Q 66: Quantum Effects (Entanglement and Decoherence)

Time: Friday 10:30–12:30 Location: K 1.013

Q 66.1 Fri 10:30 K 1.013

Forgetting and remembering – the story of Markovian and non-Markovian evolution — •Filip Wudarski — Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Freiburg, Germany

Markovian and non-Markovian evolutions are one of key concepts in the theory of open quantum systems. Interestingly their sets do not exhibit convex structure, and it is possible to obtain non-Markovian evolution by mixing two Markovian ones, and vice versa. In this talk, we will present some basic concepts of Markovian and non-Markovian evolution and discuss the non-convex structure of the sets. We will refer to mathematical concepts and present their experimental implementation in photonic systems.

Q 66.2 Fri 10:45 K 1.013

Parametrization and optimization of Gaussian non-Markovian unravelings for open quantum dynamics — •Nina Megier[1], Walter T. Strunz[1], Carlos Viviescas[2], and Kimmo Luoma[1] — [1]Institut für Theoretische Physik, Technische Universität Dresden, Germany — [2]Departamento de Fisica, Universidad Nacional de Colombia, Bogota D.C., Colombia

A complete parametrization of diffusive stochastic Schrödinger equations in the Markovian regime is known (Wiseman, Diósi, Chem. Phys. 268, 91 (2001); Chia, Wiseman, PRA 84, 012119 (2011)). Changing these parameters allows control over the noise correlations driving the stochastic dynamics, which can be used to optimize the trajectories e.g. for entanglement detection (Viviescas et al., PRL 105, 210502 (2010); Guevara, Viviescas, PRA 90, 012338 (2014)).

A general non-Markovian Gaussian stochastic Schrödinger equation was recently postulated (Diósi, Ferialdi, PRL 113, 200403 (2014); Ferialdi, PRL 116, 120402 (2016)). Based on a microscopic model, we here derive a family of Gaussian non-Markovian stochastic Schrödinger equations with a single shot measurement interpretation (arXiv:1710.08359). The different unravelings correspond to different choices of squeezed coherent states, reflecting different measurement schemes on the environment. Interesting applications for quantum information tasks in the non-Markovian regime are given. In particular, by optimizing the squeezing parameters, we can tailor unravelings for optimal entanglement bounds or for environment-assisted entanglement protection.

Q 66.3 Fri 11:00 K 1.013

Rotational friction and thermalization of quantum rigid rotors — •Björn Schrinski, Benjamin A. Stickler, and Klaus Hornberger — Fakultät für Physik, Universität Duisburg-Essen

We present the general Markovian quantum master equation describing rotational decoherence, friction, diffusion, and thermalization of a rigid rotor in contact with a thermal environment. The master equation describes thermalization toward a Gibbs-like rotation state and gives rise to the rotational Fokker-Planck equation in its semiclassical limit. Its adequacy and applicability is demonstrated by studying the thermalization dynamics of the linear and the planar top. Possible applications include experimental tests of the quantum superposition principle involving the rotational degree of freedom [1], molecular quantum experiments in the field of ultracold chemistry [2], as well as the assessment of the thermodynamic efficiency of quantum rotor heat engines [3].

[1] B. Schrinski et al., J. Opt. Soc. Am. B 34, C1 (2017)
[2] S. A. Moses et al., Nat. Phys. 13, 13 (2017)
[3] A. Roulet et al., Phys. Rev. E 95, 062131 (2017)

Q 66.4 Fri 11:15 K 1.013

Thermalization as an invisibility cloak for fragile quantum superpositions — •Walter Hahn[1] and Boris Fine[1,2] — [1]Skolkovo Institute of Science and Technology, Skolkovo Innovation Centre, Nobel Street 3, Moscow 143026, Russia — [2]Institute for Theoretical Physics, Philosophenweg 12, 69120 Heidelberg, Germany

We propose a method for protecting fragile quantum superpositions in many-particle systems from dephasing by external classical noise. We call superpositions fragile if dephasing occurs particularly fast, because the noise couples very differently to the superposed states. The method consists of letting a quantum superposition evolve under the internal thermalization dynamics of the system, followed by a time-reversal manipulation known as Loschmidt echo. The thermalization dynamics makes the superposed states almost indistinguishable during most of the above procedure. We validate the method by applying it to a cluster of spins 1/2.

Q 66.5 Fri 11:30 K 1.013

Quantum description of lossy integrated photonic waveguide structures — •Lucas Teuber and Stefan Scheel — Institut für Physik, Universität Rostock, D-18055 Rostock, Germany

Integrated photonic waveguide structures created by the femtosecond laser direct-writting technique are a promising candidate for the implementation of quantum computational circuits [1]. The photons, as carriers of quantum information, are guided along the laser-written waveguides and can be exchanged between different waveguides via evanescent coupling. However, decoherence effects such as photon loss, dephasing, or path walk-off, have a detrimental effect on the ability to encode, transmit, and manipulate quantum information.

