QUANTUM COMPUTING WITH TRAPPED ELECTRONS (SYQT)

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ÜBERSICHT DER SYMPOSIUMS VORTRÄGE
(Hörsaal HV)

Hauptvorträge

SYQT 1.1	Mo	10:40	(HV)	**Towards a quantum computer with trapped electrons**, Irene Marzoli
SYQT 1.2	Mo	11:10	(HV)	**Decoherence and coherent coupling of electrons in Penning traps**, Carsten Henkel, Jorge R. Zurita Sánchez
SYQT 1.3	Mo	11:40	(HV)	**Coupling trapped ions via transmission lines for quantum computing**, Hartmut Häffner, Tony Lee, Rainer Blatt
SYQT 1.4	Mo	12:00	(HV)	**A planar Penning trap**, Fernando Galve, Paula Fernandez, Stefan Stahl, Günter Werth
SYQT 1.5	Mo	12:20	(HV)	**One and two photon effects in Ising type networks**, Igor Jex, J. Novotny, T. Kiss, B. Mohring

Fachsitzungen

SYQT 1	**Quantum Computing with Trapped Electrons**	Mo 10:40–12:40	HV	SYQT 1.1–1.5

Fachsitzungen

– Hauptvorträge –

SYQT 1 Quantum Computing with Trapped Electrons

Zeit: Montag 10:40–12:40 Raum: HV

Hauptvortrag SYQT 1.1 Mo 10:40 HV

Towards a quantum computer with trapped electrons — •Irene Marzoli — Università di Camerino, Dipartimento di Fisica, Camerino (Italy)

We present a theoretical proposal to implement a quantum processor based on trapped electrons, stored in planar Penning traps. Qubits are encoded in the particle spin, that precesses around the strong homogeneous magnetic field of the trap. The typical precession frequency lies in the microwave range. The use of long-wavelength radiation for single qubit operations requires an additional magnetic field gradient to selectively manipulate the qubits via frequency addressing. The same magnetic gradient, mediated by the Coulomb interaction, realizes an effective coupling between the spin qubits of different particles. The resulting system can be regarded as an artificial molecule, suitable for nuclear magnetic resonance (NMR) quantum computation. Therefore, conditional dynamics is performed by means of well established techniques already successfully demonstrated with NMR quantum computing. The system lends itself to scalability, since the same substrate can accomodate an arbitrary number of traps. Moreover, the spin-spin coupling strength is tunable and under experimental control. To predict the performances of such a quantum processor, we take into account a realistic setting within the reach of present technology.

Hauptvortrag SYQT 1.2 Mo 11:10 HV

Decoherence and coherent coupling of electrons in Penning traps — •Carsten Henkel and Jorge R. Zurita Sánchez — Institut für Physik, Universität Potsdam, Germany

We consider electrons in Penning traps and estimate the time scales available for coherent manipulations on the cyclotron and axial degrees of freedom. Thermal excitations from the metallic electrodes are shown to be negligible at low temperature. A model for the quantum fluctuations due to the circuitry connected to the electrodes is developed. The interconnection of two traps by a transmission line is explored for a two-qubit gate implementation.

Hauptvortrag SYQT 1.3 Mo 11:40 HV

Coupling trapped ions via transmission lines for quantum computing — •Hartmut Häffner[1,2], Tony Lee[1,2], and Rainer Blatt[1,2] — [1]Institut für Quantenoptik und Quanteninformation Österreichische Akademie der Wissenschaften, Innsbruck, Austria — [2]Institut für Experimentalphysik, Innsbruck, Austria

An oscillating trapped ion induces oscillating image charges in the trap electrodes. If this current is sent to the electrodes of a second trap, it influences the motion of an ion in the second trap. This inter–trap coupling may be used for scalable quantum computing, cooling ion species that are not directly accessible to laser cooling, for the non-invasive study of superconductors, and for coupling an ion–trap quantum computer to a solid–state quantum computer, e.g. a system of Josephson junctions.

We will discuss the feasibility of experiments towards these goals with trapped Calcium ions. The most relevant sources of decoherence are heating (e.g. Johnson–noise) and dephasing of the electronic wave–function inside the transmission line connecting the traps. Using superconducting transmission lines a coherent current transport over macroscopic distances (>1 mm) is possible. In addition, Johnson–noise heating would be greatly reduced, and the coherent coupling of two ions becomes feasible. The expected time for a complete exchange of the ion motions is 1 ms for a trap with a characteristic size of 50 μm.

Hauptvortrag SYQT 1.4 Mo 12:00 HV

A planar Penning trap — •Fernando Galve, Paula Fernandez, Stefan Stahl, and Günter Werth — Johannes Gutenberg University, Mainz

We have developed a planar Penning trap consisting of concentric ring electrodes placed on a substrate. It is intended to be used for trapping single electrons for quantum computing applications. Successful operation of the trap with many electrons will be reported. Measurement of motional frequencies and storage times serve to optimize the trapping parameters with respect to harmonicity of the trapping potential. The results will be compared to potential simulations.

Hauptvortrag SYQT 1.5 Mo 12:20 HV

One and two photon effects in Ising type networks — •Igor Jex, J. Novotny, T. Kiss, and B. Mohring — Czech Technical University in Prague, Zikova 4, Praha 6, Czech Republic

We analyze the dynamics of single and two particle states in Ising-type networks. The mutual entanglement is quantified using the concept of concurrence. We derive explicit expressions for the concurrence for single and two particle initial states in arbitrary passive networks and specify the result for Ising-type networks. We show how to design a network to prepare a prescribed pattern of entanglement for one excitation and study the maximum attainable entanglement for passive optical networks in general. The effect of network randomization on average entanglement is also studied. Effects of localization can be found for certain types of randomization in phase as well as conenctivity of the networks.