Self-Induced Backaction Trapping

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Self-induced backaction (SIBA) trapping is a concept developed in optics for trapping of polarizable particles [1,2]. The goal of this project is the analyze, design and characterize an electromechanical analog of SIBA trapping.

The operating principle is shown in the figure below. An electrical $LC$ resonator with resonance frequency $\omega_0$ is driven by an external source. The electric field between the capacitor plates exerts a force on a particle (mass $m$) attached to a restoring spring (stiffness $k$) and attracts it towards the capacitor. The particle changes the capacitance $C$ and detunes the resonance of the $LC$ circuit. As a consequence, the field between the capacitor plates drops and the force on the particle weakens. The particle is then pulled back by the spring and the resonance in the $LC$ circuit is restored. From here, the procedure repeats itself.

The student will 1) theoretically analyze the electrical SIBA trap shown in the figure, 2) develop alternative schemes (using electrostatic and magnetostatic forces), 3) design an experiment and characterize the performance of an electromechanical SIBA trap.


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Prerequisites: Basic knowledge of electrodynamics, electronics, and measurement techniques.