物理公式

PHYSICAL FORMULA

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刚体

力矩$\boldsymbol{M}=\boldsymbol{r}\times\boldsymbol{F}$

$M=J\alpha$

转动惯量$J=\int r^2\mathrm{d}m$

平行轴定理$J=J_c+md^2$

角动量$\boldsymbol{L}=\boldsymbol{r}\times\boldsymbol{p}=m\boldsymbol{r}\times\boldsymbol{v}$

$$\boldsymbol{M}=\frac{\mathrm{d}\boldsymbol{L}}{\mathrm{dt}}$$

角动量守恒$\boldsymbol{L}=J\boldsymbol{\omega}=const$

功$W=\int M\mathrm{d}\theta$

转动动能$E_k=\frac{1}{2}J\omega^2$

相对论

$$\beta=\frac{v}{c}\qquad\gamma=\frac{1}{\sqrt{1-\beta^2}}$$

$$\begin{cases}x'=\gamma(x-vt)\\ y'=y\\ z'=z\\ t'=\gamma\left(t-\frac{vx}{c^2}\right)\end{cases}$$

$$\begin{cases}x=\gamma(x'+vt')\\ y=y'\\ z=z'\\ t=\gamma\left(t'+\dfrac{vx'}{c^2}\right)\end{cases}$$

$$\begin{cases}u_x'=\dfrac{u_x-v}{1-\frac{v}{c^2}u_x}\\ u_y'=\dfrac{u_y}{\gamma\left(1-\frac{v}{c^2}u_x\right)}\\ u_z'=\dfrac{u_z}{\gamma\left(1-\frac{v}{c^2}u_x\right)}\end{cases}$$

$$\begin{cases}u_x=\dfrac{u_x'+v}{1+\frac{v}{c^2}u_x'}\\ u_y=\dfrac{u_y'}{\gamma\left(1+\frac{v}{c^2}u_x'\right)}\\ u_z=\dfrac{u_z'}{\gamma\left(1+\frac{v}{c^2}u_x'\right)}\end{cases}$$

$l=l_0\sqrt{1-\beta^2}$

$\Delta t=\gamma\Delta t_0$

$\boldsymbol{p}=\gamma m_0\boldsymbol{v}$

$m=\gamma m_0$

$E_k=mc^2-m_0c^2$

$E^2-E_0^2=p^2c^2$

静电场

库仑定律$\boldsymbol{F}=\frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}\boldsymbol{e_r}$

电场强度$\boldsymbol{E}=\frac{\boldsymbol{F}}{q_0}=\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\boldsymbol{e_r}$

高斯定理$\boldsymbol{\Phi_e}=\oint_S\boldsymbol{E}\cdot\mathrm{d}\boldsymbol{S}=\frac{q}{\varepsilon_0}$

静电场环路定理$\oint_l \boldsymbol{E}\cdot \mathrm{d}\boldsymbol{l}=0$

电势能$q_0\int_{AB}\boldsymbol{E}\cdot \mathrm{d}\boldsymbol{l}=E_{pA}-E_{pB}$

电势$V_A=-\int_{\infty A}\boldsymbol{E}\cdot \mathrm{d}\boldsymbol{l}$

电势差$U_{AB}=V_A-V_b$

$$=\int_{AB}\boldsymbol{E}\cdot \mathrm{d}\boldsymbol{l}$$

电场力做功$W_{AB}=qU_{AB}$

$$V=\frac{q}{4\pi\varepsilon_0}\frac{1}{r}$$

$$\boldsymbol{E}=-\left(\frac{\partial V}{\partial x}\boldsymbol{i}+\frac{\partial V}{\partial y}\boldsymbol{j}+\frac{\partial V}{\partial z}\boldsymbol{k}\right)$$

$$=-\frac{\mathrm{d}V}{\mathrm{d}l_n}\boldsymbol{e_n}=-\boldsymbol{\nabla V}$$

$$E=\frac{E_0}{\varepsilon_r}$$

电容率$\varepsilon_0\varepsilon_r=\varepsilon$

点极化强度$\boldsymbol{P}=\frac{\Sigma \boldsymbol{p}}{\Delta V}=\sigma'$

$$=(\varepsilon_r-1)\varepsilon_0\boldsymbol{E}=\chi_e\varepsilon_0\boldsymbol{E}$$

