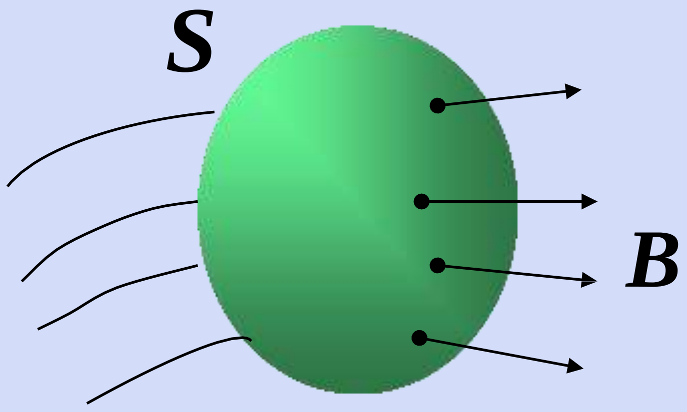
复习:磁场的基本性质与计算

一、磁场的基本性质

1、磁场的 定理

$$\oiint_S \vec{B} \bullet d\vec{s}$$

穿过任意闭曲面的磁通量等于零



$\boxed{\text{磁场是无源场}}$

二、磁场的计算

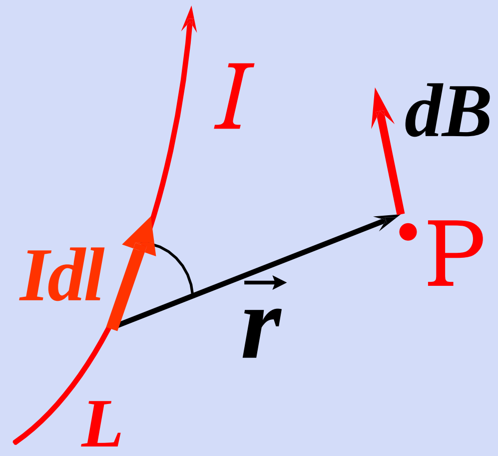
1、叠加法计算磁感强度—— --沙伐尔定律

电流元产生的磁感:

$$d\vec{B} = \frac{\mu_0}{\ } \quad Idl$$

一条载流导线产生的磁感:

$$\vec{B} = \int_L d\vec{B} = \int_L \frac{\mu_0}{4\pi} \frac{Idl \times \vec{r}}{r^3}$$



