# Charged Bead Moving Along Axis of Charged Ring

Consider a negatively charged bead (mass $m$, charge $-q$) constrained to move without friction along the axis of a positively charged ring.

- Place bead on $x$-axis near center of ring: $|x| \ll a: \; E_x \simeq \dfrac{kQx}{a^3}$
- Restoring force: $F = -qE_x = -k_s x$ with $k_s = \dfrac{kQq}{a^3}$
- Acceleration: $a = \dfrac{F}{m} = -\dfrac{k_s}{m}\, x$
- Equation of motion: $\dfrac{d^2x}{dt^2} = -\dfrac{k_s}{m}\, x$
- Harmonic oscillation: $x(t) = A\cos(\omega t + \phi)$
- Angular frequency: $\omega = \sqrt{\dfrac{k_s}{m}} = \sqrt{\dfrac{kQq}{ma^3}}$