Q 32: Quantum Information: Concepts and Methods V

Time: Wednesday 14:30–16:15 Location: P 2

Q 32.1 Wed 14:30 P 2

Fluorescence state detection of single atoms on a non-cycling transition — •Bo Wang, Matthias Körber, Stefan Langenfeld, Olivier Morin, Andreas Neuzner, Stephan Ritter, and Gerhard Rempe — Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Str. 1, 85748, Garching, Germany

State-selective fluorescence is widely used to readout the internal state of atoms or ions. Applications range from optical clocks to quantum information processing. To reach a high accuracy, many scattered photons are required. Any loss channel leading to a dark state stops the fluorescence and reduces the fidelity. Therefore, standard fluorescence detection is only applicable for a few internal states that can be excited via a cycling transition, like the $\left|^5S_{1/2},\ F=2\right\rangle$ state in ^{87}Rb. We now theoretically and experimentally study schemes for the detection of the $\left|^5S_{1/2},\ F=1\right\rangle$ state in ^{87}Rb for which a cycling transition does not exist. Our schemes are based on cavity-enhanced fluorescence and alternating probe-beam configurations. By optimizing the control sequence, we currently achieve a hyperfine-state-detection fidelity of 96% in 12 μs. Theoretical concepts for further optimization will be presented.

Q 32.2 Wed 14:45 P 2

Quantum Imaging with Incoherent Light From a Free-Electron Laser — •Raimund Schneider for the Quantum Imaging Collaboration — Universität Erlangen-Nürnberg, Staudtstr. 1, 91058 Erlangen — Deutsches Elektronen-Synchrotron DESY, Notkestr. 85, 22607 Hamburg — Universität Hamburg, Luruper Chaussee 149, 22761 Hamburg

We report on a new method to reconstruct an unknown geometry of independent thermal sources radiating at VUV wavelengths. Our imaging algorithm is based on measuring higher order spatial intensity correlations allowing to extract structural information about the source distribution from the light field even though the sources emit completely incoherently. We present experimental results of imaging an artificial molecule where the atoms are mimicked by holes in a SiN membrane. The hole mask is illuminated by incoherent light scattered from a diffusor which itself is illuminated by the beam of the free electron laser FLASH at DESY, Hamburg. This imaging method is of particular interest in the x-ray regime as the coherence of high energy photons is easily lost, e.g., due to imperfect beam optics or incoherent scattering processes.

Q 32.3 Wed 15:00 P 2

Detection of quantum correlations without quantum discord — •Semjon Köhnke, Elizabeth Agudelo, Melanie Mraz, Oskar Schlettwein, Werner Vogel, and Boris Hage — Institut für Physik, Universität Rostock, Germany

Currently a variety of different nonclassicality criteria are discussed. They should classify whether a quantum state has a classical character or is governed by quantum phenomena.

For testing nonclassicality criteria phase diffused squeezed states were successfully used [1]. These states are a mixture of squeezed states with a stochastically distributed phase. In our experiment we go a step further. We produce an entangled state out of two squeezed fields which interfere on a 50/50 beam splitter. Using phase diffusion at one of the outputs gives us a fully randomized phase relation between both of them. Thereby the entanglement gets destroyed.

To identify quantum correlation effects the quantum discord is widely spread as universal indicator. Though this indicator fails and does not reveal the nonclassical correlations from our experiment. In contrast using the sampling formula of the regularized Glauber-Sudarshan P function [2] we obtain a quasiprobability distribution which uncovers any quantum correlations, going beyond quantum entanglement and quantum discord.

[1] Schnabel et al., Phys. Rev. A 79, 022122 (2009).
[2] Vogel et al., Phys. Rev. A 87, 033811 (2013).

