Multimode telecom quantum memories compatible with quantum dot photon sources

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The realization of large-scale quantum networks requires efficient, coherent interfaces between quantum memories and deterministic sources of photonic qubits. We recently demonstrated a hybrid quantum node interfacing an atomic quantum memory with a quantum dot photon source at telecom wavelengths – a key step toward fiber-compatible quantum repeaters and distributed quantum information processing. Here, we report new results showing a significant extension of the memory storage time while maintaining high-bandwidth and low-noise operation. We also demonstrate storage of multiple temporal modes encoded in time-bin qubits, increasing information capacity and enabling compatibility with photonic encodings used in long-distance quantum communication. These results provide a pathway toward scalable, multiplexed quantum networks integrating solid-state photon sources with atomic memories in the telecom regime.