

Optical Control of the Resonant Dipole-Dipole Interaction between Rydberg Atoms

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<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.119.053202> [2]

We report on the local control of the transition frequency of a spin 1/2 encoded in two Rydberg levels of an individual atom by applying a state-selective light shift using an addressing beam. With this tool, we first study the spectrum of an elementary system of two spins, tuning it from a nonresonant to a resonant regime, where “bright” (super-radiant) and “dark” (subradiant) states emerge. We observe the collective enhancement of the microwave coupling to the bright state. We then show that after preparing an initial single spin excitation and letting it hop due to the spin-exchange interaction, we can freeze the dynamics at will with the addressing laser, while preserving the coherence of the system. In the context of quantum simulation, this scheme opens exciting prospects for engineering inhomogeneous XY spin Hamiltonians or preparing spin-imbalanced initial states.

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