高斯定理$\oint_S \boldsymbol{D}\cdot \mathrm{d}\boldsymbol{S}=\sum_{i=1}^{n}Q_{0i}$

$$\boldsymbol{D}=\boldsymbol{P}+\varepsilon_0\boldsymbol{E}$$

电容$C=\frac{Q}{U}$

并联$C=C_1+C_2$

串联$\frac{1}{C}=\frac{1}{C_1}+\frac{1}{C_2}$

电能$W=\frac{1}{2}QU$

电场能量$w_e=\frac{1}{2}\varepsilon E^2$

恒定磁场

$$I=\frac{\mathrm{d}q}{\mathrm{d}t}$$

电流密度$j=\frac{\Delta Q}{\Delta t\Delta S\cos\alpha}=\frac{\Delta I}{\Delta S\cos\alpha}$

$$\oint_S \boldsymbol{j}\cdot \mathrm{d}\boldsymbol{S}=-\frac{\mathrm{d}Q_i}{\mathrm{d}t}$$

欧姆定律$\boldsymbol{j}=\frac{\boldsymbol{E}}{\rho}$

电动势$\mathcal{E}=\oint_l \boldsymbol{E}_k\cdot \mathrm{d}\boldsymbol{l}=\int_{内}\boldsymbol{E}_k\cdot \mathrm{d}\boldsymbol{l}$

$$\boldsymbol{F}=q\boldsymbol{v}\times\boldsymbol{B}$$

毕-萨$\mathrm{d}\boldsymbol{B}=\frac{\mu_0}{4\pi}\frac{I\mathrm{d}\boldsymbol{l}\times\boldsymbol{e_r}}{r^2}=\frac{\mu_0}{4\pi}\frac{I\mathrm{d}\boldsymbol{l}\times\boldsymbol{r}}{r^3}$

无限长直导线$B=\frac{\mu_0 I}{2\pi R}$

圆环$B=\frac{\mu_0 I}{2R}$

无限长螺线管$B=\mu_0 nI$

磁矩$\boldsymbol{m}=IS\boldsymbol{e_n}$

$$\phi=\boldsymbol{B}\cdot\boldsymbol{S}$$

磁场高斯$\oint_S \boldsymbol{B}\cdot \mathrm{d}\boldsymbol{S}=0$

安培环路$\oint_l \boldsymbol{B}\cdot \mathrm{d}\boldsymbol{l}=\mu_0\sum_{i=1}^{n}I_i$

带电粒子受力$\boldsymbol{F_m}=q\boldsymbol{v}\times\boldsymbol{B}$

载流导线受力$\boldsymbol{F}=\int_l I\mathrm{d}\boldsymbol{l}\times\boldsymbol{B}$

磁力矩$\boldsymbol{M}=IS\boldsymbol{e_n}\times\boldsymbol{B}=\boldsymbol{m}\times\boldsymbol{B}$

N匝线圈磁力矩$\boldsymbol{M}=NIS\boldsymbol{e_n}\times\boldsymbol{B}$

磁化强度$\boldsymbol{M}=\frac{\sum\boldsymbol{m}_i}{\Delta V}=\chi_m\boldsymbol{H}$

磁场强度$\boldsymbol{H}=\frac{\boldsymbol{B}}{\mu_0}-\boldsymbol{M}$

磁介质中的安培环路$\oint_l \boldsymbol{H}\cdot \mathrm{d}\boldsymbol{l}=I$

$\boldsymbol{B}=\mu_0\mu_r\boldsymbol{H}$

磁化电流$I=M\cdot 2\pi r$

感生电动势$E=-\frac{\mathrm{d}\Phi}{\mathrm{d}t}$

动生电动势$E=\int_l(\boldsymbol{v}\times\boldsymbol{B})\cdot \mathrm{d}\boldsymbol{l}$

