

FAST NEUTRAL-ATOM TRANSPORT AND TRANSFER BETWEEN OPTICAL TWEEZERS

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In this work we focus on the optimization of the transport and transfer of neutral atoms between optical tweezers, both critical steps in the implementation of quantum computers and simulators. We analyze four experimentally relevant pulse shapes (piecewise linear, piecewise quadratic, minimum jerk, and a combination of linear and minimum jerk) and we develop a protocol using shortcuts-to-adiabaticity (STA) techniques that incorporates the effects of the static tweezers. By computing the infidelity as a measure of the final transport error and two measures of heating during transport, we show that our proposed STA protocol consistently outperforms all the experimentally inspired pulses. After further optimizing the pulse shapes we find a lower bound on the protocol duration that is compatible with the time at which the vibrational excitations exceed half of the states hosted by the moving tweezer. This lower bound is at least eight times faster than the one reported in recent experiments therefore highlighting the importance of including and optimizing the transfer from and to the static traps which constitutes the most time-consuming bottleneck to speed-up. Finally, our STA results demonstrate that a modulation in the depth of the moving tweezer designed to counteract the effect of the static traps is the key ingredient to reduce the errors and pulse duration. Finally, to motivate the implementation of our STA pulses in future experiments, we provide for simple analytical expressions for the position and depth of the moving-trap.