FAKULTÄT für PHYSIK
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PHYSIK-DEPARTMENT
TECHNISCHE UNIVERSITÄT MÜNCHEN
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Garchinger Maier-Leibnitz-Kolloquium

Donnerstag, 05.12.2024, 16^{15} Uhr

Hörsaal der LMU in Garching, Am Coulombwall 1
Treffen zum gemeinsamen Kaffee 16 Uhr

Priv. Doz. Dr. Jeanette Lorenz

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What we can learn from applications for the development of quantum computing?

Although the development of quantum computing hardware and software is progressing fast with many papers appearing on arXiv daily, the advantage of using quantum computing for real-life (industry and academic) applications remains unclear.
Present quantum computers are still limited in the number of qubits, the connectivity and are affected by noise. This makes it impossible to profit from theoretically proven quantum advantages like in Grover's or Shor's algorithms already today. However, recently, first experimental demonstrations of logical qubits were made in experimental settings. Additionally, experiments showed that commercially available quantum algorithms start to compete with the best-known classical algorithms on certain mathematical problems, using sophisticated error mitigation techniques and by co-designing hardware and software.
These developments put applications of quantum computing in the centre of understanding into which directions quantum hardware, software and algorithms should be further developed. First, it needs to be understood for which kind of application use cases quantum computers will provide an advantage over classical computers. Second, quantum hardware, software and algorithms need to be improved in a co-design manner to realize this practical quantum advantage. Thirdly, it is very likely that quantum computers will operate in a synergetic manner with classical computers - but to achieve this, the integration of quantum computers into HPC systems and into more complex quantum-classical workflows need to be considered early on.
After an introduction to the essentials of quantum computing, my talk will cover a couple of aspects within this thematic landscape: What is a 'practical' quantum advantage? What are example applications where we might hope to find it? How severe is the problem of noise from the application perspective? Where do we need fault-tolerant quantum computers? And finally: how to integrate quantum computers into a quantum-classical algorithmic workflow?

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