Continuous Charge Distributions

$\vec{F} = \int k\frac{dq\,q_0}{r^2}\hat{r}$ $\vec{E} = \int k\frac{dq}{r^2}\hat{r}$

- Define a coordinate system.
- Select random position along charge distribution for dq.
  - dx (or $Rd\phi$) is differential length along charge distribution.
  - $dq = \lambda dx$ (or $dq = \lambda Rd\phi$)
  - $\lambda = \frac{Q}{L}$ (or $\lambda = \frac{Q}{R\Delta\theta}$, $\Delta\theta$ in radians)

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- Define a coordinate system.
- Select random position for dq.
- $\vec{r}$ goes from dq to position where $\vec{E}$ or $\vec{F}$ is to be determined. (If finding force on distribution, $\vec{r}$ goes from other charge to dq.)
  - $r = \sqrt{r_x^2 + r_y^2}$
  - $\hat{r} = \frac{\vec{r}}{r} = \frac{r_x}{\sqrt{r_x^2+r_y^2}}\hat{\imath} + \frac{r_y}{\sqrt{r_x^2+r_y^2}}\hat{\jmath}$

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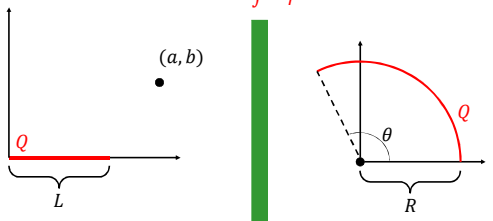
- Integrate along charge distribution
  - Limits are the endpoints of the charge distribution.

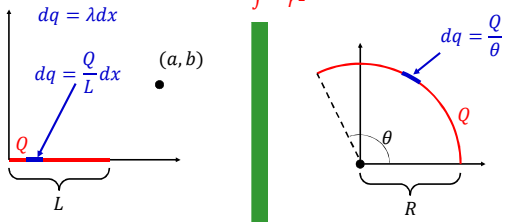
$$\vec{E} = \int d\frac{dq}{r^2}\hat{r}$$



$$\vec{E} = \int d\frac{dq}{r^2}\hat{r}$$

$dq = \lambda dx$

$dq = \frac{Q}{L}dx$



$dq = \lambda R d\phi$

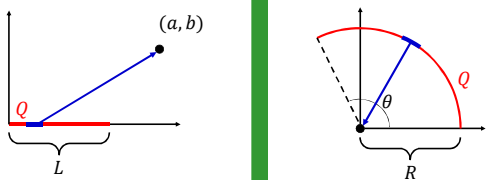
$dq = \frac{Q}{\theta}d\phi$

(θ in radians)

$$\vec{E} = \int d\frac{dq}{r^2}\hat{r}$$

$\vec{r} = (a - x)\hat{\imath} + b\hat{\jmath}$

$r = \sqrt{(a-x)^2 + b^2}$



$\hat{r} = \frac{(a - x)\hat{\imath} + b\hat{\jmath}}{\sqrt{(a-x)^2 + b^2}}$

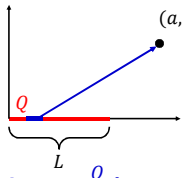
$\vec{r} = -R\cos\phi\,\hat{\imath} - R\sin\phi\,\hat{\jmath}$

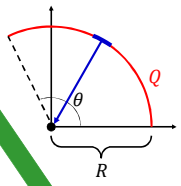
$r = R$

$\hat{r} = -\cos\phi\,\hat{\imath} - \sin\phi\,\hat{\jmath}$

$$\vec{E} = \int d\frac{dq}{r^2}\hat{r}$$

$$\vec{E} = \int_0^{\theta} k\frac{\frac{Q}{\theta}d\phi}{R^2}(-\cos\phi\,\hat{\imath} - \sin\phi\,\hat{\jmath})$$





$$\vec{E} = \int_0^{L} k\frac{\frac{Q}{L}dx}{[(a-x)^2 + b^2]^{3/2}}[(a-x)\hat{\imath} + b\hat{\jmath}]$$