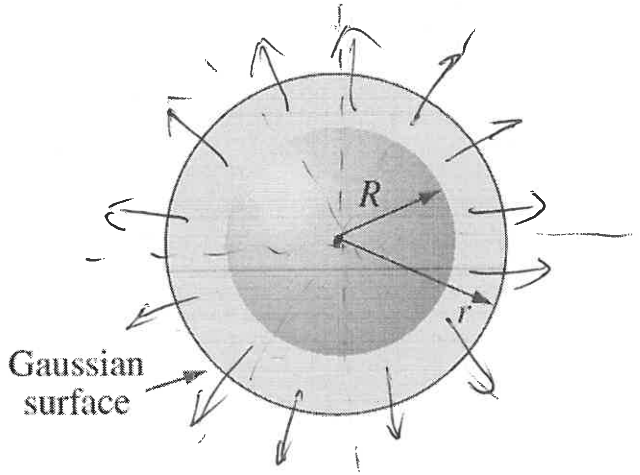
Example 2.3. Find the field outside a uniformly charged solid sphere of radius R and total charge q.



rotational symmetry about any axis passing the origin.

$\Rightarrow \vec{E} = E\hat{r}$

Gauss's law

$\oint \vec{E} \cdot d\vec{a} = \frac{1}{\varepsilon_0} Q_{enc}$ $\qquad Q_{enc} = q$

$\oint \vec{E} \cdot d\vec{a}$ $\qquad d\vec{a} = \hat{r}\, d\theta\, d\phi = r^2 \sin\theta\, d\theta\, d\phi\, \hat{r}$

$= \oint E\hat{r} \cdot \hat{r}\, da = E \oint da = E \int_0^{2\pi}\int_0^{\pi} r^2 \sin\theta\, d\theta\, d\phi = E\, 4\pi r^2 = \frac{q}{\varepsilon_0}$

$\Rightarrow E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} \Rightarrow \vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r}$