Q 32.4 Wed 15:15 P 2

Entanglement and coherence in quantum state merging — •Alexander Streltsov[1,2], Eric Chitambar[3], Swapan Rana[1], Manabendra Nath Bera[1], Andreas Winter[4,5], and Maciej Lewenstein[1,5] — [1]ICFO, ES-08860 Castelldefels, Spain — [2]Freie Universität Berlin, D-14195 Berlin, Germany — [3]Southern Illinois University, Carbondale, Illinois 62901, USA — [4]Universitat Autònoma de Barcelona, ES-08193 Bellaterra (Barcelona), Spain — [5]ICREA, ES-08010 Barcelona, Spain

Understanding the resource consumption in distributed scenarios is one of the main goals of quantum information theory. A prominent example for such a scenario is the task of quantum state merging where two parties aim to merge their parts of a tripartite quantum state. In standard quantum state merging, entanglement is considered as an expensive resource, while local quantum operations can be performed at no additional cost. Here, we consider the task of incoherent quantum state merging, where one of the parties has free access to local incoherent operations only. In this case the resources of the process are quantified by pairs of entanglement and coherence. We develop tools for studying this process, and apply them to several relevant scenarios. While quantum state merging can lead to a gain of entanglement, our results imply that no merging procedure can gain entanglement and coherence at the same time. We also provide a general lower bound on the entanglement-coherence sum, and show that the bound is tight for all pure states.
For more details see Phys. Rev. Lett. **116**, 240405 (2016).

Q 32.5 Wed 15:30 P 2

Quantum fidelity of symmetric multipartite states — •Antoine Neven[1], Pierre Mathonet[2], Otfried Gühne[3], and Thierry Bastin[1] — [1]CESAM Research Unit, Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, 4000 Liège, Belgium — [2]Département de Mathématique, Université de Liège, 4000 Liège, Belgium — [3]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, D-57068 Siegen, Germany

For two symmetric quantum states one may be interested in maximizing the overlap under local operations applied to one of them. The question arises whether the maximal overlap can be obtained by applying the same local operation to each party. We show [1] that for two symmetric multiqubit states and local unitary transformations this is the case; the maximal overlap can be reached by applying the same unitary matrix everywhere. For local invertible operations (stochastic local operations assisted by classical communication equivalence), however, we present counterexamples, demonstrating that considering the same operation everywhere is not enough.

[1] A. Neven, P. Mathonet, O. Gühne, and T. Bastin, Phys. Rev. A **94**, 052332 (2016).

Q 32.6 Wed 15:45 P 2

Absolutely maximally entangled states of seven qubits do not exist — •Felix Huber[1], Otfried Gühne[1], and Jens Siewert[2,3] — [1]Naturwissenschaftlich-Technische Fakultät, Universität Siegen, 57068 Siegen, Germany — [2]Departamento de Química Física, Universidad del País Vasco UPV/EHU, E-48080 Bilbao, Spain — [3]IKERBASQUE Basque Foundation for Science, E-48013 Bilbao, Spain

Pure multiparticle quantum states are called absolutely maximally entangled if all reduced states obtained by tracing out at least half of the particles are maximally mixed. We provide a method to characterize these states for a general multiparticle system. With that, we prove that a seven-qubit state whose three-body marginals are all maximally mixed does not exist. Furthermore, we obtain an upper limit on the possible number of maximally mixed three-body marginals and identify the state saturating the bound. This solves the seven-particle problem as the last open case concerning maximally entangled states of qubits.

Q 32.7 Wed 16:00 P 2

Almost all pure four-qubit states are uniquely determined by their two-body marginals — •Nikolai Wyderka, Felix Huber, and Otfried Gühne — Naturwissenschaftlich Technische Fakultät, Universität Siegen, Walter-Flex-Str. 3, D-57068 Siegen, Germany

Thermal states of Hamiltonians with two-body interactions are of great interest in quantum information processing as these states may be experimentally realised by engineering the Hamiltonian. The question of whether the ground state of such an Hamiltonian is unique is closely connected to the question whether the state is uniquely determined by its two-body marginals. For generic three-qubit states, it was shown that generic pure states are uniquely determined among all states by their two-body marginals [1]. We show that generic four-qubit states are uniquely determined among pure states by their two-body marginals.

[1] N. Linden, S. Popescu, and W. K. Wootters. Phys. Rev. Lett. 89, 207901 (2002).