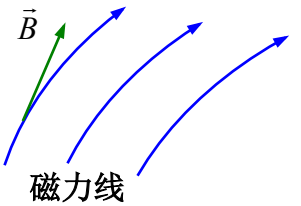
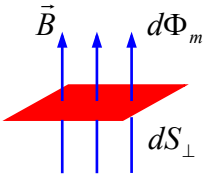
11—3 磁通量　磁高斯定理

一、磁力线

$B=\dfrac{d\Phi_m}{dS_\perp}$

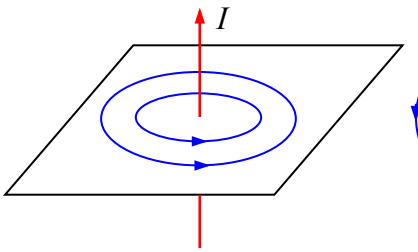
B 等于通过和磁场相垂直的单位面积上的磁力线条数

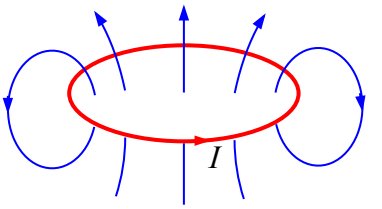




性质：

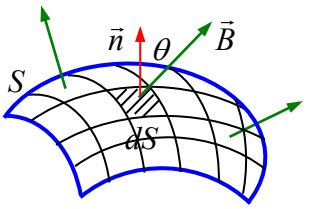
“磁力线都是闭合曲线，并与电流相互套合，
磁力线的回绕方向与电流方向满足右手定则。”





二、磁通量

穿过曲面 S 的磁力线条数 Φ_m：磁通量（标量）



$d\Phi_m=BdS_\perp=BdS\cos\theta=B_ndS$

$d\Phi_m=\vec{B}\cdot d\vec{S}$

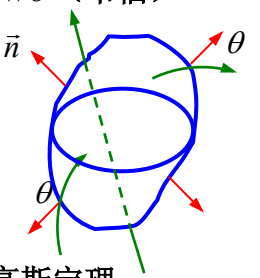
$\Phi_m=\int d\Phi_m=\int_S\vec{B}\cdot d\vec{S}$　　**SI**：$Tm^2=Wb$（韦伯）

三、磁高斯定理

闭合曲面：

$\Phi_m=\oint_S\vec{B}\cdot d\vec{S}$

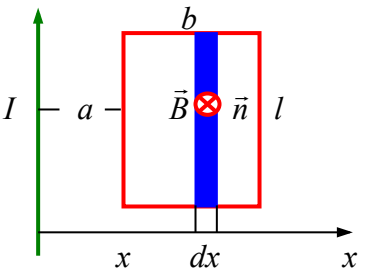
取闭合曲面的外法线方向为正法线方向



$$\boxed{\oint_S\vec{B}\cdot d\vec{S}=0}$$ —— 磁高斯定理

磁场是无源场

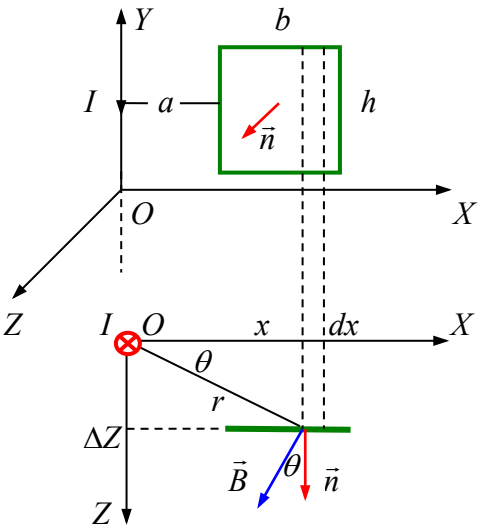
例：求 Φ_m



解：$d\Phi_m=\vec{B}\cdot d\vec{S}=B\cos\theta dS=\dfrac{\mu_0 I}{2\pi x}ldx$

$\Phi_m=\int d\Phi_m=\int_a^{a+b}\dfrac{\mu_0 I}{2\pi x}ldx=\dfrac{\mu_0 Il}{2\pi}\ln\dfrac{a+b}{a}$

例：求Φ_m

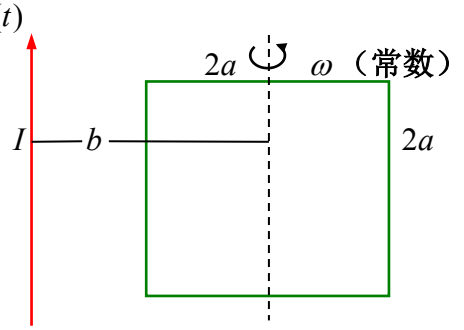


解：$d\Phi_m = \vec{B}\cdot d\vec{S} = B\cos\theta dS = \dfrac{\mu_0 I}{2\pi r}\dfrac{x}{r}hdx = \dfrac{\mu_0 Ih}{2\pi}\dfrac{xdx}{x^2+(\Delta Z)^2}$

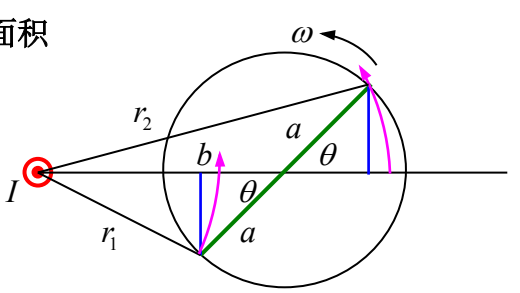
$$\Phi_m = \int d\Phi_m = \int_a^{a+b}\frac{\mu_0 Ih}{2\pi}\frac{xdx}{x^2+(\Delta Z)^2}$$

$$= \frac{\mu_0 Ih}{4\pi}\ln[x^2+(\Delta Z)^2]\Big|_a^{a+b} = \frac{\mu_0 Ih}{4\pi}\ln\frac{(a+b)^2+(\Delta Z)^2}{a^2+(\Delta Z)^2}$$

例：求$\Phi_m(t)$



解：等效面积



$\theta = \omega t$， $\Phi_m(t) = \dfrac{\mu_0 I}{2\pi}2a\ln\dfrac{r_2}{r_1}$

$r_2^2 = a^2+b^2+2ab\cos\omega t$， $r_1^2 = a^2+b^2-2ab\cos\omega t$

$$\Phi_m(t) = \frac{\mu_0 Ia}{2\pi}\ln\frac{a^2+b^2+2ab\cos\omega t}{a^2+b^2-2ab\cos\omega t}$$