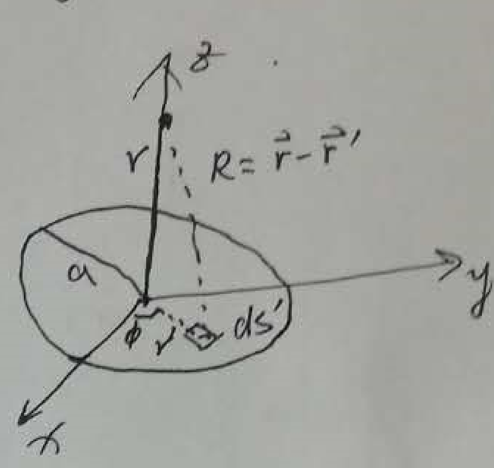
2.3. Find the $\vec{E}$ on the axis of uniformly charged disc. Disk radius is a, surface charge density is ρ_s.



$$d\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{\vec{r}-\vec{r}'}{|\vec{r}-\vec{r}'|^3}\rho_s ds'$$

$\vec{r}=z\vec{e_z}$, $\vec{r}'=r'\cos\phi\,\vec{e_x}+r'\sin\phi\,\vec{e_y}$

$|\vec{r}-\vec{r}'|=(z^2+r'^2)^{1/2}$ $ds'=r'dr'd\phi$

代入积分

$$\vec{E}=\frac{\rho_s}{4\pi\varepsilon_0}\int_0^{2\pi}\int_0^{a}\frac{z\vec{e_z}-r'\cos\phi\vec{e_x}-r'\sin\phi\vec{e_y}}{(z^2+r'^2)^{3/2}}r'dr'd\phi$$

$$=\vec{e_z}\frac{\rho_s}{2\varepsilon_0}\left(1-\frac{z}{\sqrt{a^2+z^2}}\right)\quad z>0$$

2.6. A cylinder whose radius is a, and its length is infinity, and surface charge density ρ_s is uniformly distributed on the surface of the cylindrical. Find $\vec{E}$ inside and outside the cylinder.

Gauss Laws:

$r<a$ $\oint\vec{E}\cdot d\vec{s}=\oint E_r ds=E_r\cdot 2\pi r\cdot\Delta l=0\Rightarrow E_r=0$.

$r\geq a$ $\oint\vec{E}\cdot d\vec{s}=E_r 2\pi r\Delta l=\frac{\rho_s 2\pi a\times\Delta l}{\varepsilon_0}\Rightarrow E_r=\frac{\rho_s a}{\varepsilon_0 r}$.

2.7 There is a sphere whose electric charge volume density is ρ (radius is a), the permittivity both inside and outside the sphere are ε_0. Find $\vec{E}$ inside and outside the sphere

$r<a$, $\oint\vec{E}\cdot d\vec{s}=\frac{Q}{\varepsilon_0}\Rightarrow 4\pi r^2\cdot E_r=\frac{1}{\varepsilon_0}\rho\cdot\frac{4}{3}\pi r^3\Rightarrow E_r=\frac{\rho r}{3\varepsilon_0}$

$r>a$. $4\pi r^2 E_r=\frac{1}{\varepsilon_0}\rho\frac{4}{3}\pi a^3\Rightarrow E_r=\frac{\rho a^3}{3\varepsilon_0 r^2}$