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Optically-accessible hot spins possessing hour-long coherence times OFER FIRSTENBERG, Weizmann Institute of Science — Spins of noble gases are a unique system that exhibits hours-long coherence at room temperature and above. These spins, unfortunately, are not coupled to any optical transition and therefore have not been employed in any quantum optics application to date. We present a new approach to this challenge, forming a quantum interface between noble-gas spins and light, utilizing alkali atoms as mediators. First, we study the coupling of light to the spin orientation of alkali vapor and demonstrate a 400-millisecond storage lifetime, a record for an optical memory at room temperature. We then show that the spin orientation can mediate the coupling between light and noble-gas spins via random, thermal, spin-exchange collisions. We provide a full quantum model of this interface and show, theoretically and experimentally, that it is coherent and externally controllable. We study the optimal strategies for realizing hour-long quantum memories and entanglement of remote ensembles. Finally, we experimentally reach the strong-coupling regime with helium-3 spins and demonstrate optical spectroscopy of line as narrow as 0.1 Hz and light storage with extremely long lifetimes.

Ofer Firstenberg
Weizmann Institute of Science

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