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Observation of vacuum-enhanced electron spin resonance of optically levitated nanodiamonds TONGCANG LI, THAI HOANG, JONGHOON AHN, JAEHOON BANG, Purdue University — 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 low vacuum. We observe that the strength of electron spin resonance (ESR) is enhanced when the air pressure is reduced. To better understand this novel system, we also investigate the effects of trap power and measure the absolute internal temperature of levitated nanodiamonds with ESR after calibration of the strain effect. Our results show that optical levitation of nanodiamonds in vacuum not only can improve the mechanical quality of its oscillation, but also enhance the ESR contrast, which pave the way towards a novel levitated spin-optomechanical system for studying macroscopic quantum mechanics. The results also indicate potential applications of NV centers in gas sensing.

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