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Discovery of supercoupling between heavy-hole and light-hole in self-assembled quantum dots[1] JUN-WEI LUO, NREL, GABRIEL BESTER, Max-Planck-Institut für Festkörperforschung, Heisenbergstrasse 1, D-70569 Stuttgart, Germany, ALEX ZUNGER, University of Colorado, Boulder, Colorado 80309, USA — The mixing of quantum states is a fundamental principle of quantum mechanics. In the case of a diatomic molecule, the eigenstates of atom A mix with the ones of atom B to form molecular orbitals with a mixing inversely proportional to the energy separation between the respective eigenvalues. This fundamental result of quantum mechanics leads to the expectation that states that are well separated in energy will tend to retain their own character and avoid mixing. By studying self-assembled quantum dots, often denoted as "artificial atoms", we show that heavy-hole (HH) states can significantly mix with light-hole (LH) states, despite the fact that they are energetically well separated, through supercoupling — a coupling meditated by intermediate states (as in superexchange). This new interband coupling mechanism explains light-hole mixing, which is the key quantity for the use of quantum dots in quantum information and quantum optical schemes, such as for the generation of entangled photon pairs, the decoherence of hole states, the optical polarization anisotropy and the preparation of qubits.

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