Q 9 Quanteninformation I

Zeit: Montag 14:00–16:00 Raum: HI

Q 9.1 Mo 14:00 HI

Experimental Quantum Cryptography with Qutrits — •Simon Gröblacher[1], Thomas Jennewein[2], Alipasha Vaziri[3], Gregor Weihs[4], and Anton Zeilinger[1,2] — [1]Institut für Experimentalphysik, Universität Wien, Boltzmanngasse 5, A-1090 Wien, Austria — [2]Institut für Quantenoptik und Quanteninformation (IQOQI), Österreichische Akademie der Wissenschaften, Boltzmanngasse 3, A-1090 Wien, Austria — [3]Physics Department, University of Maryland, College Park, MD 20742, USA — [4]Institute for Quantum Computing & Department of Physics, University of Waterloo 200, University Ave. W, Waterloo, ON N2L 3G1, Canada

We produce two identical keys using, for the first time, entangled trinary quantum systems (qutrits) for quantum key distribution. The advantage of qutrits over the normally used binary quantum systems is an increased coding density and a higher security margin. The qutrits are encoded into the orbital angular momentum of photons, namely Laguerre-Gaussian modes with azimuthal index l +1, 0 and -1, respectively. The orbital angular momentum is controlled with phase holograms. In an Ekert-type protocol the violation of a three-dimensional Bell inequality verifies the security of the generated keys. A key is obtained with a qutrit error rate of approximately 10%.

Q 9.2 Mo 14:15 HI

Single-Copy Entanglement, Criticality, and Entanglement-Area Laws in Quasi-Free Systems — •Marcus Cramer[1], Jens Eisert[2], Roman Orús[3], Julian Dreissig[1], Martin Plenio[2], and José Ignacio Latorre[3] — [1]Universität Potsdam — [2]Imperial College London — [3]Universitat de Barcelona

For harmonic bosonic systems on general graphs of arbitrary dimension we give an overview of the relation between decay of correlations, energy gap and entanglement area laws [1-3]. For critical one-dimensional spin chains we establish the fact that the entropy of entanglement of a block of spins is exactly twice the entanglement that can be distilled from a single copy of the chain [4,5].

[1] M.B. Plenio, J. Eisert, J. Dreissig, and M. Cramer, Phys. Rev. Lett. 94, 060503 (2005).
[2] M. Cramer, J. Eisert, M.B. Plenio, and J. Dreissig, Phys. Rev. A 72 (2005).
[3] M. Cramer and J. Eisert, quant-ph/0509167.
[4] J. Eisert and M. Cramer, Phys. Rev. A 72, 042112 (2005).
[5] R. Orus, J.I. Latorre, J. Eisert, and M. Cramer, submitted to Phys. Rev. Lett., quant-ph/0506023.

Q 9.3 Mo 14:30 HI

Approximating ground states with long-range entanglement using weighted graph states — •Simon Anders[1], Martin Plenio[2], Wolfgang Dür[1,3], and Hans J. Briegel[1,3] — [1]Institut für Theoretische Physik, Universität Innsbruck, Austria — [2]Institute for Mathematical Sciences, Imperial College, London, UK — [3]Institut für Quantenoptik und Quanteninformation der ÖAW, Innsbruck, Austria

We present a variational method for the approximation of ground states of strongly interacting spin systems in arbitrary geometries and spatial dimensions. The approach is based on so-called deformed weighted graph states and superpositions thereof. These states allow for the efficient computation of all localized observables including the energy. They include states with diverging correlation length and unbounded multi-particle entanglement. As a demonstration, we apply our approach to the Ising model on 1D, 2D and 3D square lattices.

Q 9.4 Mo 14:45 HI

Genuine three-partite entangled states with a local hidden variable model — •Geza Toth[1] and Antonio Acin[2] — [1]Theoretical Division, Max Planck Institute for Quantum Optics, Hans-Kopfermann-Strasse 1, D-85748 Garching, Germany — [2]ICFO-Institut de Ciencies Fotoniques, Mediterranean Technology Park, 08860 Castelldefels (Barcelona), Spain

We present a family of three-qubit quantum states with a basic rotationally symmetric local hidden variable model. Any von Neumann measurement can be described by a local model for these states. We show that some of these states are genuine three-partite entangled. The generalization for larger dimensions or higher number of parties is also discussed. As a byproduct, we present symmetric extensions of two-qubit Werner states.

For further details, please see quant-ph/0512088.

