UNI KASSEL VERSITÄT

Physikalisches Kolloquium

Thursday, 21.11.13, 17:15, HS 100
Reception with coffee & cookies 16:45

Prof. Dr. Giovanna Morigi, Universität des Saarlandes, Saarbrücken

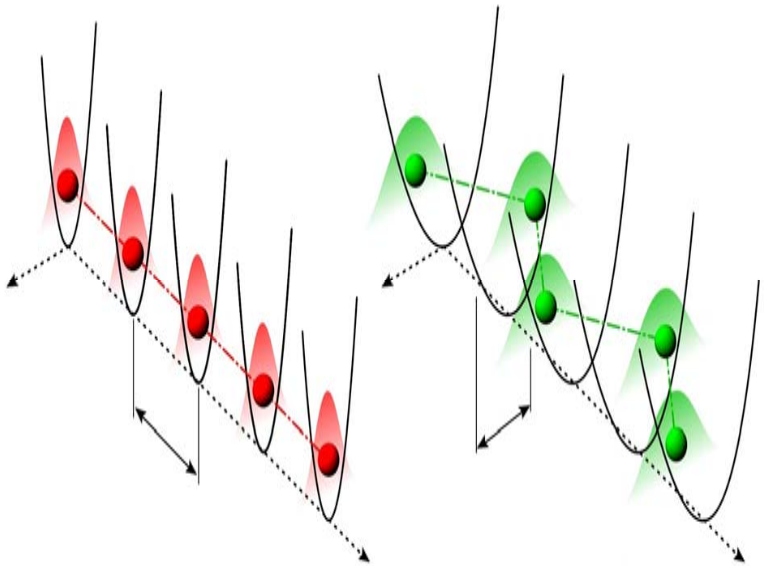
Ion Coulomb crystals at structural instabilities: Thermodynamics, Quantum Dynamics, and Quantum simulators

Abstract

Coulomb crystals are organized structures of charged particles, which interact through the Coulomb repulsion and organize in regular patterns at sufficiently low temperatures in presence of a confining potential. These potentials are realized by means of Paul or Penning traps, and their geometry determines the crystal- structure. These crystals represent a kind of rarefied condensed matter, the interparticle distance being of the order of several micrometers, allowing to study the structure by means of optical radiation. Variation of the potential permits one to control the crystal shape as well as the number of ions, thus offering the unique opportunity to study the transition from few particles to mesoscopic systems.

In this talk I show that a string of trapped ions at zero temperature exhibits a structural phase transition to a zigzag structure, tuned by reducing the transverse trap potential or the interparticle distance. The transition is driven by transverse, short wavelength vibrational modes.This is a quantum phase transition, which can be experimentally realized and probed. Indeed, by means of a mapping to the Ising model in a transverse field, one can estimate the quantum critical point in terms of the system parameters, and find a finite, measurable deviation from the critical point predicted by the classical theory. These results are confirmed by numerical simulations based on DMRG. A measurement procedure is suggested which can probe the effects of quantum fluctuations at criticality.

I then discuss various schemes realizing quenches of the trapping potential across the linear-zigzag instability. In particular, a procedure is presented which allows one for creating coherent superpositions of motional states of ion strings. The motional states are across the structural transition, and their coherent superposition is achieved by means of spin-dependent forces, such that a coherent superposition of the electronic states of one ion evolves into an entangled state between the chain's internal and external degrees of freedom. It is shown that the creation of such an entangled state can be revealed by performing Ramsey interferometry with one ion of the chain.



All of you interested in physics are cordially invited!

Contact: Prof. Dr. Ch. Koch, More Information: uni-kassel.de/go/physikalisches_kolloquium