Q 41: Quanteninformation (Konzepte II)

Zeit: Mittwoch 14:00–16:00 Raum: 5L

Q 41.1 Mi 14:00 5L

Experimental Test of Nonlocal Hidden-Variable Theories — •Tomasz Paterek[1,2,3], Simon Gröblacher[3,4], Rainer Kaltenbaek[4], Caslav Brukner[3,4], Marek Zukowski[1,4], Markus Aspelmeyer[3,4], and Anton Zeilinger[3,4] — [1]Institut für Theoretische Physik und Astrophysik, Universität Gdansk, ul. Wita Stwosza 57, 08-952 Gdansk, Polen — [2]The Erwin Schrödinger International Institute for Mathematical Physics, Boltzmanngasse 9, 1090 Wien, Österreich — [3]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Boltzmanngasse 3, 1090 Wien, Österreich — [4]Institut für Experimentalphysik, Universität Wien, Boltzmanngasse 5, 1090 Wien, Österreich

I will discuss experimental incompatibility tests of a class of nonlocal hidden variable theories, which have been recently introcuded by Leggett. The theories under test maintain assumptions of physical realism while providing an explanation for current Bell experiments. However, they can be tested with a different set of experiments.

Q 41.2 Mi 14:15 5L

Practical Scheme for Noiseless Filtering of Continuous-Variable Information with Non-Gaussian Noise — •Christoffer Wittmann[1], Dominique Elser[1], Ulrik L. Andersen[1], Radim Filip[2], Petr Marek[2], and Gerd Leuchs[1] — [1]Institut für Optik, Information und Photonik, Max-Planck Forschungsgruppe, Universität Erlangen-Nürnberg, — [2]Department of Optics, Palacký University,

Every practical quantum channel degrades the quality of quantum states transmitted between two parties. In order to establish a communication with a low error rate, it is therefore important to determine and, if possible, to decrease the influence of noise in the quantum channel. We investigate an optical quantum channel with non-Gaussian noise characteristics, which transforms a signal state into a statistical mixture of signal and vacuum.

We propose and experimentally demonstrate a new scheme for a noiseless and optimal quantum filter or quantum relay filtering vacuum states from this mixture. Two different filters were implemented; one which is relying on weak homodyne measurements and one on weak on/off measurements. The performance of the two schemes is compared relative to the optimal scheme.

Q 41.3 Mi 14:30 5L

Time-continuous quantum state estimation — •Artur Scherer[1], Lajos Diosi[2], Thomas Konrad[3], and Jürgen Audretsch[1] — [1]Fachbereich Physik, Universität Konstanz, Fach M 674, 78457 Konstanz, Germany — [2]Research Institute for Particle and Nuclear Physics, 1525 Budapest 114, P.O.Box 49, Hungary — [3]School of Pure and Applied Physics, University of KwaZulu-Natal, Durban 4000, South Africa

Controlling single quantum systems is an important issue in quantum information processing technology. Recent experimental advancements have made feasible time-continuous weakly disturbing quantum measurements on a single system. New perspectives of quantum feed-back control have raised an immediate related task: the time-continuous estimation and real-time determination of a quantum state. We discuss the time-continuous quantum state estimation problem and present a new non-linear stochastic master equation that governs the time-evolution of the estimated quantum state. Its differential evolution corresponds to the infinitesimal updates that depend on the time-continuous measurement of the true quantum state. The new stochastic master equation couples to the two standard stochastic differential equations of time-continuous quantum measurement. We prove that the calculated estimate almost always converges to the true state. We demonstrate this convergence by a numerically simulated evolution of the true and the estimated wave function of a particle in a double-well potential.

Q 41.4 Mi 14:45 5L

Invariance of quantum cellular automata under all lattice symmetries — •Holger Vogts and Reinhard Werner — Institut für Mathematische Physik, TU Braunschweig, www.imaph.tu-bs.de

Quantum cellular automata (QCAs) are local discrete time dynamical evolutions on a lattice of finite dimensional quantum systems, e.g. spin chains. Usually, one requires these operations to be translationally invariant. But in general the underlying lattice provides more symmetries. So it is a natural question to look for QCAs, which commute with these additional symmetry operations, and study the constraints on the local QCA rules. In the one dimensional lattice we consider QCAs, which are invariant under reflection. Nearest neighbor QCAs with this property are up to a cell-wise rotation phase gates. In higher dimensional lattices we also study the invariance under discrete lattice rotations.

