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Controlling ultrafast Rydberg dynamics with ultracold atoms in optical tweezers

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Rydberg atoms, with their giant electronic orbitals, exhibit dipole-dipole interaction reaching the GHz range at a distance of a micron, making them a prominent contender for realizing ultrafast quantum operations. However, such strong interactions have never been harnessed so far because of the stringent requirements on the atom position fluctuation and the necessary excitation strength. Here, we introduce novel techniques to enter this regime and explore it with two strongly-interacting single atoms. This interaction is the key to the realization of an ultrafast two-qubit gate for cold-atom quantum computers. The techniques demonstrated here open the path for ultrafast quantum simulation and computation

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