自感$\Phi=LI$

$$E_L=-L\frac{\mathrm{d}I}{\mathrm{d}t}$$

互感$\Phi_{21}=MI_1$

$$E_{21}=-M\frac{\mathrm{d}I_2}{\mathrm{d}t}$$

磁场能量$W_m=\frac{1}{2}LI^2=\frac{1}{2}\frac{B^2}{\mu}V$

磁场能量密度$\omega_m=\frac{W_m}{V}=\frac{1}{2}\frac{B^2}{\mu}$

$$=\frac{1}{2}\mu H^2=\frac{1}{2}BH$$

光速$c=\frac{1}{(\mu_0\varepsilon_0)^{1/2}}$

极板内传导电流$I_c=S\frac{d\sigma}{dt}$

位移电流密度$\boldsymbol{j}_d=\frac{\partial \boldsymbol{D}}{\partial t}$

位移电流$I_d=\frac{\mathrm{d}\Psi}{\mathrm{d}t}$

全电流$\boldsymbol{I_s}=\boldsymbol{I_c}+\boldsymbol{I_d}$

电磁场基本方程

$$\oint_S \boldsymbol{D}\cdot \mathrm{d}\boldsymbol{S}=\int_V \rho \mathrm{d}V=q$$

$$\oint_l \boldsymbol{E}\cdot \mathrm{d}\boldsymbol{l}=-\int_S\frac{\partial \boldsymbol{B}}{\partial t}\cdot \mathrm{d}\boldsymbol{S}$$

$$\oint_S \boldsymbol{B}\cdot \mathrm{d}\boldsymbol{S}=0$$

$$\oint_L \boldsymbol{H}\cdot \mathrm{d}\boldsymbol{l}=\int_S\left(\boldsymbol{j}_c+\frac{\partial \boldsymbol{D}}{\partial t}\right)\cdot \mathrm{d}\boldsymbol{S}$$

振动

$F=-kx$

$a=-\omega^2x$

$x=a\cos(\omega t+\varphi)$

$$T=2\pi\sqrt{\frac{m}{k}}$$

$$A=\sqrt{x_0^2+\frac{v_0^2}{\omega^2}}$$

$$\tan\varphi=\frac{-v_0}{\omega x_0}$$

单摆

$$\frac{\mathrm{d}^2\theta}{\mathrm{d}t^2}=-\frac{g}{l}\theta$$

$$\omega=\frac{g}{l}$$

$$T=2\pi\sqrt{\frac{l}{g}}$$

动能$E_k=\frac{1}{2}m\omega^2A^2\sin^2(\omega t+\varphi)$

势能$E_p=\frac{1}{2}kA^2\cos^2(\omega t+\varphi)$

$$E=\frac{1}{2}kA^2$$

简谐运动合成

$$A=\sqrt{A_1^2+A_2^2+2A_1A_2\cos(\varphi_1+\varphi_2)}$$

$$\tan\varphi=\frac{A_1\sin\varphi_1+A_2\sin\varphi_2}{A_1\cos\varphi_1+A_2\cos\varphi_2}$$

波动

$$u=\frac{\lambda}{T}=\lambda v$$

$=\sqrt{\frac{G}{\rho}}$(横波，G为切变模量)

$=\sqrt{\frac{E}{\rho}}$(纵波，E为弹性模量)

$=\sqrt{\frac{K}{\rho}}$(纵波，K为体积模量)

$$y_p=A\cos\omega\left(t-\frac{x}{u}\right)$$

$$y=A\cos 2\pi\left(\frac{t}{T}-\frac{x}{\lambda}\right)$$

$$=A\cos(\omega t-kx)$$

$$\Delta\varphi=\frac{2\pi}{\lambda}\Delta x$$

$$\mathrm{d}W=(\rho\mathrm{d}V)A^2\omega^2\sin^2\omega\left(t-\frac{x}{u}\right)$$

能量密度$w=\frac{\mathrm{d}W}{\mathrm{d}V}$

$$=\rho A^2\omega^2\sin^2\omega\left(t-\frac{x}{u}\right)$$

平均能量密度$\overline{w}=\frac{1}{2}\rho A^2\omega^2$

能流$P=wuS$

平均能流$\overline{P}=\overline{w}uS$

能流密度$I=\frac{\overline{P}}{S}=\overline{w}u$

$$=\frac{1}{2}\rho A^2\omega^2u$$

合振幅最大$\delta=\pm k\lambda$

合振幅最小$\delta=\pm(2k+1)\frac{\lambda}{2}$

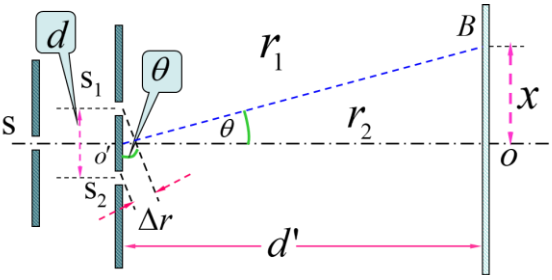
驻波$y=2A\cos 2\pi\frac{x}{\lambda}\cos 2\pi vt$

