Mechanical-EM Coupling

Coupling of wall displacement q to cavity fields e_0 and e_1:

Energy in 0 and 1 modes

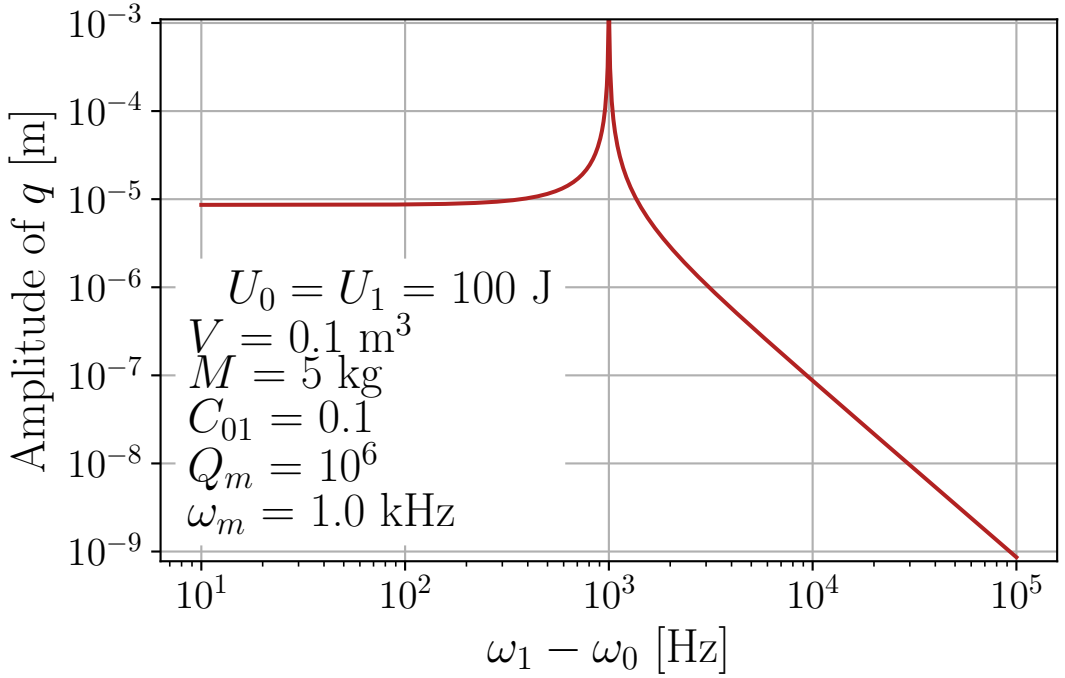
Coupling of 0 and 1 Mode to Vibration

$$\ddot{q}(t) + \frac{w_m}{Q_m}\dot{q}(t) + \omega_m^2 q(t) = 2\frac{\sqrt{U_0 U_1}}{V^{\frac{1}{3}} M} C_{01}^m e_0^*(t) e_1(t)$$

Cavity volume and mass

=> On Resonance with w_1-w_0 the modes e_0 and e_1 drive q with amplitude:

$$\mathrm{AMP}[q(t)] = \frac{2Q_m}{\omega_m^2}\frac{\sqrt{U_0 U_1}}{V^{\frac{1}{3}} M} C_{01}^m$$



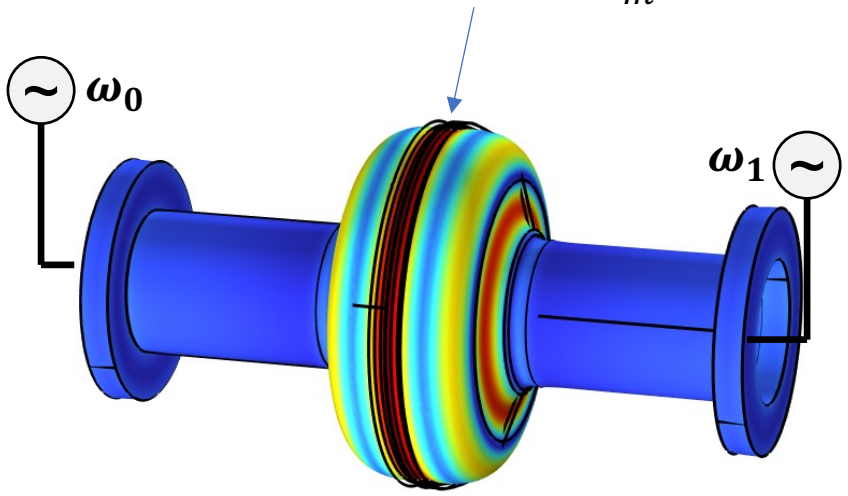
Real Amplitude depends on position on wall:

$A(x,t) = \boldsymbol{\xi}(x) \cdot q(t), \quad |\boldsymbol{\xi}_{peak}| \approx O(1)$

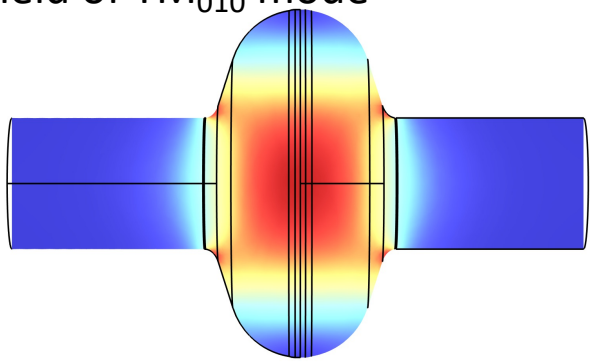
Displacement Field

Possible Measurement with e.g. one cell cavity

Mechanical Vibration around $\omega_m = 5$ kHz



E field of TM_{010} mode



IDEA:

- Drive e.g. TM_{010} Mode at $\boldsymbol{\omega_0 = \omega_{010} - \omega_m/2}$ AND at $\boldsymbol{\omega_1 = \omega_{010} + \omega_m/2}$
- If coupling $\boldsymbol{C_{01}^m \neq 0}$ this should excite a vibration at $\boldsymbol{\omega_1 - \omega_0 = \omega_m}$
- The vibration could be measured with lasers or accelerometers

Requirement: Oscillator bandwidth << bandwidth of EM eigenmode (≈ kHz)

GOALS:

- Measure $\boldsymbol{C_{01}^m}$
- verify theoretical treatment of EM-Mechanical Coupling
- verify EM back-action effects

IN THE FUTURE:

- Could repeat with GW cavity but drive pump and signal mode
  -> Check if quadrupole mode gets excited