Q 41.5 Mi 15:00 5L

Adiabatic quantum algorithms as quantum phase transitions: 1^{st} versus 2^{nd} order — •Gernot Schaller and Ralf Schützhold — Institut für Theoretische Physik, Technische Universität Dresden, 01062 Dresden

In the continuum limit (large number of qubits), adiabatic quantum algorithms display a remarkable similarity to sweeps through quantum phase transitions. We find that transitions of second or higher order are advantageous in comparison to those of first order. With this insight, we propose a novel adiabatic quantum algorithm for the solution of 3-satisfiability (3-SAT) problems (exact cover), which is significantly faster than previous proposals according to numerical simulations (up to 20 qubits). These findings suggest that adiabatic quantum algorithms can solve NP-complete problems such as 3-SAT much faster than the Grover search routine (yielding a quadratic enhancement), possibly even with an exponential speed-up.

Q 41.6 Mi 15:15 5L

Novel schemes and states for measurement-based quantum computation — •David Gross and Jens Eisert — Imperial College London, 58 Prince's Gate, London SW7 2PE, UK

We establish a framework which allows one to systematically construct novel schemes for measurement-based quantum computation. The technique utilizes tools from many-body physics – based on finitely correlated or projected entangled pair states – to go beyond the cluster-state based one-way computer. We identify universal resource states with radically different entanglement properties than the cluster state, and computational models where the randomness is compensated in a different manner. It is shown that there exist universal resource states which are locally arbitrarily close to a pure state. We find that non-vanishing two-point correlation functions are no obstacle to universality. We comment on the possibility of tailoring computational models to specific physical systems as, e.g. in linear optical experiments.

Q 41.7 Mi 15:30 5L

Simulating time evolution with tensor trees — •Robert Hübener — Österreichische Akademie der Wissenschaften, IQOQI, Innsbruck, Austria

A possible extension of the matrix product state (MPS) formalism has recently been proposed by Vidal, Shi, Markov and Duan. Instead of a flat hierarchy of matrices, a tree tensor-network (TTN) is used to describe a state. A major advantage of this approach is the emergence of long-range and large block-wise entanglement, which is known to be suppressed for MPSs.

Our group is implementing this idea in numerical simulations of strongly correlated systems, including 1D systems with long-range couplings and 2D/3D systems. We combine this approach with our recent proposal to use weighted graph states as variational states. Since graph states incorporate long-range and large block-wise entanglement, the idea of the unification of a tree tensor-state with a graph state might improve this aspect of the simulation even further.

Applications of this formalism include the simulation of (imaginary) time evolution and the search for ground states of strongly correlated systems.

Q 41.8 Mi 15:45 5L

Coherent control in a decoherence-free subspace of a collective multi-level system — •Martin Kiffner, Jörg Evers, and Christoph H. Keitel — Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany

Decoherence-free subspaces (DFS) in a system of two dipole-dipole interacting multi-level atoms are investigated theoretically. The ground state of each atom is a S_0 singlet state, and the excited state multiplet is a P_1 triplet which consists of three Zeeman sublevels. Since we consider arbitrary geometrical alignments of the atoms, all Zeeman sublevels of the atomic multiplets have to be taken into account [1]. It is shown that the collective state space of the two dipole-dipole interacting four-level atoms contains a four-dimensional DFS [2]. We describe a method that allows to populate the antisymmetric states of the DFS by means of a laser field, without the need of a field gradient between the two atoms. These antisymmetric states are identified as long-lived entangled states. Further, we show that any single-qubit operation between two states of the DFS can be induced by means of a microwave field. Typical operation times of these qubit rotations can be significantly shorter than for a nuclear spin system.

[1] M. Kiffner, J. Evers, and C. H. Keitel, arXiv:quant-ph/0611071.
[2] M. Kiffner, J. Evers, and C. H. Keitel, arXiv:quant-ph/0611084.