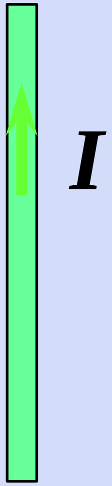
•载流直导线

$$\boxed{B=\frac{\mu_0 I}{4\pi a}(\cos\ {}_1-\cos\ {}_2)}$$

•无限长载流直导线

${}_1=0\qquad {}_2=\pi$

$$\boxed{B=\frac{\mu_0 I}{2\pi a}}$$



•半无限长载流直导线

${}_1=\pi/2\qquad {}_2=\pi$

$$\boxed{B=\frac{\mu_0 I}{4\pi a}}$$

直导线延长线上

$$\boxed{B=0}$$

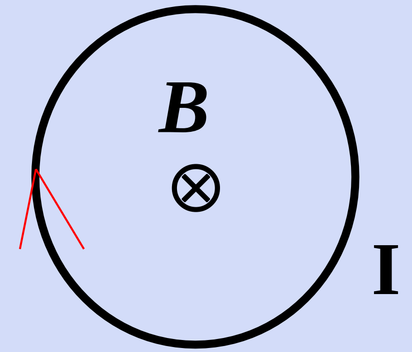
${}_1={}_2=0$

圆电流轴线上：

$$B = \frac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$$

圆心处：

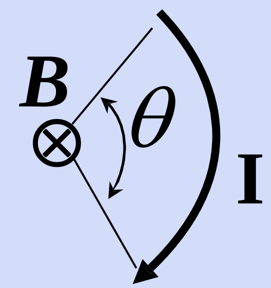
$$\boxed{\therefore B = \mu}$$



载流圆弧： 圆心角 θ

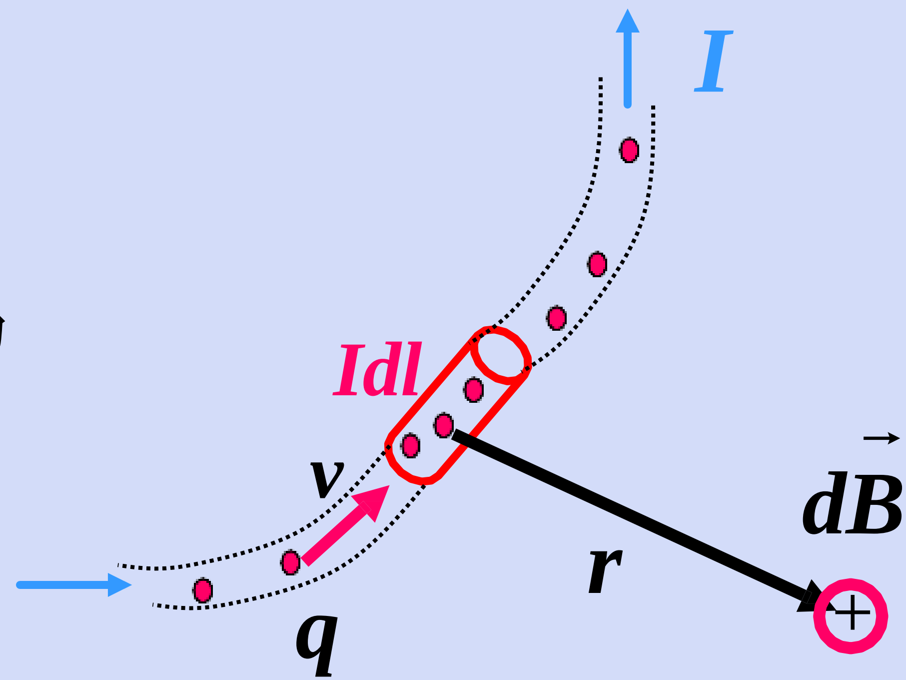
$$\therefore B = \mu_0 I$$

$$\boxed{\therefore B = \frac{\mu_0 I \theta}{4\pi R}}$$



三、运动电荷产生的磁场

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l} \times \vec{r}}{r^3}$$

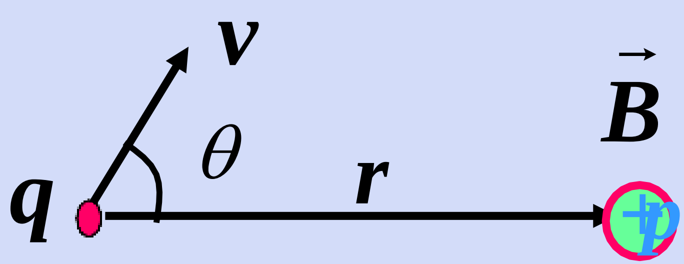


1、一个运动电荷产生的磁场

$$\vec{B}_0 = \frac{\mu_0}{\quad} q\vec{v}$$

大小：$B_0 = \dfrac{\mu_0}{4\pi}\dfrac{|q|vr\sin\theta}{r^3}$

方向：由 $q\vec{v} \times \vec{r}$ 决 定

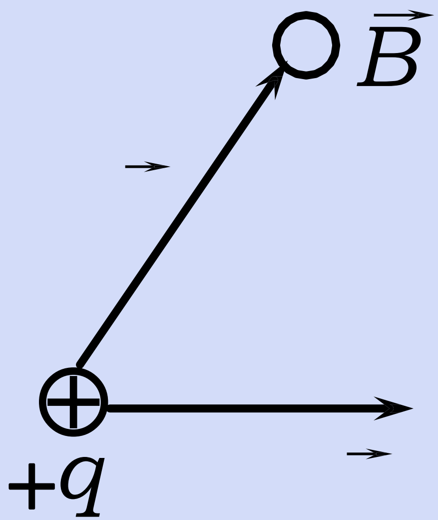


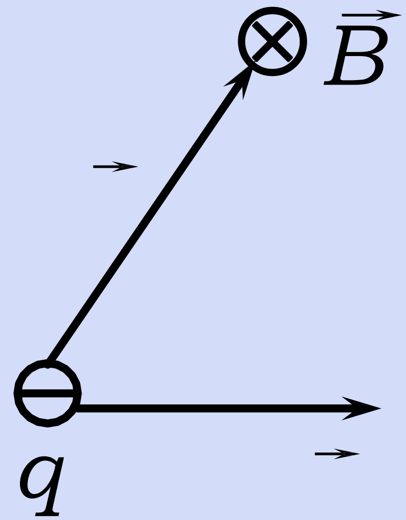
一个以速度 $\vec{v}$ 运动的电荷, 在距它r 处所激励的磁感应强度为：

$$\vec{B}=\frac{\mu_0}{4\pi}\frac{q\vec{v}\times\vec{r}}{r^3}$$

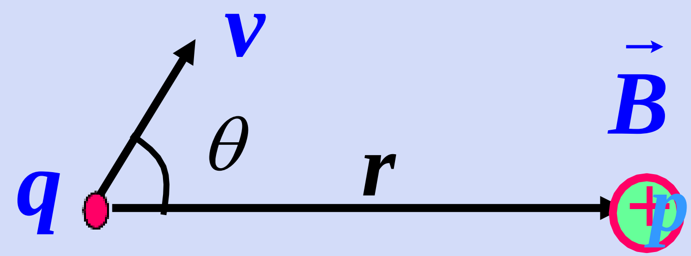
若$q>0$**,** $\vec{B}$**与**$\vec{v}\times\vec{r}$**同向。**

若$q<0$**,** $\vec{B}$**与**$\vec{v}\times\vec{r}$**反向。**

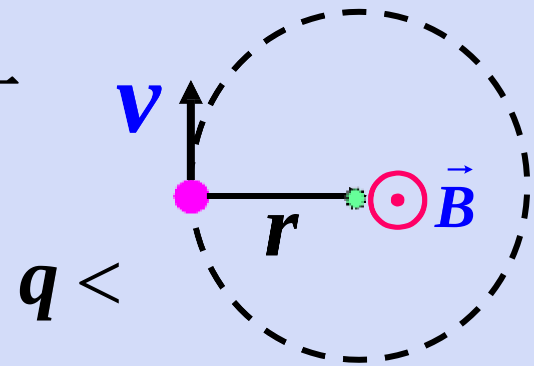




$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\vec{r}_0}{r^2}$$



例题：考虑氢原子中的电子处于第一玻尔轨道时在原子核处产生的磁感。



$$q = e = 1.6\times10^{-19}C$$

$$r = 0.53\times10^{-10}m$$

$$v = 2.18\times10^{6}m/s$$

$$\vec{v}\perp\vec{r}$$

$$\because v\perp r, \therefore \sin\theta = 1$$

$$B_0 = \frac{\mu_0}{\quad} q v s$$

$$\therefore B_0 = \frac{\mu_0}{4\pi}\frac{ev}{r^2} = 12.4T$$

方向：垂直向外