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Quantum Science with Alkaline Earth Tweezer Arrays

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Recently cold atoms in optical tweezer arrays have emerged as a versatile platform for quantum science experiments. I will review some of these developments, specifically, atom-by-atom assembly [1] as a fast and simple method to generate defect-free atomic arrays and Rydberg-based quantum simulation of spin models. While already reaching competitive results, these systems are still in their infancy and limitations in coherence, detection fidelity, and scalability remain. I will outline how we can improve on these issues and at the same time open new avenues in quantum metrology by using alkaline earth atoms, followed by an overview of recent results: 1) A record in imaging-fidelity for neutral atoms and demonstration of narrow-line cooling in tweezers [2, 3]. 2) High-fidelity Rydberg excitation from a clock state, including a record in entanglement-fidelity for two neutral atoms [4]. 3) Demonstration of an optical clock with single-atom detection in tweezer arrays [5].

[1] Endres et al., Science 354, 1024 (2016)
[2] Covey et. al, Phys. Rev. Lett. 122, 173201 (2019)
[3] Cooper et al., Phys. Rev. X 8, 041055 (2018)
[4] Madjarov*, Covey*, et al., arXiv:2001.04455 (2020)
[5] Madjarov et al., Phys. Rev. X 9, 041052 (2019)