Q 5: Quanteninformation: Konzepte I

Zeit: Montag 10:45–12:30 Raum: VMP 6 HS-D

Q 5.1 Mo 10:45 VMP 6 HS-D

Copies with high fidelity from a simple quantum cloning machine — •Michael Siomau[1] and Stephan Fritzsche[1,2,3] — [1]Max-Planck-Institut für Kernphysik, Postfach 103980, D-69117 Heidelberg, Germany — [2]Gesellschaft für Schwerionenforschung, D-64291 Darmstadt, Germany — [3]Frankfurt Institute for Advanced Studies, D-60438 Frankfurt am Main, Germany

We investigate theoretically a symmetric quantum cloning machine (QCM) which provides two identical copies for any given input qubit. When compared with the Universal QCM [1], that produces copies with constant fidelity $F = 5/6 \approx 0.83$ for any given input state, and the Equatorial QCM [2] (copies with fidelity $F \approx 0.85$ for states on the equator of the Bloch sphere), our suggested scheme produces copies with fidelity $0.95 \geq F \geq 0.90$ for some selected region of the Bloch sphere. The properties of the new transformation are discussed along with possible applications of this scheme.

[1] V. Bužek and M. Hillery, Phys.Rev.A. 54, 1844 (1996)
[2] D. Bruß, M. Cinchetti, G.M. D'Ariano and C. Macchiavell, Phys.Rew.A 62, 012302 (2000)

Q 5.2 Mo 11:00 VMP 6 HS-D

Deterministic purification of an entangled state using a single copy — •Matthias Kleinmann, Oleg Gittsovich, and Otfried Gühne — Institut für Quantenoptik und Quanteninformation, Technikerstraße 21a, 6020 Innsbruck, Austria

Two remote parties cannot prepare any entangled quantum state if the communication between them is limited to be classical. However, if both parties initially share an entangled state it is possible to prepare with a probability of one any state from a certain family of entangled states. While –by definition– the entanglement cannot increase in such a scenario, it might well be possible to achieve a pure final state, even if starting from a mixed initial state [1]. We consider conditions and examples for such purification protocols and study the interlink to the entanglement-preserving distinction of pure states [2].

[1] E. Chitambar *et al.*, `arXiv:0811.3739`
[2] S. Cohen, Phys. Rev. A **75**, 052313 (2007)

Q 5.3 Mo 11:15 VMP 6 HS-D

Manipulating entanglement sudden death of two-qubit X-states in zero- and finite-temperature reservoirs — •Mazhar Ali[1], Gernot Alber[1], and Ravi Rau[2] — [1]Institut für Angewandte Physik, Technische Universität Darmstadt, D-64289, Germany — [2]Department of Physics and Astronomy, Louisiana State University, Baton Rouge, Louisiana 70803, USA

The finite-time end of quantum entanglement or *entanglement sudden death* (ESD) has been investigated both theoretically and experimentally. In many situations however it is of interest to stabilize quantum states against ESD. Recently, we have shown that, it is possible to hasten, delay or even avert ESD in zero-temperature reservoirs [1]. Generalizing these first results it is demonstrated that ESD of two qubits interacting with statistically uncorrelated thermal reservoirs can also be controlled by application of simple local unitary transformations. In particular, for initially prepared X-states of two qubits a simple (necessary and sufficient) criterion for ESD can be derived with the help of the Peres-Horodecki criterion. Based on this criterion it is possible to prove that, in contrast to the zero-temperature case, at finite temperatures of at least one of the reservoirs all initially prepared two-qubit X-states exhibit ESD. General conditions are derived under which ESD can be hastened, delayed, or averted [2].

