A 23: Dissertation Prize Symposium

Time: Wednesday 11:00–13:00 Location: E 415

Invited Talk A 23.1 Wed 11:00 E 415
Photonic Quantum Computing — •Stefanie Barz — Vienna Center for Quantum Science and Technology, Faculty of Physics, University of Vienna, Boltzmanngasse 5, A-1090 Vienna, Austria

Quantum physics has revolutionized our understanding of information processing and enables computational speed-ups that are unattainable using classical computers. In this talk I will present a series of experiments in the field of photonic quantum computing.

The first experiment is in the field of photonic state engineering and realizes the generation of heralded polarization-entangled photon pairs. It overcomes the limited applicability of photon-based schemes for quantum information processing tasks, which arises from the probabilistic nature of photon generation.

The second experiment uses polarization-entangled photonic qubits to implement "blind quantum computing," a new concept in quantum computing. Blind quantum computing enables a nearly-classical client to access the resources of a more computationally-powerful quantum server without divulging the content of the requested computation.

Finally, the concept of blind quantum computing is applied to the field of verification. A new method is developed and experimentally demonstrated, which verifies the entangling capabilities of a quantum computer based on a blind Bell test.

Invited Talk A 23.2 Wed 11:30 E 415
Comparative Studies on some Blackcurrant Odorants and Fruit Esters using a Combination of Microwave Spectroscopy and Quantum Chemical Calculations — •Halima Mouhib — IPC, RWTH Aachen University, Aachen, Germany

Using a combination of molecular beam Fourier transform microwave spectroscopy (MB-FTMW) and different quantum chemical calculations, highly accurate structural information on the lowest energy conformers of molecules can be obtained. This kind of information is especially needed, when a large number of conformations make it difficult to decide which is the lowest in energy.

During the first part of my PhD thesis, I investigated the structures of valerianic ethyl ester (ethyl isovalerate) and its structural isomers ethyl pivalate, ethyl valerate, and 2-methyl ethyl butyrate. The investigated fruit esters turned out to possess large amplitude motions, causing difficulties for the prediction of the theoretical geometries at different levels of theory. The correct geometries could therefore not be predicted properly using calculations at the MP2/6-311++G(d,p) level. Here, the experimental data were crucial to validate the results obtained from quantum chemical calculations and yielded new insight into the structure and dynamics of these small esters. In the second part, the same technique was applied to investigate different types of blackcurrant odorants. Although microwave spectroscopy has recently moved towards solving the structures of sizeable molecules, this was the first approach to determine the gas phase structure of odorants and show the usefulness of this method for structure-odor correlations.

Invited Talk A 23.3 Wed 12:00 E 415
The Standard Model under Extreme Conditions: The g-Factor of Highly Charged Ions — •Sven Sturm — Max-Planck Institute for Nuclear Research, Heidelberg, Germany

A single electron, bound to a heavy nucleus, is exposed to electric fields of up to 10^{16} V /cm, the strongest fields obtainable in the laboratory. We have addressed the question whether fundamental symmetries and interactions, described by Quantum Electrodynamics (QED), are still valid under these conditions. To this end, we have developed a Penning trap system that allowed us to store a single, hydrogenlike $^{28}Si^{13+}$ ion for several months at an extremely low restgas pressure of 10^{-16} mbar and determine its magnetic moment with an unprecedented relative accuracy of a few parts in 10^{10}. The comparison of the hereby determined value of the g-factor of the bound electron with the similarly precise prediction of theory yielded the most stringent test of QED in strong fields, probing for the first time higher-order contributions to the two-loop QED of bound states. Beyond that, the development of a novel, phase-sensitive detection method for the eigenfrequencies of the ion has enabled a breakthrough in the attainable precision of Penning trap experiments and allowed a further improvement of the precision of the g-factor measurement by an order of magnitude to a few parts in 10^{11}. The developed method paves the way towards a determination of fundamental constants as e.g. the mass of the electron, with unrivaled precision.

Invited Talk A 23.4 Wed 12:30 E 415
Entanglement and Interference of Identical Particles — •Malte Christopher Tichy — Physikalisches Institut, Universität Freiburg, Germany — Department of Physics and Astronomy, University of Aarhus, Denmark

Entanglement and the indistinguishability of identical particles pose a great challenge to our intuition, owing to the lack of classical counterparts. In particular, the connection between these phenomena is often elusive, especially for many particles. Here, we trace back correlated behavior, such as many-particle interference and entanglement, to the permutation symmetry of few and many identical particles.

We first restrict ourselves to two particles, comparing the classical behavior of distinguishable particles to the quantum dynamics of identical bosons and fermions. Bunching of bosons is opposed to anti-bunching of fermions, but both species are equivalent sources for bipartite entanglement. The realms of two indistinguishable and distinguishable particles are connected by a monotonic quantum-to-classical transition. As we move to larger systems, any attempt to understand many particles via the two-particle paradigm fails: In contrast to two-particle bunching and anti-bunching, the same correlations can be exhibited by bosons and fermions, and many bosons generate more multipartite entangled states than many fermions. Finally, the many-particle quantum-to-classical transition features experimentally confirmed non-monotonic structures. While the same physical principles govern small and large systems, it is the intrinsic complexity of many-particle interference that makes more particles behave differently.