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Singlet-triplet oscillations with pairs of neutral atoms in an optical superlattice STEFAN TROTZKY, YU-AO CHEN, UTE SCHNORRBERGER, PATRICK CHEINET, SIMON FÖLLING, IMMANUEL BLOCH, Ludwig-Maximilian Universitaet Muenchen — We show the creation, detection and manipulation of effective-spin triplet and singlet pairs with ultracold ^{87} Rb atoms in an optical superlattice. Starting from two atoms on a lattice site being in different Zeeman states labeled by $|\uparrow\rangle$ and $|\downarrow\rangle$, we split the sites into symmetric double-wells to form delocalized spin triplets $|\uparrow,\downarrow\rangle + |\downarrow,\uparrow\rangle$. We use a magnetic field gradient to achieve a coherent coupling between the triplet and the corresponding singlet state. The detection of the emerging oscillations relies on measuring the parity of the spatial two-body wavefunction after merging the double-wells. A superexchange coupling between adjacent double-wells realizes a SWAP operation that stretches the entangled pairs over more than one lattice spacing. Our method provides a tool to detect short-range spin correlations e.g. emerging in Fermi-Hubbard type systems close to the Neel temperature. The SWAP operation realizes an important step towards the creation of robust multiparticle entangled states suitable for one-way quantum computing.

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