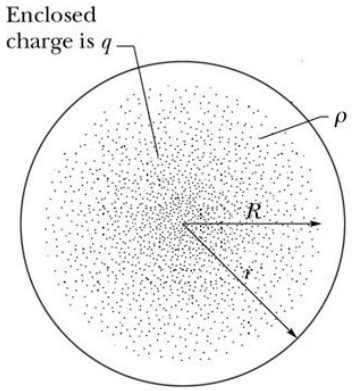
Answer on Question #62055-Physics-Electromagnetism

Explain with the help of diagrams what spherically and cylindrically symmetric charge distributions are. What is the electric field at a point inside a hollow metallic sphere of radius R having volume charge density ρ?

Solution

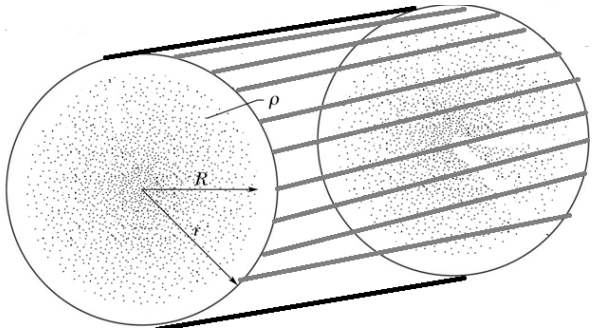
Spherically symmetric charge distribution is distribution for which the charge density depends only on distance from some point:

$$\rho_V = f(r).$$



Cylindrically symmetric charge distribution is distribution for which the charge density depends only on cylindrical coordinate r:

$$\rho_V = f(r).$$



The electric field at a distance r from the center of the sphere:

$$E_r = \frac{kQ_{inside}}{R^3} r$$

$$Q_{inside} = \rho V_{inside} = \frac{4}{3}\pi r^3 \rho.$$

$$E_r = \frac{k\left(\frac{4}{3}\pi r^3 \rho\right)}{R^3} r = \frac{\rho r^4}{3\epsilon_0 R^3}.$$

Where we used $k = \frac{1}{4\pi\epsilon_0}$.