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Hybrid Spin and Valley Quantum Computing with Singlet-Triplet Qubits NIKLAS ROHLING, MAXIMILIAN RUSS, GUIDO BURKARD, Department of Physics, University of Konstanz, Germany — The valley degree of freedom in the electronic band structure of silicon, graphene, and other materials is often considered to be an obstacle for quantum computing (QC) based on electron spins in quantum dots. Here we show that control over the valley state opens new possibilities for quantum information processing. Combining qubits encoded in the singlet-triplet subspace of spin and valley states allows for universal QC using a universal two-qubit gate directly provided by the exchange interaction. We show how spin and valley qubits can be separated in order to allow for single-qubit rotations [1].

[1] N. Rohling, M. Russ, and G. Burkard, Phys. Rev. Lett. **113**, 176801 (2014)

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