

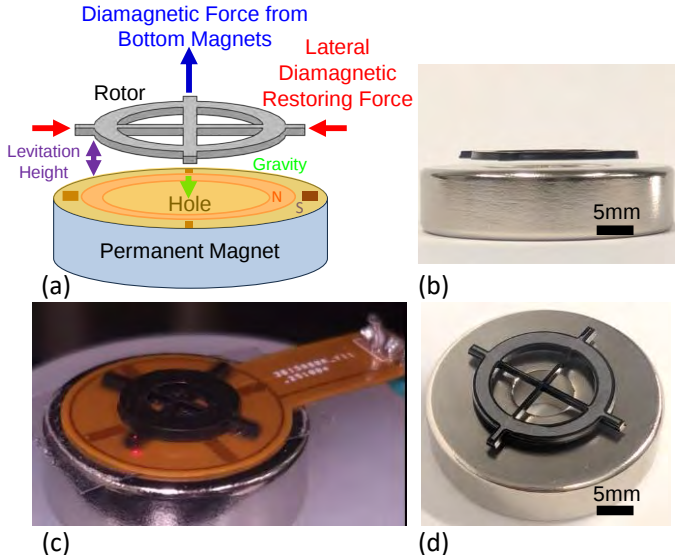


Figure 1: Diamagnetically levitated rotor system. (a) Schematic illustration of full diamagnetic levitation and three-dimensional (3D) trapping of a concentric ring-shaped graphite rotor above permanent magnets with alternating magnetization. (b) side view of the levitated rotor. (c) Photograph of the rotor system integrated above the printed circuit board. (d) Perspective view of the rotor.

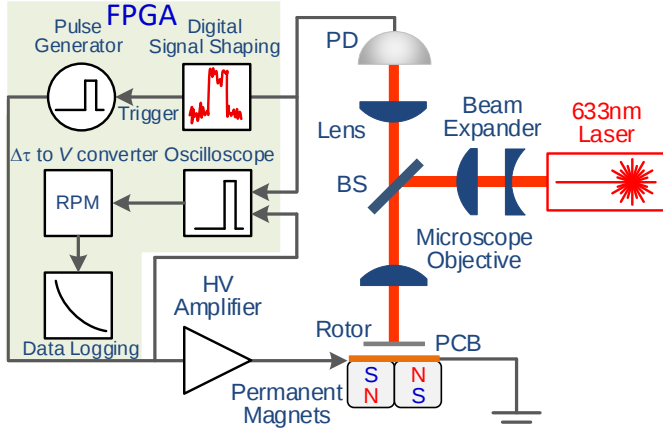


Figure 2: Experimental system for the levitated rotor. Schematic of a customized ultrasensitive laser interferometry system used to measure the resonance response of the levitated graphite rotor. PD denotes the photodetector; BS denotes the beam splitter.

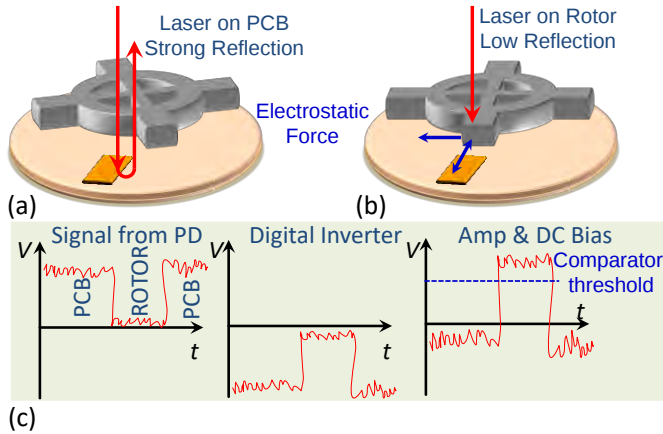


Figure 3: Optical event-based sensing and FPGA-synchronized electrostatic actuation of a levitated graphite rotor. (a) Optical reflectivity contrast between PCB and rotor arm. (b) Schematic of signal conditioning and comparator-based trigger generation.

