

## Einladung zum Physikalischen Kolloquium

26.04.2024 **Rainer Blatt, Universität Innsbruck**  
**»The Quantum Way of Doing Computations,  
Simulations and Measurements«**  
*Einführung: D. Hunger*



In this presentation, we review the fundamental functional principles of quantum information processing and provide an update on the status of the Innsbruck trapped-ion quantum computer [1]. Using strings of trapped ions, we implement a quantum information processor to carry out quantum operations. We present an overview of the available quantum toolbox and discuss the scalability of this approach. The quantum computing methodology is exemplified through analog and digital quantum simulations [2,3]. By utilizing the quantum toolbox for entanglement-enhanced Ramsey interferometry, we determine optimal parameters for quantum metrology [4]. To protect against the impact of noise, quantum computers encode logical quantum information redundantly across multiple qubits using error-correcting codes. We highlight the implementation of a fault-tolerant universal set of gates on two logical qubits within the trapped-ion quantum computer [5]. With Alpine Quantum Technologies, a commercially available NISQ-type quantum processor has been developed and is already accessible for industrial applications.

- [1] I. Pogorelov et al., PRX Quantum 2, 020343 (2021)
- [2] C. Kokail et al., Nature 569, 355–360 (2019)
- [3] M. K. Joshi et al., Science 376, 720 (2022)
- [4] C. D. Marciniak et al., Nature 603, 604 (2022)
- [5] L. Postler et al., Nature 605, 675 (2022)

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