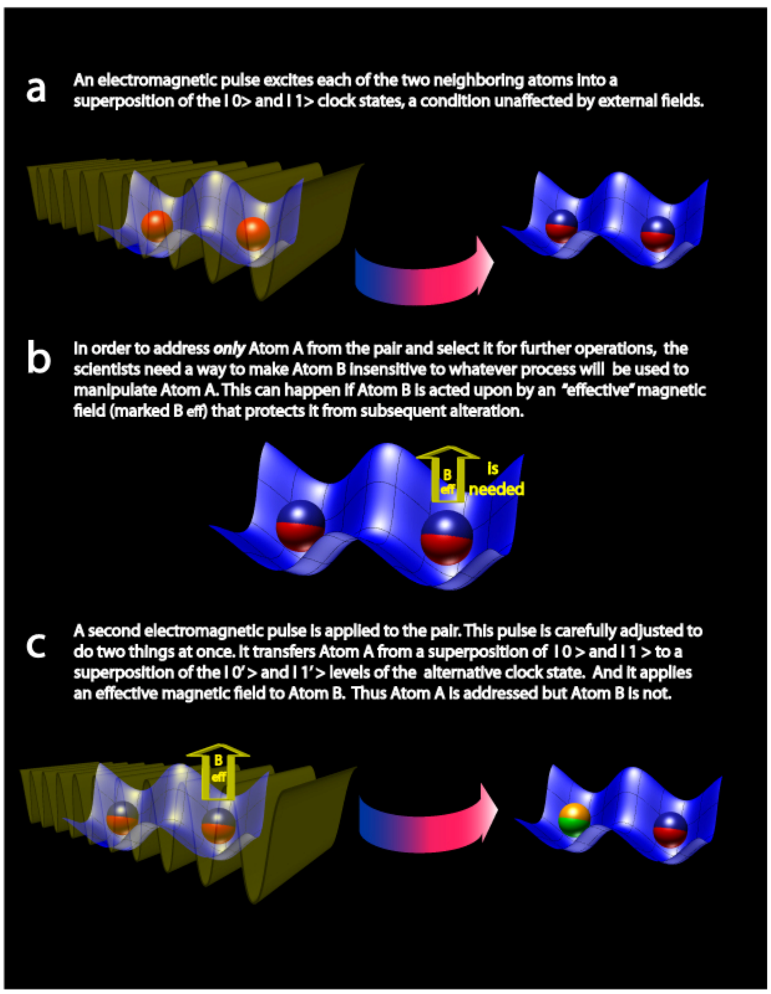
Qubit basis switching

The design of many proposed quantum computation platforms is driven by competing needs: isolating the quantum system from the environment to prevent decoherence while simultaneously controlling the system with external fields. Pairs of so-called "clock states" in neutral atoms provide nearly ideal qubits, which are magnetic-field-insensitive and therefore insensitive to field-environmental decoherence. On the other hand, these states are also insensitive to control fields that allow, for example, selective addressing of single qubits using techniques similar to magnetic resonance imaging. We have developed a technique to simultaneously preserve qubit insensitivity and allow field sensitive addressing. The trick is to use *two* pairs of clock states (four states total.) Each pair of states is itself insensitive to fields, but the transitions *between* the pairs of states are field sensitive. We demonstrate this approach in a double-well optical lattice, where we first stored the qubit information in field insensitive "memory" states. We then transferred selected qubits from the memory states to a different pair of "working" states. The selected qubits are addressed with an magnetic-field-like optical field that does not affect atoms in either the memory or workings states, but allows site specific frequency shifts for transitions between the memory and working states. This technique should allow for coherent sub-wavelength addressing of atoms in an optical lattice and may be useful for decreasing cross-talk in any quantum-computing platform with multiple sets of field-insensitive transitions.



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