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Atomic Magnetometry in the AttoTesla Regime[1] HOAN BUI DANG, MICHAEL ROMALIS, Princeton University — An atomic magnetometer operated in the spin-exchange relaxation-free (SERF) regime can have atom-shot-noise-limited fundamental sensitivity below 10 aT/$\sqrt{\text{Hz}}$. Not only does it surpass the sensitivity of superconducting quantum interference devices (SQUID's), it also proves advantageous by not requiring cryogenic refrigeration. We have designed and built a SERF magnetometer to push the current sensitivity limit. Johnson noise from mu-metal shields is avoided by using ferrite for the innermost shielding layer. The loss factor of different ferrites was measured in the selection for one with the lowest magnetization noise. With gradient measurement technique, a sensitivity level of 200 aT/$\sqrt{\text{Hz}}$ was achieved at a low frequency (below 20Hz), which according to our model may be further improved by optimizing the system for a better signal-to-noise. Such a sensitive magnetometer is useful in many applications, for example thermal demagnetization measurements in rock magnetism. A particularly weakly-magnetized geological sample was measured with a very clean signal, demonstrating the practicality of the magnetometer.

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