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Magnetometry via spin-mechanical coupling in levitated optomechanics[1] PARDEEP KUMAR, MISHKAT BHATTACHARYA, Rochester Institute of Technology — Recently hybrid levitated optomechanics have been realized using a nanodiamond containing a single nitrogen vacancy (NV) center. In such nanomechanical systems the mechanical oscillation of levitated diamond couples to its spin degree of freedom by means of magnetic field gradient thereby providing a versatile platform for sensing applications. Here, we propose magnetometry based on an NV-center optically levitated in an ultrahigh vacuum and subjected to feedback cooling. In particular, we describe magnetic field gradient sensitivity in two ways (i) by analyzing the position spectrum of the mechanical oscillator (ii) by maneuvering spin degree of freedom. The first scheme offers a magnetic field gradient sensitivity of 1 $\mu\mathrm{Tm}^{-1}/\sqrt{\mathrm{Hz}}$ under the conditions of ultrahigh vacuum and feedback cooling. However, working at high pressure and room temperature degrades the sensitivity to a value of 100 $m\mathrm{Tm}^{-1}/\sqrt{\mathrm{Hz}}$. Further, we use Ramsey interferometry to manipulate the spin degree of freedom and obtain photon-shot noise and spin-projection noise limited magnetic field gradient sensitivity of 100 $\mu\mathrm{Tm}^{-1}/\sqrt{\mathrm{Hz}}$. Thus, the proposed nanomagnetometer provides a promising platform for ultrasensitive applications.

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