Q 9.5 Mo 15:00 HI

Two-setting Bell Inequalities for Graph States — •Geza Toth[1,2], Otfried Gühne[3], and Hans J. Briegel[3,4] — [1]Research Institute of Solid State Physics and Optics, Hungarian Academy of Sciences, H-1525 Budapest P.O. Box 49, Hungary — [2]Max-Planck-Institut für Quantenoptik, Hans-Kopfermann-Straße 1, D-85748 Garching, Germany — [3]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, A-6020 Innsbruck, Austria — [4]Institut für Theoretische Physik, Universität Innsbruck, Technikerstraße 25, A-6020 Innsbruck, Austria

We present Bell inequalities for graph states with high violation of local realism. In particular, we show that there is a basic Bell inequality for every nontrivial graph state which is violated by the state at least by a factor of two. This inequality needs the measurement of at most two operators for each qubit and involves only some of the qubits. We also show that for some families of graph states composite Bell inequalities can be constructed such that the violation of local realism increases exponentially with the number of qubits. We prove that some of our inequalities are facets of the convex polytope containing the many-body correlations consistent with local hidden variable models. Our Bell inequalities are built from stabilizing operators of graph states. For further details, please see quant-ph/0510007.

Q 9.6 Mo 15:15 HI

Optimal entanglement witnesses for continuous-variable systems — •Philipp Hyllus and Jens Eisert — QOLS, Blackett Laboratory, and Institute of Mathematical Sciences, Imperial College London, SW7 London 2PE, United Kingdom.

We present work which is concerned with all tests for continuous-variable entanglement that arise from linear combinations of second moments or variances of canonical coordinates, as they are commonly used in experiments to detect entanglement. All such tests for bi-partite and multi-partite entanglement correspond to hyperplanes in the set of second moments. It is shown that all optimal tests, those that are most robust against imperfections with respect to some figure of merit for a given state, can be constructed from solutions to semi-definite optimization problems. Moreover, we show that for each entanglement witnesses, there is a one-to-one correspondence between the witness and a stronger product criterion, based on the same measurements. This generalizes the known product criteria. To provide a service to the community, we also present the documentation of two numerical routines, FULLYWIT and MULTIWIT, which have been made publicly available.

Q 9.7 Mo 15:30 HI

Entanglement studies on the valence-shell photoionization — •Thomas Radtke[1], Stephan Fritzsche[1], and Andrey Surzhykov[2] — [1]Universität Kassel, Institut für Physik, D–34109 Kassel, — [2]Max-Planck-Institut für Kernphysik, D–69117 Heidelberg

Atomic photoionization is certainly one of the most intensively studied physical processes today. Recently, new interest in this process has appeared within the context of quantum computing and quantum information as it allows also to observe and manipulate quantum entanglement. In particular, we have studied the effect of a single photoionization process on a pair of spin-state entangled electrons for the case of two non-interacting hydrogen-like ions [1].

In this contribution, we extend these studies towards the valence-shell photoionization of alkaline-earth metals for which the two outer electrons are naturally correlated. The initial two-electron state is thus completely entangled. We investigate the change of the degree of entanglement (in terms of the concurrence measure) between the ejected electron and the remaining alkaline-like ion in the $^2s_{1/2}$ ground state as function of various parameters, such as photon energy, polarization and/or the angle of detection.

[1] T. Radtke, S. Fritzsche, A. Surzhykov, Phys. Lett. A 347 (2005) 73.

Q 9.8 Mo 15:45 HI

Erzeugung quantenmechanisch verschränkter Zustände von vier bis acht Ionen — •Christian Roos[1,2], Hartmut Häffner[1,2], Wolfgang Hänsel[1,2], Jan Benhelm[1,2], Dany Chek-al-kar[2], Michael Chwalla[2], Timo Körber[1,2], Umakant Rapol[1,2], Mark Riebe[2], Piet Schmidt[2], Otfried Gühne[1], Wolfgang Dür[1,3] und Rainer Blatt[1,2] — [1]Institut für Quantenoptik und -information, Österreichische Akademie der Wissenschaften, Technikerstr. 21a, A-6020 Innsbruck — [2]Institut für Experimentalphysik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck — [3]Institut für theoretische Physik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck

Die Erzeugung vielteilchen-verschränkter Zustände steht seit einigen Jahren im Zentrum intensiver experimenteller Bemühungen. Wir berichten über die Herstellung verschränkter Zustände von vier bis acht Ionen. Die Ionen werden in einer linearen Paulfalle gespeichert und mittels Laserpulsen in ihrem quantenmechanischem Zustand kontrolliert. Durch eine geeignete Pulsfolge lassen sich N-Ionen W-Zustände erzeugen, die wir vollständig durch Messung ihrer Dichtematrix charakterisieren. Dabei zeigt sich, dass die erzeugte Matrix sich nicht als Produktzustand beschreiben läßt, sondern vielmehr echte N-Ionenverschränkung enthält.