Q 41: Quanteninformation (Konzepte und Methoden III)

Zeit: Donnerstag 14:00–16:00 Raum: 1B

Q 41.1 Do 14:00 1B

Channel Representation of Quantum Error-Correcting Codes — •Johannes Gütschow, Holger Vogts, and Reinhard Werner — Institut für Mathematische Physik, TU Braunschweig, www.imaph.tu-bs.de

Quantum error-correcting codes (qeccs) are essential for most of the proposed realizations of quantum computation to correct errors due to decoherence. Quantum convolutional codes (qccs) are a promising candidate for on line encoding and decoding of a flow of quantum information thus enabling the sending party to begin with the transmission of quantum information before the end of the flow (or a block) is reached. Analogously the decoding process can begin before the end of the transmission. Until now, only the noise and interaction with the environment were described in the channel formalism. We investigate qeccs and describe their encoders as channels. Block encoders are represented by memoryless channels, whereas convolutional encoders are described by memory channels. Convolutional encoders need to be "non-catastrophic", meaning an error on a single source qubit should only affect a finite number of target qubits. We investigate the relation between this condition and the "forgetfulness"-property of quantum memory channels.

Q 41.2 Do 14:15 1B

Quasi-Free States on Clifford Quantum Cellular Automata — •Sonja Uphoff[1], Zoltan Zimboras[2], and Reinhard Werner[1] — [1]Institut für Mathematische Physik, TU Braunschweig, www.imaph.tu-bs.de — [2]Theoretische Physik, Universität des Saarlands, www.uni-saarland.de/fak7/rieger

Clifford Quantum Cellular Automata (CQCA) are a particularly simple class of Quantum Cellular Automata that can be used for generating entanglement. We are interested in the asymptotics of states under CQCA action, one aspect being entanglement of invariant states. For a special class of CQCA it is possible to obtain these states on the spin chain by employing the Araki Jordan-Wigner transformation between the spin chain and the fermionic chain. In this case we can construct quasi-free states that are invariant under the time evolution of the CQCA.

Q 41.3 Do 14:30 1B

Completeness of classical spin systems and universal quantum computation — •Gemma De las Cuevas[1], Robert Hübener[1], Maarten Van den Nest[1], Wolfgang Dür[1,2], and Hans J. Briegel[1,2] — [1]Institut für Quantenoptik und Quanteninformation der Österreichischen Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Theoretische Physik, Universität Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria

It was recently shown [quant-ph/0708.2275] how classical spin models, such as the Ising and Potts models on arbitrary graphs, can be mapped onto the stabilizer formalism from quantum information theory. Moreover, by invoking the universality of the one-way quantum computer it was proven how the partition function on an arbitrary graph can be expressed as a special instance of the Ising partition function on a 2D square lattice. However, in order to obtain this result the coupling strengths and local magnetic fields on the 2D square lattice had to be complex, and thus did not allow for a physical interpretation. In this talk, we will first present the completeness of the 2D Ising model with complex parameters and we will then show that a complete model with real parameters is obtained when the 3D Ising model is considered. We will further investigate how generalizations of the 2D Ising model allow us to strengthen the completeness results, and will consider other possible mappings between the partition function and the quantum stabilizer formalism.

Q 41.4 Do 14:45 1B

Three-tangle for mixtures of generalized GHZ and generalized W states — •Christopher Eltschka[1], Andreas Osterloh[2], and Jens Siewert[1] — [1]Institut für theoretische Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Institut für theoretische Physik, Leibnitz Universität Hannover, D-30167 Hannover, Germany

The occurrence of entanglement in multipartite systems is one of the most important and distinctive features in quantum theory. While mixed state entanglement of two qubits is already well understood, for three qubits even for the simplest case of rank-2 mixed states, no general solution is known.

We give analytic expressions for the three-tangle and corresponding optimal decompositions for a class of mixed states consisting of a generalized GHZ and an orthogonal generalized W state. We derive a characteristiic structure of the three-tangle function which is independend of the choice of the generalized GHZ and W states to be mixed. Especially we identify the "zero simplex" of *all* states inside the corresponding Bloch sphere with zero three-tangle.

Moreover, as a special case we obtain a general solution for a family of states consisting of a generalized GHZ state and an orthogonal product state. For that case, we provide an analytic solution for all mixed states inside the Bloch sphere defined by those two states.

Q 41.5 Do 15:00 1B

Phase-space Characterization of Multipartite Entanglement — •Agung Budiyono[1], Alejo Salles[1,2], Fernando de Melo[1], Thomas Wellens[1], and Andreas Buchleitner[1] — [1]Physikalisches Institut Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Str. 3, D-79104, Freiburg, Germany — [2]Instituto de Física, Universidade Federal do Rio de Janeiro,

We consider a sequence of two levels atoms interacting one by one resonantly with a cavity sustaining a single mode, according to the Jaynes-Cummings model. We evaluate the amount of entanglement in the initial atomic state which is needed to prepare certain classes of target field state. Furthermore, we investigate how this entanglement should be shared by the different subsystems in order to optimize the target field state creation. In this way, we explore how the multipartite entanglement of the initial atoms is mapped onto the phase-space of the field in the cavity.

Q 41.6 Do 15:15 1B

Entanglement Quantum Nondemolition Measurement — Bruno de Moura Escher[1], •Fernando de Melo[2], Ruynet L. de Matos Filho[1], Andreas Buchleitner[2], and Luiz Davidovich[1] — [1]Instituto de Física, Universidade Federal do Rio de Janeiro, Caixa Postal 68528, Rio de Janeiro RJ 21941-972, Brazil — [2]Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder-Strasse 3, D-79104 Freiburg, Germany

We present a quantum circuit which allows for the nondemolition measurement of a two-qubit system. The protocol employs two simultaneous copies of the state, in order to give an operational meaning to the entanglement measure, an can thus be applied for all pure states. The complementarity relation between single particle characteristics and bipartite entanglement is scrutinized in the light of the proposed measurement.

Q 41.7 Do 15:30 1B

Decoherence protection for nuclear spin quantum memory in a quantum dot — •Zoltan Kurucz[1], Martin Sørensen[2], and Michael Fleischhauer[1] — [1]Fachbereich Physik, TU Kaiserslautern — [2]Nils-Bohr Institute, Kopenhagen

We reconsider the possibility of storing quantum information in an ensemble of nuclear spins constituting a semiconductor quantum dot [1]. The nuclear magnetic moments are collectively interacting with an excess electron of the quantum dot through inhomogeneous hyperfine coupling. We present a configuration in which the collective nuclear spin states used as the qubit basis are energetically separated from the remaining states, thus protecting the quantum memory from various sources of decoherence.

[1] J. Taylor, C. Marcus, M. Lukin, Phys. Rev. Lett. 90, 206803 (2003)

Q 41.8 Do 15:45 1B

Covariance Matrices as a Tool in Entanglement Theory — •Oleg Gittsovich[1,2], Otfried Gühne[1], Philipp Hyllus[3], and Jens Eisert[4] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, *Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Otto-Hittmair-Platz, 1, 6020 Innsbruck, Austria — [2]Institut für Theoretische Physik,Universität Innsbruck, Techniker-

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One of the most interesting features of a quantum state from the point of view of the quantum information theory is entanglement. Entangled states are used everywhere in this field and allow to achieve such tasks as teleportation of a quantum state, quantum communication for two or more parties and intensively used in quantum computation and quantum cryptography.

In this talk we will have look at this problem from perspective of view, which uses familiar notions like variances and covariance matrix (CM).