



CRC 1227
Designed Quantum States of Matter



GUEST LECTURE

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(Guest of Prof. Dr. Piet O. Schmidt)

Leibniz Universität Hannover
Welfengarten 1, 30167 Hannover
(building 1101)
Seminar room D326
at the Institute of Quantum Optics
23 May 2019, 3:30 pm

"Programmable Quantum Simulators with Atoms and Ions"

Programmable analog quantum simulators have recently emerged as a new paradigm in quantum information processing. In contrast to the universal quantum computer, programmable quantum simulators are non-universal quantum devices with restricted sets of quantum operations, which however can be naturally scaled to a large number of qubits. In this talk we will focus on programmable analog quantum simulators with trapped ions and Rydberg tweezer arrays, and discuss various scenarios and applications of programming these quantum machines. We show results from a theory-experiment collaboration at Innsbruck demonstrating hybrid classical-quantum algorithms where a 20 qubit ion analog simulator computes the energy of the ground state of a lattice Schwinger model representing 1D QED. Remarkably, in this experiment we can not only compute the energy on the quantum machine but also the algorithmic error (error bar of the energy) by measuring the energy variance. Further examples include theoretical studies where variational algorithms are applied to generate optimal spin squeezed states for given (restricted) quantum resources provided by Rydberg tweezer arrays, which has potential applications in quantum sensing. We conclude with a discussion of the generic question of cross platform verification of quantum computers and quantum simulators, where the goal is to compare quantum devices on the level of many-qubit wavefunctions with protocols requiring only classical communication, which can be implemented in present day experiments.

**All DQ-mat members and all interested
are cordially invited to attend.**