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Cooling of the Mechanical Motion of Diamond Nanocrystals in a Magneto-Gravitational Trap in High Vacuum[1] JEN-FENG HSU, PENG JI, CHARLES W. LEWANDOWSKI, BRIAN D'URSO, University of Pittsburgh —
We present a magneto-gravitational trap for diamagnetic particles, such as diamond nanocrystals, with stable trapping from atmospheric pressure to high vacuum. Characterization and feedback cooling of the mechanical motion of the trapped particle are described. This static trap is achieved by permanent magnets and ferromagnetic pole pieces. The magnetic field confines the particle in two dimensions, while confinement in the third dimension relies on gravity. The weak trapping forces result in mechanical oscillation frequencies in the extremely low to super low frequency range and exceptionally high sensitivity to external forces. Particles can be trapped for an indefinite length of time without active cooling. With feedback, the mechanical motion can be cooled by several orders of magnitude. With trapped diamond nanocrystals containing nitrogen-vacancy centers, the system has potential as a platform for experiments in quantum nanomechanics.

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