Audimax

Cooperative effects of external control and dissipation in open quantum systems — •Rebecca Schmidt, Jürgen T. Stockburger, and Joachim Ankerhold — Institut für Theoretische Physik, Universität Ulm, Albert Einstein-Allee 11, 89069 Ulm

Coherent optimal control of non-Markovian open quantum systems is crucial in tailored-matter such as quantum information processing. In general, the presence of dissipative reservoirs is considered as detrimental to quantum coherence and entanglement. However, tailored control pulses [1] may change the role of a heat bath from being destructive on quantum resources to an asset promoting them. Here we show that the cooperative interplay between optimal control signals and a dissipative medium may indeed induce phenomena such as entropy reduction (cooling) [1,2] and creation of bi-partite entanglement [3].

[1] R. Schmidt, A. Negretti, J. Ankerhold, T. Calarco and J.T. Stockburger, PRL **107**, 130404 (2011)

[2] R. Schmidt, S. Rohrer, J.T. Stockburger and J. Ankerhold, Phys. Scr. **T151**, 014034 (2012)

[3] R. Schmidt, J.T. Stockburger, and J. Ankerhold, PRA **88**, 052321 (2013)

A 55.4 Fri 15:00 Audimax

Nonlinear spectroscopy with quantum light — •Frank Schlawin[1], Konstantin Dorfman[2], Benjamin Fingerhut[2], and Shaul Mukamel[2] — [1]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Straße 3, 79108 Freiburg, Germany — [2]Department of Chemistry, University of California, Irvine, California 92697-2025, USA

Nonlinear spectroscopy has evolved into an indispensable tool to probe non-equilibrium dynamics of complex quantum systems. Typically, the interpretation of these signals suffers from the enormous number of free parameters in the underlying Hamiltonians of the system and its coupling to the environment. It is highly desirable to develop new tools to extract further information from those systems. We will discuss the possibility of exploiting strong correlations of entangled light to manipulate nonlinear spectra of complex quantum systems such as photosynthetic complexes. Exciton transport can be suppressed, and two-exciton states can be selectively excited.

A 55.5 Fri 15:15 Audimax

Dynamical Algebras and Many-body Physics — •Zoltán Zimborás[1], Robert Zeier[2], Zoltán Kádár[3], Michael Keyl[2], and Thomas Schulte-Herbrüggen[2] — [1]University of the Basque Country (UPV/EHU), Bilbao, Spain — [2]Technische Universität München (TUM), Germany — [3]University of Leeds (UL), UK

Dynamical algebras, i.e., Lie algebras generated by Hamiltonians, are basic tools both in Quantum Control and Quantum Simulation Theory. In this talk, we will argue that these algebras might also have relevance in Many-Body Physics. By studying Lie closures of translation-invariant Hamiltonians, we show that nearest-neighbor Hamiltonians do not generate all translation-invariant interactions. We discuss the relevance of this result in simulating many-body dynamics. Furthermore, we point out that our results [1] also provides a surprising Lie algebraic explanation of a previous finding of ours concerning the absence of gap in quasifree models with (twisted) reflection-symmetry breaking [2].

[1] Z. Zimborás, R. Zeier, M. Keyl, and T. Schulte-Herbrüggen, "A Dynamic Systems Approach to Fermions and Their Relations to Spins", arXiv:1211.2226.

[2] Z. Kádár and Z. Zimborás, "Entanglement entropy in quantum spin chains with broken reflection invariance", Phys. Rev. A 82, 032334 (2010).

Invited Talk A 55.6 Fri 15:30 Audimax

Feedback control: from Maxwell's demon to quantum phase transitions — •Tobias Brandes — TU Berlin

I will give an overview of our recent attempts to understand the thermodynamics and quantum mechanics of closed loop (feedback) control. I will discuss a minimal implementation of Maxwell's demon in a solid state system with only four states [1], but also the opposite case of many collective degrees of freedom, i.e. models for phase transitions (Dicke superradiance model [2], quantum Ising chain [3]).

[1] P. Strasberg, G. Schaller, T. Brandes, and M. Esposito, Phys. Rev. Lett. 110, 040601 (2013). [2] T. Brandes, Phys.Rev.E 88 032133 (2013). [3] M. Vogl, G. Schaller, T. Brandes, Phys. Rev. Lett. 109, 240402 (2012).