Discussion 9: Drive Force

Announcements:
- HW#8 is due next Wednesday

Today:
- Drive Force Example

Drive Force Example

Find $\frac{AC}{ax}$:

$$\frac{AC}{ax} = 2\varepsilon_{0}h \left\{ (L_0 - x(\cos \theta)(1 - (g_0 + x\sin \theta)^{-2}) \cos \theta \right\}$$

$$= 2\varepsilon_{0}h \left\{ (L_0 - x(\cos \theta)(\sin \theta)^2) \frac{\cos \theta}{(g_0 + x\sin \theta)^2} \right\}$$

$$= 2\varepsilon_{0}h \left\{ -L_0 \sin \theta + \frac{x(\cos \theta) - g_0 \cos \theta - x(\cos \theta)\sin \theta}{(g_0 + x\sin \theta)^2} \right\}$$

Binomial Theorem

Find $k_e$:

Get the force equation, then pull out the $90^\circ$ phase shifted term (which corresponds to $k_e$)

$$F_d = \frac{1}{2}(V_d - V_p)^2 \frac{AC}{ax} = \frac{1}{2}(V_d^2 - 2V_dV_p + V_p^2) \left( \frac{C_{eff}}{g_0} \right) (1 - 2\sin \theta \frac{x}{g_0})$$

$$= \frac{1}{2} \left( -\frac{C_{eff}}{g_0} \right) (V_d^2 - 2V_dV_p + V_p^2) \frac{A_x}{V_d - V_p \left( A_x - V_p \frac{A_x}{2} \right)}$$

Taking only terms @ resonance:

$$F_d = \frac{V_p \frac{C_{eff}}{g_0} N_x + \frac{1}{2} \frac{C_{eff}}{g_0} V_p^2 A_x}{N_x} \frac{k_e}{N_x}$$

$$V_p = \frac{C_{eff} \frac{V_p^2}{g_0} A_x}{N_x} \frac{k_e}{N_x}$$
\[ k_e = V_p^2 \frac{2 \epsilon_0 h (L_0 \sin \theta + g \cos \theta)}{g_0^2} \sin \theta \]