

Q 31: Quanteninformaton (Konzepte und Methoden I)

Zeit: Donnerstag 8:30–10:30

Raum: 1B

Q 31.1 Do 8:30 1B

Effective Spin Systems in Coupled Arrays of Cavities — ●MICHAEL HARTMANN^{1,2}, FERNANDO BRANDÃO^{1,2}, and MARTIN PLENIO^{1,2} — ¹Institute for Mathematical Sciences, Imperial College London, 53 Exhibition Road, London, SW7 2PG, United Kingdom — ²QOLS, Blackett Laboratory, Imperial College London, Prince Consort Road, London, SW7 2BW, United Kingdom

We show that atoms trapped in micro-cavities that interact via the exchange of virtual photons can model an anisotropic Heisenberg spin-1/2 lattice in an external magnetic field. All parameters of the effective Hamiltonian can individually be tuned via external lasers. Since the occupations of excited atomic levels and photonic states are strongly suppressed, the effective model is robust against decoherence mechanisms, has a long lifetime and its implementation is feasible with current experimental technology. The model provides a feasible way to create cluster states in these devices.

Q 31.2 Do 8:45 1B

Possibility, Impossibility and Cheat-Sensitivity of Quantum Bit String Commitment — HARRY BUHRMAN¹, ●MATTHIAS CHRISTANDL², PATRICK HAYDEN³, HOI-KWONG LO⁴, and STEPHANIE WEHNER¹ — ¹CWI Amsterdam, The Netherlands — ²University of Cambridge, United Kingdom — ³McGill University, Montreal, Canada — ⁴University of Toronto, Canada

Unconditionally secure non-relativistic bit commitment is known to be impossible in both the classical and the quantum worlds. But when committing to a string of n bits at once, how far can we stretch the quantum limits? In this paper, we introduce a framework for quantum schemes where Alice commits a string of n bits to Bob in such a way that she can only cheat on a bits and Bob can learn at most b bits of information before the reveal phase.

Our results are two-fold: we show by an explicit construction that in the traditional approach, where the reveal and guess probabilities form the security criteria, no good schemes can exist: $a + b$ is at least n . If, however, we use a more liberal criterion of security, the accessible information, we construct schemes where $a = 4 \log_2 n + O(1)$ and $b = 4$, which is impossible classically.

We furthermore present a cheat-sensitive quantum bit string commitment protocol for which we give an explicit tradeoff between Bob's ability to gain information about the committed string, and the probability of him being detected cheating.

Q 31.3 Do 9:00 1B

Complementarity, Privacy, and Entanglement — ●JOSEPH M. RENES¹ and JEAN-CHRISTIAN BOILEAU² — ¹Institut für Angewandte Physik, TU Darmstadt, Germany — ²Center for Quantum Information and Quantum Control, University of Toronto, Canada

We develop a complementary information tradeoff which bounds the amount of information about complementary observables that can be simultaneously extracted from a quantum system. This leads directly to a simple characterization both private states (the quantum version of secret keys) and maximally-entangled states, revealing these to be a direct manifestation of the quantum mechanical phenomenon of complementarity. Furthermore, we conjecture a strengthened version of the tradeoff and show how these ideas can be adapted to create protocols for distilling secret keys or entangled states.

Q 31.4 Do 9:15 1B

Maximally entangled fermions — ●DIRK-MICHAEL SCHLINGEMANN^{1,2}, LORENZO CAMPOS VENUTI¹, MARCO COZZINI¹, and MICHAEL KEYL^{1,2} — ¹ISI Foundation Torino, Quantum information theory unit, Torino, Italy — ²Institut f. Mathematische Physik, TU-Braunschweig, Germany

Fermions play an essential role in many areas of quantum physics and it is desirable to understand the nature of entanglement within systems that consists of fermions. Whereas the issue of separability for bipartite fermions has extensively been studied in the present literature, this talk reports on our recent paper [arXiv:0711.3394] that is concerned with maximally entangled fermions. A complete characterization of maximally entangled quasifree (gaussian) fermion states is given in terms of the covariance matrix. This result can be seen as a step towards distillation protocols for maximally entangled fermions.

