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Back-reaction and dipolar interaction noise of a spin magnetometer SEUNG-KYUN LEE, M.V. ROMALIS, Princeton University — An atomic magnetometer detects magnetic field through magnetic resonance of atomic spins, and competes in its sensitivity with a superconducting quantum interference device (SQUID). In this work we compare the fundamental quantum noise of a dc SQUID with that of a spin-based magnetometer. In particular, we calculate the back-reaction noise of a generic spin magnetometer coupled to an input coil, and show that a linear amplifier built from such a magnetometer is bound by a universal noise limit derived from the uncertainty principle. Dipolar spin-spin interaction is a fundamental physical process which affects decoherence and fluctuation in a spin magnetometer. We argue that an isolated magnetometer dominated by such interaction can reach a magnetic field sensitivity many orders of magnitude higher than that of a dc SQUID, and present numerical examples based on observed decoherence times in various atomic spin systems.

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