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Complete quantum control of an exciton qubit bound to an isoelectronic center in GaAs GABRIEL ETHIER-MAJCHER, PHILIPPE ST-JEAN, Polytechnique Montreal, GIANLUCA BOSO, ALBERTO TOSI, Politecnico di Milano, SEBASTIEN FRANCOEUR, Polytechnique Montreal — Various schemes of quantum information processing rely on interconnection of matter qubits via optical photons, flying qubits. To achieve scalable and robust quantum computing and networking within those schemes, matter qubits must present high optical homogeneity and strong coupling to photons. Here, coherent optical manipulation of excitons bound to single isoelectronic centers formed from a pair of nitrogen isovalent impurities in GaAs is demonstrated. Using a time-gated technique, resonant fluorescence of the exciton is measured and the power dependence of the fluorescence shows Rabi rotations from which a dipole moment as high as 55 D can be extracted. Interestingly, excitation induced dephasing, a phenomenon lowering the fidelity of exciton gating in quantum dots, is strongly reduced in our system. The complete quantum control of the qubit is demonstrated through Ramsey interferometry. The coherence time of the exciton reaches 115 ps. Our results show that isoelectronic centers combine the strong dipole moments of quantum dots and the optical homogeneity and predictability of atomic systems such as NV centers in diamond, establishing them as promising candidates for quantum information processing.

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