Here we report on our efforts to solve these problems. We derive a quantum mechanical description by discretizing the structures along the propagation direction and employing commutator-preserving input/output relations [2] for propagation and coupling. Additionally, we analyse different lossy waveguide structures to formulate suitable quantum eigenstates for optimal transport of quantum information.

[1] Meany, T. et al., Laser Photonics Rev. 9, 363 (2015).
[2] Scheel, S. and Buhmann, S.Y., Acta Phys. Slov. 58, 675 (2008).

Q 66.6 Fri 11:45 K 1.013

Jump-based Control of the Lipkin-Meshkov-Glick model — Sven Zimmermann, •Wassilij Kopylov, and Gernot Schaller — Institut für theoretische Physik, TU Berlin, Berlin, Germany

We apply a measurement based closed loop control scheme to the dissipative Lipkin-Meshkov-Glick model to affect the quantum phase transition[1-3]. Here we use the Wiseman-Milburn control scheme and apply it on the level of the master equation to the system dissipator [4]. Our interest lies in the steady state properties of the Lipkin-Meshkov-Glick system under the feedback action. We show, by calculating the averaged spin expectation values, that the considered control scheme changes the critical point of the phase transition. Furthermore, by investigating the waiting time distribution and the concurrence, we show, that the emission properties of the system and the entanglement can be strongly modified by the feedback control.

[1] H.J. Lipkin, N. Meshkov and A. Glick, Nucl. Phys., 62, 188 (1965)
[2] S. Morrison and A. S. Parkins PRL 100, 040403 (2008)
[3] W. Kopylov and T. Brandes, NJP 17, 103031 (2015)
[4] H. M. Wiseman and G. J. Milburn, Quantum Measurment Control, Cambrige University Press, Campridge (2010)
[5] G. Kießlich, C. Emary, G. Schaller and T. Brandes, NJP 14, 123036 (2012)

Q 66.7 Fri 12:00 K 1.013

Entanglement among degrees of freedom of a composite quasiparticle scattering by an impurity on a lattice — •Fumika Suzuki[1], Marina Litinskaya[2], and William G. Unruh[1] — [1]Department of Physics, University of British Columbia, Vancouver, V6T 1Z1, Canada — [2]Department of Chemistry, University of British Columbia, Vancouver, V6T 1Z1, Canada

We study scattering of a composite quasiparticle, which possesses a degree of freedom corresponding to relative separation between two bound particles, by a delta-like impurity potential on a one-dimensional discrete lattice. Different from a composite object in continuum space, for a composite quasiparticle on a discrete lattice, the entanglement between its relative and centre of mass coordinate degrees of freedom arises naturally due to inseparability of the two-particle Hamiltonian. One of the main focuses of our study is to investigate how this inseparability or the entanglement among degrees of freedom of the composite quasiparticle affects the way how it interacts with an external object such as an impurity. We also report the existence of excitation-impurity bound states whose energies are located in the continuum band. Finally, we discuss a change in the entanglement of a composite quasiparticle wave packet during a single impurity scattering and the decoherence effect on the interference pattern created by it.

Ref: F. Suzuki, M. Litinskaya and W. G. Unruh, Phys. Rev. B. 96, 054307 (2017).

Q 66.8 Fri 12:15 K 1.013

Exploring Fano interferometers towards entanglement detection — •Jörg Evers and Fabian Lauble — Max-Planck-Institut für Kernphysik, Heidelberg

Interferometry is an indispensable tool across all the natural sciences. Recently, we have proposed and implemented a new type of interferometer based on phase-sensitive Fano resonances. These Fano resonances appear if photons have two indistinguishable pathways from source to detector: either via a spectrally broad continuum channel, or via a spectrally narrow resonant bound state scattering channel. We have shown that these two channels can form interferometer arms [1], and experimentally demonstrated two different implementations of Fano interferometers in x-ray quantum optics [1,2]. Here, we review these Fano interferometers, and discuss their capabilities in particular related to the detection of single-photon mode entanglement [3].

[1] K. P. Heeg et al., *Interferometric phase detection at x-ray energies via Fano resonance control*, Phys. Rev. Lett. 114, 207401 (2015).

[2] K. P. Heeg et al., *Spectral narrowing of x-ray pulses for precision spectroscopy with nuclear resonances*, Science 357, 375 (2017).

[3] F. Lauble and J. Evers, *in preparation.*