



GUEST LECTURE

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(Guest of Prof. P.O. Schmidt and Prof. K.Hammerer)

Leibniz Universität Hannover
DQ-mat Colloquium

25 May 2023, 4.00 pm

Room D326

Building 1101, Welfengarten 1

"Quantum computing with trapped (Rydberg) ions"

Quantum technologies allow for fully novel schemes of hybrid computing. We employ modern segmented ion traps. I will sketch architectures, the required trap technologies and fabrication methods, control electronics for quantum register reconfigurations, and recent improvements of qubit coherence and gate performance. Currently gate fidelities of 99.995% (single bit) and 99.8% (two bit) are reached. We are implementing a reconfigurable qubit register and have realized multi-qubit entanglement [1] and fault-tolerant syndrome readout [2] in view for topological quantum error correction [3] and realize user access to quantum computing [4]. The setup allows for mid-circuit measurements and real-time control of the algorithm. We are currently investigating various applications, including variational quantum eigensolver approaches for chemistry or high energy relevant models, and measurement-based quantum computing. Complementary to scaling up the number of fully connected qubits, we aim for improving on the speed of entanglement generation. The unique and exotic properties of ions in Rydberg states [5] are explored experimentally, starting with spectroscopy [6] of nS and nD states where states with principal quantum number $n=65$ are observed. The high polarizability [7] of such Rydberg ions should enable sub- μ s gate times [8].

[1] Kaufmann et al, Phys. Rev. Lett. 119, 150503 (2017)

[2] Hilder, et al., Phys. Rev. X.12.011032 (2022)

[3] Bermudez, et al, Phys. Rev. X 7, 041061 (2017)

[4] <https://iquan.physik.uni-mainz.de/>

[5] A. Makhberi, M. Hennrich, F. Schmidt-Kaler, Trapped Rydberg ions: a new platform for quantum information processing, Advances In Atomic, Molecular, and Optical Physics, Academic Press, Ch. 4, 69 (2020), arXiv:2003.08891

[6] Andrijauskas et al, Phys. Rev. Lett. 127, 203001 (2021)

[7] Niederlander et al, NJP 25 033020 (2023)

[8] Vogel et al, Phys. Rev. Lett. 123, 153603 (2019)

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