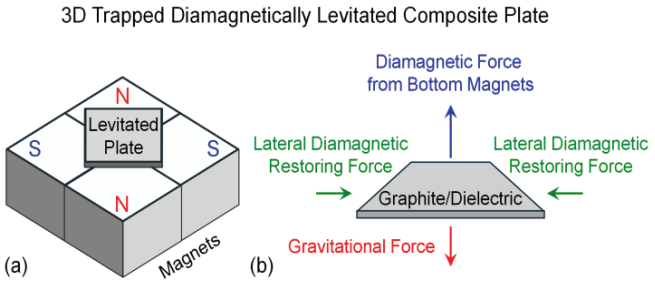

Figure 1: Full diamagnetic levitation & trapping of graphite/dielectric composite plate. (a) Schematic illustration of a levitated diamagnetic plate above four cubic $Nd_2Fe_{14}B$ permanent magnets with alternating magnetization in stable configuration. (b) Balanced vertical and lateral diamagnetic forces, along with gravitational force, enable three-dimensional (3D) trapping of the levitated plate resonators.

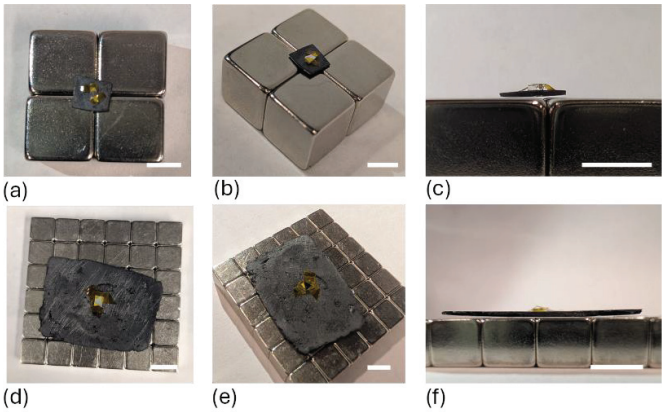

Figure 2: Image of diamagnetically levitated composite plates. (a) Top (b) Perspective and (c) Side view of Device 1 (mass, m=34mg) with dimensions of length, L=6.71mm, width, w=5.9mm, thickness, t=0.61mm, and levitation height, h=0.1mm. (d) Top (e) Perspective and (f) side view of Device 2 (m=680mg) with dimensions of L=29.04mm, w=21.6mm, t=0.95mm and levitation height, h=0.05mm. All scale bars are 6mm.

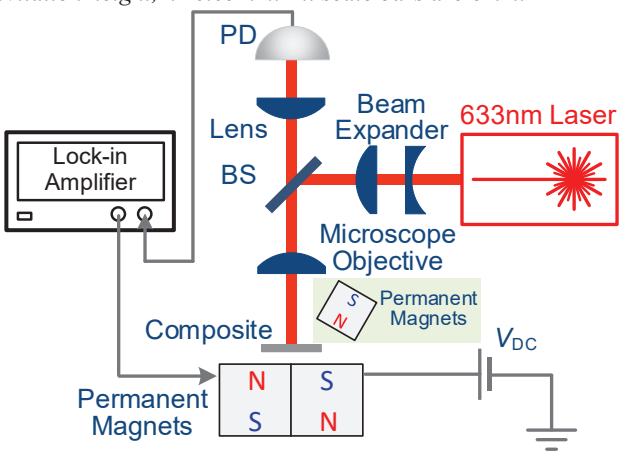

Figure 3: Illustration of ultrasensitive laser interferometry measurement system for excitation and detection of resonances of graphite-dielectric composite plates diamagnetically levitated above permanent magnets placed in a vacuum environment. PD: photodetector, BS: Beam Splitter. Additional permanent magnets are installed for magnetic field sensing.

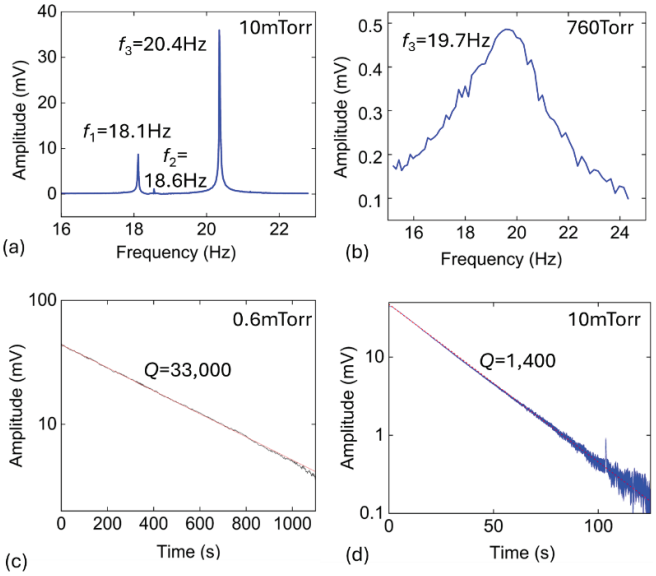

Figure 4: Frequency and time-domain resonance data for a diamagnetically levitated graphite/dielectric plate resonator with dimensions of L=6.71mm, w=5.9mm, t=0.61mm, m=34mg, and h=0.1mm at room temperature. (a) Frequency-domain resonance curves measured in moderate vacuum (~10mTorr). (b) Frequency-domain resonance curves measured in air (760Torr). (c) Envelope of ring-down responses at ~0.6mTorr. (d) Envelope of ring-down responses at ~10mTorr. Q factors are determined by fitting the envelopes (red dashed lines).

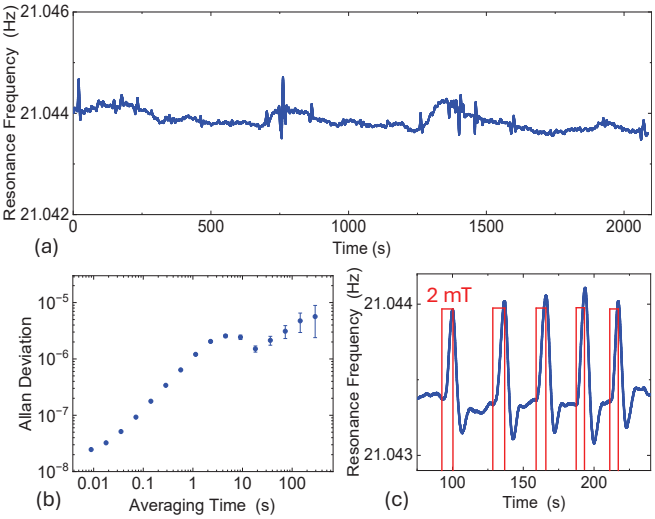

Figure 5: Frequency stability, Allan deviation, and magnetic field sensing of a diamagnetically levitated graphite-dielectric plate resonator (Device 2) with a mass of m=680mg, at room temperature. (a) Measured frequency stability of Device 2 using a phase locked loop (PLL) configuration in the lock-in amplifier. (b) Allan deviation of Device 2 converted from the measured frequency stability (a). (c) Demonstration of magnetic field sensing using Device 2. A red line shows the 2mT magnetic field on the device introduced using a permanent magnet where the magnetic field is calibrated with a conventional Hall sensor. A blue line shows the measured frequency shift and resonant sensing based on the levitated system.