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Atomic quantum memory in two limits: the Autler-Townes splitting protocol vs. the electromagnetically induced transparency protocol LINDSAY LEBLANC, ANINDYA RASTOGI, ERHAN SAGLAMYUREK, TARAS HRUSHEVSKYI, SCOTT HUBELE, University of Alberta — Autler-Townes splitting (ATS) and electromagnetically induced transparency (EIT) are related but distinct quantum optical phenomena: EIT is described by quantum interference between transition pathways, while ATS is a manifestation of the ac Stark shift. Likewise, the mechanisms underlying light-storage techniques based on EIT and ATS manifest opposite limits of the light-matter interaction due to their inherent adiabatic vs. non-adiabatic nature. Numerical simulations show that the EIT protocol, which relies on signal delay via slow light and must be optimized by shaping the control pulses, operates best in the adiabatic regime and is well-suited to narrow-band signal storage. In contrast, we show that the ATS memory, which relies on reëmission for signal delay and can be optimized via pulse-area control, is efficient even in the non-adiabatic regime and is best suited for broad-band signals. We determine optimal conditions for each protocol and analyze ambiguous regimes in the case of broadband storage, where non-optimal memory implementations can possess characteristics of both EIT and ATS protocols. These fundamental differences are demonstrated in a proof-of-concept rubidium cold-atoms experiment. We also report on other recent experiments using ATS quantum memory.

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