Speaker: **Govind Unnikrishnan, University of Stuttgart**

Title: **AbaQus: A Dynamically Reconfigurable Triple-Magic Atom Array For The Sr Fine-Structure Qubit**

Date: **Friday, May 22, 11 am (s.t.).**

Place: **Seminar room 915**

Abstract: **AbaQus: A Dynamically Reconfigurable Triple-Magic Atom Array For The Sr Fine-Structure Qubit**

Quantum computing with neutral atoms trapped in optical tweezer arrays has seen unprecedented progress in the past few years. This not only comprises recent advances in achieving high-fidelity gates, but also entails unique possibilities enabled by the matured field of optical tweezer technology, including error correction. While systems with a single optically active electron has achieved impressive results, divalent systems such as Sr and Yt allow for extended control that opens up further possibilities. Here, we report on the realization of a novel qubit encoding using the long-lived, metastable fine-structure states 3P2 and 3P0 of the Sr atom, enabling single-qubit rotations on the 100 ns timescale while also providing favorable heating properties [1]. Furthermore, we engineer triple-magic trapping conditions for both the qubit states as well as for the Rydberg state used for the realization of two-qubit gates. This allows us to achieve long coherence times on the qubit and eliminate motional dephasing during Rydberg excitation. Finally, we report on the progress on scaling up our system using a novel tweezer architecture to achieve a dynamically reconfigurable atom array with over 640 qubits [2,3], all encoded into the fine-structure manifold. Our tweezer infrastructure allows for native re-configurability using on-the-fly atom detection and frequency chirp calculations at the hardware level, allowing us to reach latencies well within the measured coherence time of the qubit and hence opening up the path to mid-circuit measurements and error-correction.

[1] G. Unnikrishnan et al., Coherent Control of the Fine-Structure Qubit in a Single Alkaline-Earth Atom, Phys. Rev. Lett. 132, 150606

[2] M. Adams et al., Optical setup for a two-dimensional tweezer array with independently adjustable columns for neutral atom quantum computing, Proceedings Volume 12911, Quantum Computing, Communication, and Simulation IV; 129110L (2024)

[2] F. Meinert et al., Device and Method for Generating Optical Tweezers, US Patent 18530288