



CRC 1227
Designed Quantum States of Matter



GUEST LECTURE

Prof. Dr. Markus Müller

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

Leibniz Universität Hannover

DQ-mat Colloquium

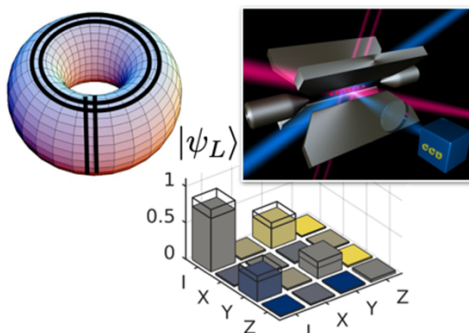
22 June 2023, 4.00 pm

Room D326

Building 1101, Welfengarten 1

"Fault-Tolerant Quantum Computers: Progress and Perspectives"

Quantum computers hold the promise to efficiently solve some computationally hard problems, for which efficient solutions are intractable on classical computers. Unfortunately, unavoidable noise limits the capabilities of current so-called noisy intermediate-scale quantum (NISQ) devices. To date, the construction of scalable fault-tolerant quantum computers remains a fundamental scientific and technological challenge. In my talk, I will first introduce basic concepts of quantum computing, review some of the promising applications, and then outline concepts from quantum error correction. The latter approach allows one to protect quantum information during storage and processing by redundant encoding of information in logical qubits formed of multiple physical qubits. I will discuss recent theory work, perspectives and recent collaborative experimental breakthroughs towards fault-tolerant quantum error correction on various physical quantum computing platforms. This includes the first realisations of repeated, high-performance quantum error-correction cycles on topological error correcting codes with superconducting qubits, and the first execution of universal and fault-tolerant logical quantum gates with trapped ions. Furthermore, I will highlight alternative explorative approaches towards robust quantum processors, based e.g. on quantum machine-learning based concepts, and outline some promising pathways to scale up current systems towards scalable, error-corrected quantum processors.



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