SYSA 1 Quantum state analysis and estimation I

Zeit: Dienstag 10:30–12:30 Raum: HVI

Hauptvortrag SYSA 1.1 Di 10:30 HVI

Detection and characterization of multipartite entanglement in atomic systems — •Dieter Jaksch and Rebecca Palmer — University of Oxford, Parks road, OX1 3PU Oxford, United Kingdom

We investigate the detection and characterization of multi partite entangled states in systems on neutral atoms. Such states have been realized in seminal recent experiments using optical lattices but their detailed characterization has not been achieved yet. Our scheme is based on measuring violations of entropic inequalities using simple quantum networks involving only two copies of the state under consideration. We first give a detailed discussion of the ideal scheme where no errors are present and full spatial resolution in the measurements is available. Then we discuss the situation where no spatial resolution is available and find that even in this case entanglement can be detected and characterized in various kinds of states including cluster states and macroscopic superposition states. We also study the effects of detection errors and imperfect dynamics on the detection network. For our scheme to be practical these errors have to be on the order of one over the number of investigated lattice sites. Finally, we consider the case of limited spatial resolution and conclude that significant improvement in entanglement detection and characterization compared to having no spatial resolution is only possible if single lattice sites can be resolved.

Hauptvortrag SYSA 1.2 Di 11:00 HVI

Improved entanglement witnesses — •Otfried Gühne[1], Wolfgang Dür[1,2], Norbert Lütkenhaus[3], and Geza Toth[4] — [1]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, A-6020 Innsbruck — [2]Institut für Theoretische Physik, Universität Innsbruck, A-6020 Innsbruck — [3]Quantum Information Theory Group, Institut für Theoretische Physik I, und Max-Planck Research Group, Institute of Optics, Information and Photonics, Universität Erlangen-Nürnberg, D-91058 Erlangen — [4]Max-Planck-Institut für Quantenoptik, D-85748 Garching

Due to the rapid development of experimental techniques multiparticle entangled states of several ions or photons are now available. To confirm the success of an experiment, the analysis of the state has to verify that genuine multipartite entanglement was indeed produced. Entanglement witnesses are one of the most powerful tools for this task. These are linear inequalities for mean values of certain observables, where violation indicates entanglement.

In this talk we present several ideas to improve witnesses for special experimental situations. This can be done in several directions: First, one can reduce the required measurements, minimizing the experimentalists effort. Then, one can use new types of witnesses, which are more robust against noise. Also, one may apply local operations on the state, which do not change the entanglement properties. Finally, one may use nonlinear entanglement witnesses. We will also explain recent experiments, where some of these ideas have been used.

Hauptvortrag SYSA 1.3 Di 11:30 HVI

Zustands-Tomographie in einem Ionen-Quantenprozessor — •Ferdinand Schmidt-Kaler[1], Hartmut Häffner[2,3], Christian Roos[2,3], Timo Körber[2], Wolfgang Hänsel[2], Mark Riebe[2], Jan Benhelm[2], Umarkant Rapol[2], Rainer Blatt[2,3] und Christoph Becher[4] — [1]Abteilung für Quanten-Informationsverarbeitung, Universität Ulm, Deutschland — [2]Institut für Experimentalphysik, Universität Innsbruck, Österreich — [3]Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Innsbruck, Österreich — [4]Technische Physik, Universität des Saarlandes, Deutschland

Skalierbare Quantenprozessoren auf der Basis von Kristallen gefangener Ionen haben es ermöglicht Vielteilchen-Verschränkung zu realisieren. Zur Analyse dieser Quantenzustände und ebenso zur Beschreibung quantenlogischer Operationen werden tomographische Methoden genutzt. Ich diskutiere diese Methoden anhand der Experimente zur Prozesstomographie der Teleportation [1] und der Tomographie langlebiger Bellzustände von zwei Ionen [2].

[1] H. Häffner, F. Schmidt-Kaler, C.F. Roos, T., Körber, M. Chwalla, M. Riebe, J. Benhelm, U. D. Rapol, C. Becher, R. Blatt, Appl. Phys. B 81 (2005) 151.

[2] M. Riebe, H. Häffner, C. F. Roos, W. Hänsel, J. Benhelm, G. P. T. Lancaster, T. W. Körber, C. Becher, F. Schmidt-Kaler, D. F. V. James, R. Blatt, Nature 429 (2004) 734

Hauptvortrag SYSA 1.4 Di 12:00 HVI

Analysing entangled states — •Harald Weinfurter[1,2], Nikolai Kiesel[1,2], Wieslaw Laskowski[3], Wenjamin Rosenfeld[1], Christian Schmid[1,2], Geza Toth[2], Markus Weber[1], Marek Zukowski[3], and Jürgen Volz[1] — [1]Ludwig-Maximilians Universität München — [2]Max-Planck-Institut für Quantenoptik — [3]Universität Danzig

Entanglement often is labeled as the key resource or currency of quantum information. But particularly for the "currency" picture it is quite important to know the real value of your money and also where you can use it at all.

We consider several experiments on atom-photon and on multi-photon entangled states to demonstrate the various possibilities for the experimental analysis of entangled states. Key requirement for such an analysis are of course short measurement time and low uncertainty. Even if general schemes exist, it is of great advantage to tailor the measurements and measurement methods to the particular state and physical system under investigation.