[1] A. R. P. Rau, M. Ali, and G. Alber, Eur. Phys. Lett. 82, 40002 (2008).
[2] M. Ali, G. Alber, and A. R. P. Rau, arXiv: quant-ph/0810.2936 (To appear in J. Phys. B)

Q 5.4 Mo 11:30 VMP 6 HS-D

Post-selection technique for quantum channels with applications to quantum cryptography — •Matthias Christandl[1], Robert Koenig[2], and Renato Renner[3] — [1]University of Munich, Germany — [2]California Institute of Technology, Pasadena, CA, United States of America — [3]ETH Zurich, Switzerland

We propose a general method for studying properties of quantum channels acting on an n-partite system, whose action is invariant under permutations of the subsystems. Our main result is that, in order to prove that a certain property holds for any arbitrary input, it is sufficient to consider the special case where the input is a particular de Finetti-type state, i.e., a state which consists of n identical and independent copies of an (unknown) state on a single subsystem. A similar statement holds for more general channels which are covariant with respect to the action of an arbitrary finite or locally compact group.

Our technique can be applied to the analysis of information-theoretic problems. For example, in quantum cryptography, we get a simple proof for the fact that security of a discrete-variable quantum key distribution protocol against collective attacks implies security of the protocol against the most general attacks. The resulting security bounds are tighter than previously known bounds obtained by proofs relying on the exponential de Finetti theorem [Renner, Nature Physics 3,645(2007)].

Q 5.5 Mo 11:45 VMP 6 HS-D

Models of continuous-variable quantum computing — •Matthias Ohliger und Jens Eisert — Institut für Physik und Astronomie, Universität Potsdam, Karl-Liebknecht-Straße 24/25, 14476 Potsdam, Germany

We discuss strictly efficient models for measurement-based quantum computing using physical continuous variables, such as field modes of light. Such measurement-based quantum computing (MBQC) provides a promising paradigm for quantum computation as it does not require performing unitary gates during the computation, but rather appropriate readout. Here, we introduce novel schemes for which the resource state can be reasonably and efficiently prepared, and which notably do not require having infinite squeezing or mean energy available. What is more, error correction techniques are implementable, as the logical information is stored in finite-dimensional objects grasping correlations of the quantum states. Using the ideas of computational tensor networks we discuss how to sequentially prepare suitable physical resource states with cavity QED or with non-linear optics and how to efficiently implement a computational universal set of quantum operations with feasible optical measurements like homodyne detection and photon counting.

Q 5.6 Mo 12:00 VMP 6 HS-D

Analysis of fermionic gaussian states by non-commutative phase space techniques — •Dirk-Michael Schlingemann, Michael Keyl, and Lorenzo Campos Venuti — ISI Foundation Torino, Quantum information group

The basic constituents of the matter that surrounds us in daily life are fermions. Therefore it is needless to say that theoretical investigation of fermion systems play an essential role in almost all areas of quantum physics. A particular class of states of fermion systems are quasi-free states or Gaussian fermionic states. On one hand, this class of states can be treated analytically even for very large systems, on the other hand, these states are complex enough to describe ground states of interacting spin chain systems.

We present an approach to non-commutative phase space which allows to analyze Gaussian fermionic states in complete analogy to Gaussian bosonic states. The used mathematical tools are based on a novel algebraic structure which combines the Grassmann algebra with the fermion algebra of canonical anti-commutation relations (GAR algebra).

As a new application, the corresponding theory provides an elegant tool for calculating the fidelity of two fermionic gaussian states which is needed for the study of entanglement distillation within fermionic systems.

Q 5.7 Mo 12:15 VMP 6 HS-D

On Quantum Qudit Gate Constructions — •Colin Wilmott — School of Mathematical Sciences, University College Dublin, Dublin, Ireland — Institut für Theoretische Physik III, Heinrich-Heine-Universität, Düsseldorf, Deutschland

Most often it is assumed that quantum computations are predicated on a collection of 2-level quantum mechanical systems called qubits. However, there is a view to generalise to d-level, or qudit, quantum mechanical systems. Furthermore, it is becoming increasingly evident that much effort continues to be made into finding efficient quantum networks in the sense that for the given gate library there is no smaller network that achieves the same task.

The qubit SWAP gate has been illustrated to be a cornerstone in the networkability of quantum computation based on qubits. We introduce a quantum gate construction that generalises the qubit SWAP gate to higher dimensions. This construction makes extensive use of binomial summations and yields a quantum qudit SWAP gate determined only in the CNOT gate. In addition, the task of constructing generalised SWAP gates based on transpositions of qudit states is argued in terms of the signature of a permutation.