多普勒效应$v'=\frac{u\pm v_0}{u\mp v_s}v$

观察者向着波源运动v_0取正

波源向着观察者运动v_s取负

光学



波程差$\Delta=d\sin\theta=d\frac{x}{d'}$

$$\Delta = \begin{cases} \pm k\lambda & \text{加强} \\ \pm \dfrac{(2k+1)\lambda}{2} & \text{减弱} \end{cases}$$

条纹级次

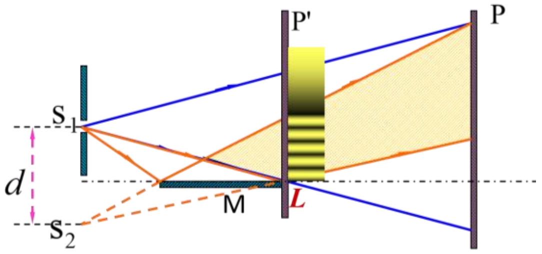
$$x = \begin{cases} \pm k\lambda \dfrac{d'}{d} & k = 0,1,2,\cdots \\ \pm (2k-1)\lambda \dfrac{d'}{2d} & k = 1,2,\cdots \end{cases}$$

复色光入射$x = k_1\lambda_1 \frac{d'}{d} = k_2\lambda_2 \frac{d'}{d}$

光强$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\Delta\phi$

非相干光源$I = I_1 + I_2$

劳埃德镜



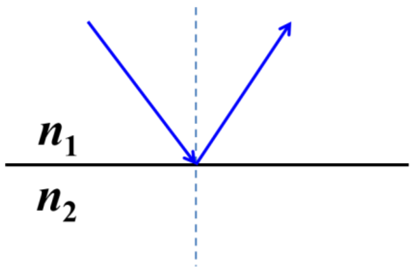
$$\Delta = r_2 - r_1 \pm \frac{\lambda}{2}$$

$$= \begin{cases} k\lambda & \text{加强} \\ (2k+1)\lambda/2 & \text{减弱} \end{cases}$$

光程$L = nl$

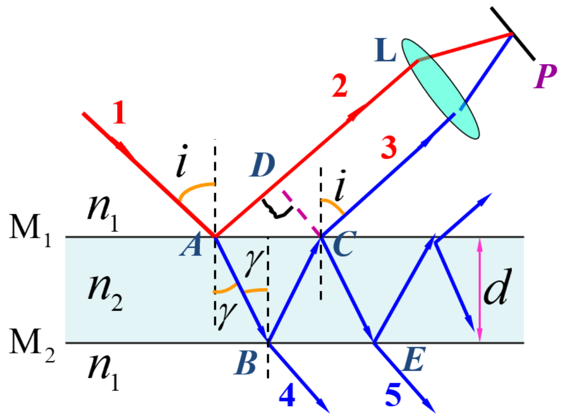
相位差$\Delta\varphi = \frac{2\pi}{\lambda}\Delta$

