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: $|x| \ll a$\:\:\,: $E_x \simeq \frac{kQx}{a^3}$

- Restoring force: $F = -qE_x = -k_s x$ with $k_s = \frac{kQq}{a^3}$

- Acceleration: $a = \frac{F}{m} = -\frac{k_s}{m} x$

- Equation of motion: $\frac{d^2x}{dt^2} = -\frac{k_s}{m} x$

- Harmonic oscillation: $x(t) = A \cos(\omega t + \phi)$

- Angular frequency: $\omega = \sqrt{\frac{k_s}{m}} = \sqrt{\frac{kQq}{ma^3}}$