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Electron spin control and torsional optomechanics of an optically levitated nanodiamond in vacuum[1] TONGCANG LI, THAI HOANG, JONGHOON AHN, JAEHOON BANG, Purdue Univ — Electron spins of diamond nitrogen-vacancy (NV) centers are important quantum resources for nanoscale sensing and quantum information. Combining such NV spin systems with levitated optomechanical resonators will provide a hybrid quantum system for many novel applications. Here we optically levitate a nanodiamond and demonstrate electron spin control of its built-in NV centers in vacuum. We observe that the strength of electron spin resonance (ESR) is enhanced when the air pressure is reduced. We also observe that oxygen and helium gases have different effects on both the photoluminescence and the ESR contrast of nanodiamond NV centers, indicating potential applications of NV centers in oxygen gas sensing. For spin-optomechanics, it is important to control the orientation of the nanodiamond and NV centers in a magnetic field. Recently, we have observed the angular trapping and torsional vibration of a levitated nanodiamond, which paves the way towards levitated torsional optomechanics in the quantum regime.

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