SYDP 1: AMOP Dissertation Prize Symposium

Time: Monday 16:30–18:30 Location: F 107

Invited Talk SYDP 1.1 Mo 16:30 F 107
Experimental all-optical one-way quantum computing — •Robert Prevedel — Faculty of Physics, University of Vienna, Austria

In recent years, one-way quantum computing has become an exciting alternative to existing proposals for quantum computers. In this specific model, coherent quantum information processing is accomplished via a sequence of single-qubit measurements applied to an entangled resource known as cluster state. In our experiments, we generate a photonic four-qubit cluster state by means of parametric down-conversion. In one-way quantum computation, the random quantum measurement error can be overcome by applying a feed-forward technique, such that the future measurement basis depends on earlier measurement results. This technique is crucial for achieving deterministic quantum computation once a cluster state is prepared. Using custom-built, ultra-fast electro-optical modulators, we show the first experimental realization of fast, active feed-forward, achieving gate times of less than 150ns. This allowed experimental demonstrations of various quantum algorithms, consisting of a few gates. Among them the so-called Deutsch-Josza algorithm, an important quantum algorithm that is capable of distinguishing whether a function is constant or balanced and the implementation of a quantum game known as Prisoner's Dilemma. Furthermore we were able to design decoherence-free subspaces for cluster states which achieve remarkable protection from environmentally induced decoherence, delivering nearly ideal computational outcomes.

Invited Talk SYDP 1.2 Mo 17:00 F 107
Benchmarks and statistics of entanglement dynamics — •Markus Tiersch — Physikalisches Institut, Universität Freiburg, Hermann-Herder-Str. 3, 79104 Freiburg, Germany — Institut für Quantenoptik und Quanteninformation, Österreichische Akademie der Wissenschaften, Technikerstr. 21A, 6020 Innsbruck, Austria — Institut für Theoretische Physik, Universität Innsbruck, Austria

The endeavor to extend genuine quantum effects to ever larger systems, and to elucidate whether or not such quantum effects play a non-trivial role in driven, complex molecular systems poses a great technological and, moreover, conceptual challenge. Entanglement is a quantum effect that is required to demonstrate the genuine features of quantum physics beyond the wave-particle duality, namely to violate a Bell-inequality, and thereby proof correlations stronger than explainable by classical physics. In order to understand and efficiently assess entanglement in dynamical, complex systems under realistic conditions, we develop a unified picture of the dynamics of entanglement in general open quantum systems. A detailed algebraic analysis reveals evolution equations of entanglement, which show that it is possible to benchmark the entanglement dynamics with a single test state. A topological perspective for large quantum systems that employs results of high dimensional geometry yields effective, statistical results, which unveil a typical behavior of entanglement evolution. Both approaches thereby simplify the understanding of entanglement in a dynamical system, and stimulate the investigation of the role that entanglement plays in driven, complex systems far from thermal equilibrium.

Invited Talk SYDP 1.3 Mo 17:30 F 107
Squeezed Light For Gravitational Wave Astronomy — •Henning Vahlbruch — Institut für Gravitationsphysik, Leibniz Universität Hannover und Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Callinstrasse 38, D-30167 Hannover

During the recent years an international network of interferometric gravitational wave (GW) detectors has been commissioned and searches for various classes of GW-signals are ongoing. Current detectors have reached astrophysically interesting sensitivity levels, however, extensive upgrades are aimed for the next decade bringing us into the era of gravitational wave astronomy. One approach to enhance the detector sensitivity is the injection of squeezed vacuum states of light replacing the ordinary quantum fluctuations entering the detector through its antisymmetric port. The application of squeezed light was proposed by Caves in 1985 but generation had become a reliable experimental technique not until the last 4 years. In this talk I present the first squeezed light source enabling the measurement of a almost 10 dB squeezed vacuum state within the entire detection bandwidth of ground-based GW-detectors (10 Hz - 10 kHz). The non-classical light source was assembled on a 1.5m^2 breadboard and includes a full coherent control system. The next upgrade of the German GEO600 GW-detector is scheduled for 2010 and will, in particular, involve the implementation of the non-classical light source presented here, allowing for the first sensitivity improvement of a GW-detector by the means of squeezed light.

Invited Talk SYDP 1.4 Mo 18:00 F 107
High-precision mass measurements with Penning traps — •Sebastian George — National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI, USA — Joint Institute for Nuclear Astrophysics (JINA)

Nuclear masses of both radioactive and stable nuclei are important key parameters in many fields of physics. The required uncertainties are ranging from 10^{-7} to below 10^{-11}. Due to a continuous development over decades Penning traps turned out to be ideal tools for the determination of nuclear masses. A major improvement in the recent past has been the adoption of Ramseys excitation method of separated oscillatory fields to the Penning trap. In a first application the masses of the radioactive isotopes ^{26}Al and ^{38}Ca have been measured at the Penning trap mass spectrometer ISOLTRAP in order to contribute to tests of the electroweak part of the Standard Model.

For applications in metrology or for the determination of fundamental constants nuclear masses have to be determined with a relative precision lower than 10-11. To this end, a novel Penning trap project called PENTATRAP has been developed. It consists of a combination of several Penning traps, each of them with single-ion detection sensitivity. PENTATRAP will be dedicated to highly-charged isotopes delivered by the EBIT at the Max-Planck-Institut of Heidelberg. Future perspectives will be discussed.