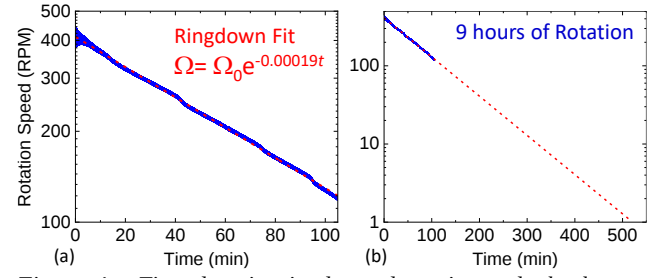


Figure 4: Time-domain ringdown dynamics and ultralong rotation lifetime of a levitated graphite rotor. (a) Rotation speed as a function of time during ringdown under chamber pressure of 100 μ Torr. (b) Logarithmic plot of rotation speed showing possible sustained free rotation exceeding 9 hours. Red dashed line indicates an exponential fit to the decay.

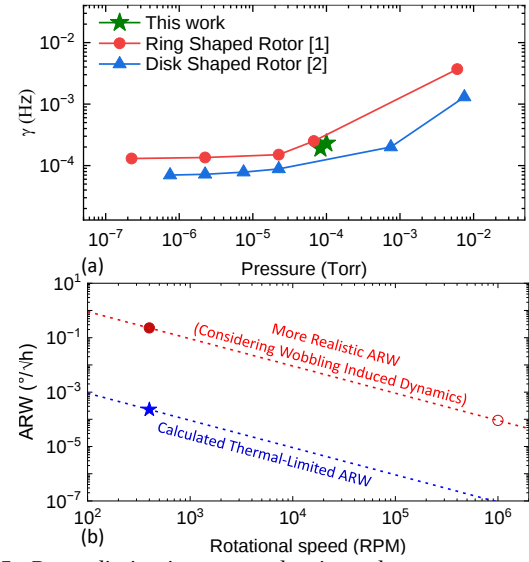


Figure 5: Rotor dissipation rate and estimated gyroscope performance. (a) Measured dissipation rate as a function of chamber pressure. (b) Estimated angular random walk (ARW) as a function of RPM (blue star indicates estimated ARW using the system parameters and the achieved RPM, red circles show more realistic ARW). [1] X. Chen, N. Raj, R. Lecamwasam, M. Chen, C. Y. L. Tan, S. M. Assad, and P. K. Lam, "Levitated Macroscopic Rotors with 10 Hours of Free Spin at Room Temperature," arXiv:2506.03803 (2025). [2] D. Kim, S. Tian, B. Calderoni, C. Sastre-Jachimska, J. Downes, and J. Twamley, "A Magnetically Levitated Conducting Rotor with Ultra-Low Rotational Damping Circumventing Eddy Loss," Communications Physics, 8, 381 (2025).

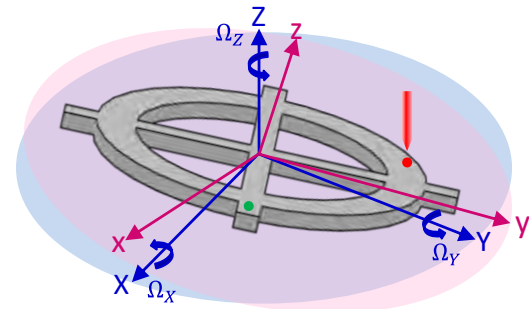


Figure 6: Schematic illustrating the coordinate systems used in the analysis: the fixed frame (blue) and the rotating frame (pink), defined for a graphite rotor. A laser is focused on a rotor arm (green dot) to trigger the driving voltage, while a second laser is focused on the rotor body (red dot) to detect the gyroscopic motion.