Kolloquium des Instituts für Angewandte Physik / Quantentechnologien

TECHNISCHE UNIVERSITÄT DARMSTADT

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Fast neutral-atom transport and transfer between optical tweezers

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Efficient, low-error transport of neutral atoms between optical tweezers is essential for the implementation of quantum computers and simulators. We compare several commonly used transport pulses—linear, quadratic, minimum-jerk, and hybrid trajectories—and introduce a shortcuts-to-adiabaticity (STA) protocol that explicitly accounts for time-dependent effects from static traps.

To motivate the implementation of our STA pulses in future experiments, we provide a simple analytical approximation for the moving-tweezer position and depth controls. Using measures of transport error and heating, we show that the STA approach consistently outperforms all experimentally inspired pulse shapes.

By further optimizing the controls using the dCRAB algorithm, we identify a lower bound on the protocol duration, compatible with the time at which the vibrational excitations exceed half of the states hosted by the moving tweezer. The protocol time limit is shown to be around eight times faster than recent experimental implementations. Our results highlight the importance of optimizing the transfer to and from static traps and show that time-dependent modulation of the tweezer depth is crucial for minimizing heating.