Q 12: Quantum Information: Concepts and Methods 2

Time: Monday 14:30–16:00 Location: SCH A118

Q 12.1 Mon 14:30 SCH A118

Poincaré sphere representation for classical inseparable states of the electromagnetic field — •Annemarie Holleczek[1,2], Andrea Aiello[1,2], Christian Gabriel[1,2], Christoph Marquardt[1,2], and Gerd Leuchs[1,2] — [1]Max Planck Institute for the Science of Light, Günter-Scharowsky-Str. 1/Bau 24, 91058 Erlangen, Germany — [2]Institute for Optics, Information and Photonics, University of Erlangen-Nuremberg, Staudtstr. 7/B2, 91058 Erlangen, Germany

Cylindrically polarized modes (CPMs) of the electromagnetic field are very intriguing objects as they combine a complex polarization pattern with a complex spatial pattern. We investigate theoretical subtleties underlying their structure, in particular, a thorough theoretical description for spatio-polarization modes is developed. We show that two hybrid Poincaré spheres can be introduced to represent simultaneously the polarization and the spatial degrees of freedom of CPMs in accordance with conventional ways of displaying properties of optical beams, such as the Poincaré sphere for polarization. Possible mode-to-mode transformations accomplishable with the help of conventional polarization and spatial phase retarders are shown within this representation.

Q 12.2 Mon 14:45 SCH A118

Solving frustration-free spin models — •Niel de Beaudrap[1], Matthias Ohliger[1], Tobias J. Osborne[2], and Jens Eisert[1] — [1]Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Strasse 24/25 14476 Potsdam — [2]Leibnitz Universität Hannover, Institut für Theoretische Physik, Appelstraße 2, 30167 Hannover, Germany

We show that ground states of unfrustrated quantum spin-1/2 systems on general lattices satisfy an entanglement area law, provided that the Hamiltonian can be decomposed into nearest-neighbor interaction terms which have entangled excited states. The ground state manifold can be efficiently described as the image of a low-dimensional subspace of low Schmidt measure, under an efficiently contractible tree-tensor network. This structure gives rise to the possibility of efficiently simulating the complete ground space (which is in general degenerate). We also show how our approach gives rise to an ansatz class useful for the simulation of almost frustration-free models in a simple fashion, outperforming mean field theory.

Q 12.3 Mon 15:00 SCH A118

Measures of Quantum Decoherence — •Julius Helm and Walter T. Strunz — Institut für Theoretische Physik, TU Dresden, 01062 Dresden

For practical purposes decoherence may often be well described on basis of a stochastic Hamiltonian. Yet, for systems of two qubits or more it is known that true quantum decoherence exists, that is, decoherence due to growing entanglement between the system and its quantum environment. While the former may be described using random unitary (RU) channels, there are quantum decoherence channels of which no RU representation can be found [1,2]. We study measures of the quantumness of a decoherence channel, that is, the norm distance to the convex set of random unitary channels.

[1] L. Landau and R.F. Streater, Lin. Alg. Appl. 193, 107 (1993).
[2] J. Helm and W.T. Strunz, Phys. Rev. A 80, 042108 (2009).

Q 12.4 Mon 15:15 SCH A118

Control of many body quantum systems — •Simone Montangero — Ulm university

We present recent results on control of many body quantum systems, in particular the control of quantum phase transition dynamics and of coherent transport in open systems such as FMO complexes.

Q 12.5 Mon 15:30 SCH A118

Polynomial invariants for discrimination and classification of four-qubit entanglement — •Oliver Viehmann[1], Christopher Eltschka[2], and Jens Siewert[3,4] — [1]Physics Department, ASC, and CeNS, Ludwig-Maximilians-Universität, München, Germany — [2]Institut für Theoretische Physik, Universität Regensburg, Regensburg, Germany — [3]Departamento de Química Física, Universidad del País Vasco – Euskal Herriko Unibertsitatea, Bilbao, Spain — [4]Ikerbasque, Basque Foundation for Science, Bilbao, Spain

It is well known that the number of entanglement classes in SLOCC (stochastic local operations and classical communication) classifications increases with the number of qubits and is already infinite for four qubits [1]. Bearing in mind the rapid evolution of experimental technology, criteria for explicitly discriminating and classifying pure states of four and more qubits are highly desirable and therefore in the focus of intense theoretical research.

We develop a general criterion for the discrimination of pure N-partite entangled states in terms of polynomial $SL(d,\mathbb{C})^{\otimes N}$ invariants. By means of this criterion, existing SLOCC classifications of four-qubit entanglement are reproduced. Based on this we propose a polynomial classification scheme in which families are identified through "tangle patterns", thus bringing together qualitative and quantitative description of entanglement.

[1] W. Dür, G. Vidal, and J.I. Cirac, Phys. Rev. A **62**, 062314 (2000).

Q 12.6 Mon 15:45 SCH A118

Driving-enhanced multi-partite entanglement in a qubit network — •Simeon Sauer[1], Florian Mintert[1,2], and Andreas Buchleitner[1] — [1]Physikalisches Institut, Albert-Ludwigs-Universität, Hermann-Herder-Str. 3, D-79104 Freiburg, Germany — [2]Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität Freiburg, Albertstraße 19, D-79104 Freiburg, Germany

Periodically driving a composite quantum system can have beneficial influence on its entanglement dynamics, if the driving parameters are suitably chosen. This fact was investigated recently for the case of bipartite entanglement in several *open* quantum systems. Yet, a general understanding of when and why entanglement is enhanced by periodic driving is not present. Furthermore, not much is know for the case of multi-partite entanglement so far.

To develop such understanding, in the presented work we consider a *closed* multi-partite quantum system, consisting of several weakly coupled qubits, and study the interplay of periodic driving and multi-partite entanglement therein. To this end, we identify the dressed states of the driven system in the Floquet picture and and quantify their entanglement by means of a multi-partite entanglement measure. Indeed, at certain values of the driving frequency and amplitude, we find a resonant behavior of entanglement. The occurrence of these resonances in parameter space coincides with avoided crossings in the Floquet spectrum. This fact enables us to explain the underlying mechanism that leads to the resonances and to predict them from the single particle Floquet spectrum only.