Quantum optical levitation of a mirror

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While the levitating mirror has seen renewed interest lately, relatively little is known about its quantum behaviour. We present a quantum theory of a one dimensional levitating mirror. The mirror forms a part of a Fabry-Pérot cavity where the circulating intracavity field supports the mirror through radiation pressure alone. We find a blue and red detuned steady-state of which only the blue detuned solution with damping on the mirror and cavity is stable.

We then consider the entanglement between both the cavity and mirror, and their respective outputs. In doing so we find strong entanglement between the mirror output and cavity output with squeezing in the mirror output. However, any squeezing in the mirror output is expected to rapidly dissipate throughout the mirrors vibrational modes and thermalise.

We then consider to what extent these effects are visible. Specifically we consider separately the heating expected due to absorption of the laser field by the floating mirror, and the thermalisation of the mirror output energy.