Q 31.5 Do 9:30 1B

Evolution equation for quantum entanglement — ●MARKUS TIERSCH^{1,2}, THOMAS KONRAD³, FERNANDO DE MELO^{1,2}, CHRISTIAN KASZTELAN⁴, ADRIANO ARAGAO^{5,2}, and ANDREAS BUCHLEITNER^{1,2} — ¹Albert-Ludwigs-Universität Freiburg, Physikalisches Institut, Hermann-Herder-Str. 3, D-79104 Freiburg, Germany — ²Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, D-01187 Dresden, Germany — ³Quantum Research Group, School of Physics, University of KwaZulu-Natal, Private Bag X54001, Durban 4000, South Africa — ⁴Institut für Theoretische Physik C, RWTH Aachen, D-52056 Aachen, Germany — ⁵Instituto de Física, Universidade Federal do Rio de Janeiro, Caixa Postal 68.528, CEP 21945-970, Rio de Janeiro, RJ, Brazil

Quantum systems composed of two qubits constitute the starting point for the study of quantum entanglement. The evolution of entanglement when such a system is subject to open system dynamics will be examined in this talk. We will derive a simple factorization relation which describes the system's final entanglement after one of the qubits has undergone an arbitrary physical process.

Q 31.6 Do 9:45 1B

Bound Entanglement and Entanglement Bounds — ●SIMEON SAUER^{1,2}, FERNANDO DE MELO^{2,3}, JOONWOO BAE⁴, FLORIAN MINTERT^{2,3}, BEATRIX HIESMAYR⁵, and ANDREAS BUCHLEITNER^{2,3} — ¹Physikalisch-Astronomische Fakultät, Friedrich-Schiller-Universität Jena, Germany — ²Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Strasse 3, D-79104 Freiburg, Germany — ³Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str.38, D-01187 Dresden, Germany — ⁴School of Computational Sciences, Korea Institute for Advanced Study, Seoul 130-012, Korea — ⁵Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria

We investigate the separability of Bell-diagonal states of two qutrits. By using lower bounds to algebraically estimate concurrence, we find convex regions of bound entangled states. Some of these regions exactly coincide with the obtained results when employing optimal entanglement witnesses, what shows that the lower bound can serve as a precise detector of entanglement. Some hitherto unknown regions of bound entangled states were discovered with this approach, and delimited efficiently.

Q 31.7 Do 10:00 1B

Indirect control of open system dynamics — ●RAFFAELE ROMANO — Max Planck Research Group, Institute of Optics, Information and Photonics, Staudstr. 7/B2, 91058 Erlangen, Germany

Although conceptually simpler, the standard open loop approach to the control of a quantum mechanical system offers a limited ability to drive the state of the system when the interaction with the external environment cannot be neglected. With this motivation in mind, closed loop approaches have been proposed (quantum feedback). In this contribution, we show that open loop controllability of an open system can be obtained if non standard control scenarios are adopted [1]. In particular, we consider the {it indirect control} technique [2], based on the use of an auxiliary system whose initial state can be arbitrarily prepared. In our model, the environmental action can be engineered to give complete controllability, and it does not only represent a source of noise and decoherence.

[1] R. Romano, D. D'Alessandro, Phys. Rev. Lett. 97, 080402(2006)

[2] R. Romano, D. D'Alessandro, Phys. Rev. A 73, 022323 (2006)

Q 31.8 Do 10:15 1B

Wave particle duality in a two atom interferometer — ●UWE SCHILLING¹, CHRISTOPH THIEL¹, THIERRY BASTIN², and JOACHIM VON ZANTHIER¹ — ¹Institut für Optik, Information und Photonik, Max-Planck-Forschungsgruppe, Universität Erlangen-Nürnberg, Germany — ²Institut de Physique Nucléaire, Atomique et de Spectroscopie, Université de Liège, Belgium

In 1996 Englert investigated the wave-particle duality in a Ramsey interferometer and derived a quantitative complementarity relation between the contrast of the interference pattern and the maximum obtainable which-way (WW) information [1].

We examine the duality relation in a system of two two-level atoms which are coherently excited by a resonant laser pulse. The atoms subsequently scatter a single photon which is recorded by a detector in the far field region. By applying Englert's definition of the distinguishability \mathcal{D} of the two paths in this interferometer, we find that \mathcal{D} becomes a function of *where* the photon is detected. As a result we derive that in this system, by choosing the detector position and the Bloch angle

of the exciting laser pulse accordingly, full WW information becomes available after the detection of the photon while the contrast of the interference pattern remains close to 100 %. By introducing a quantity which describes the *average* WW information per scattered photon, it is possible to derive a quantitative relation between the wave and the particle properties of the photon in this system.

[1] B.-G. Englert, Phys. Rev. Lett. **77**, 2154 (1996)