半波损失



$n_1 < n_2$有半波损失

薄膜干涉

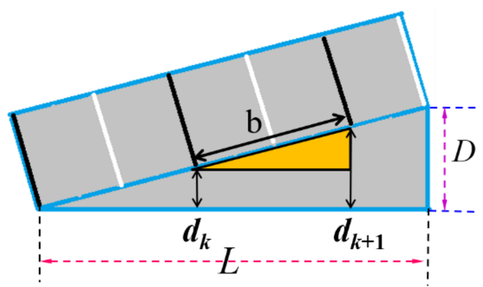


$$\frac{\sin i}{\sin\gamma} = \frac{n_2}{n_1}$$

等倾干涉：入射角相同的光线对应同一级条纹

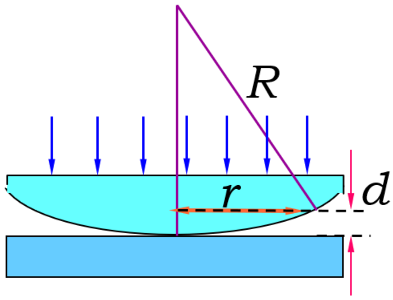
等厚干涉：膜上厚度相同的位置对应同一级条纹

劈尖干涉

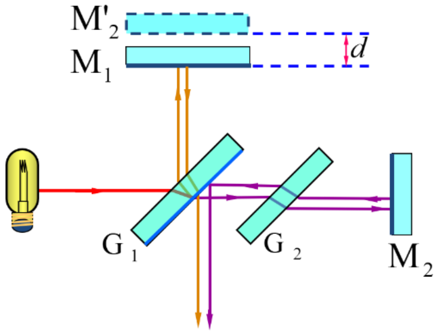


$$d = \frac{\lambda}{2nb}L$$

牛顿环



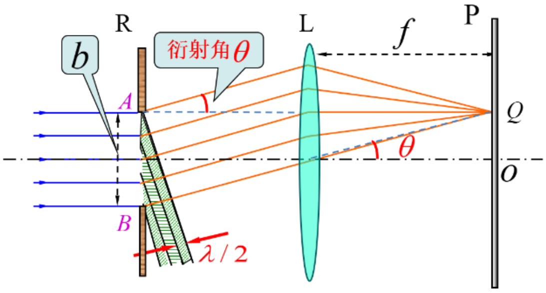
迈克尔逊干涉仪



移动反射镜 $\Delta d = \Delta k \frac{\lambda}{2}$

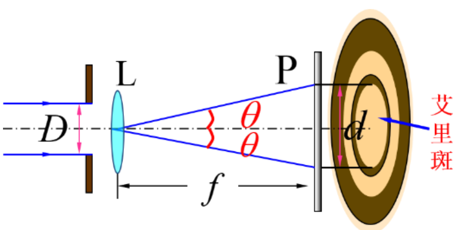
插入介质片 $2(n-1)t = \Delta k$

夫琅禾费衍射



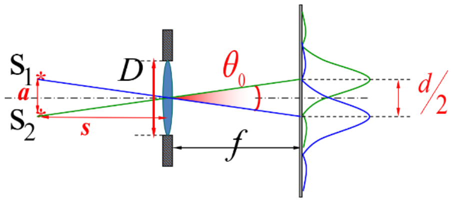
光强 $I_\theta = I_m \left(\frac{\sin\alpha}{\alpha}\right)^2, \alpha = \frac{\pi b \sin\theta}{\lambda}$

除中央明纹外宽度 $\Delta x = \frac{\lambda}{b} f$



$$\theta = \frac{d/2}{f} = 1.22\frac{\lambda}{D}$$

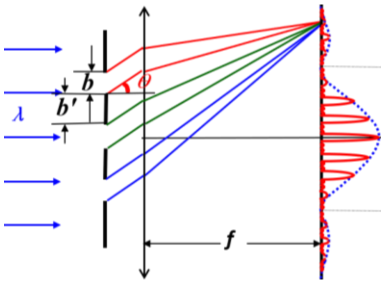
光学仪器分辨本领



最小分辨角 $\theta_0 = 1.22\frac{\lambda}{D} = \frac{a}{s}$

分辨率 $= \frac{1}{\theta_0} = \frac{D}{1.22\lambda}$

衍射光栅



光栅常数 $d = b + b'$

明纹 $d\sin\theta = \pm k\lambda$

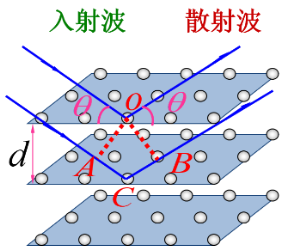
暗纹 $d\sin\theta = \pm\frac{k'}{N}\lambda, k' \neq Nk$

光强 $I' = N^2 I$

缺级 $\frac{b}{d} = \frac{k'}{k}$ 为整数比

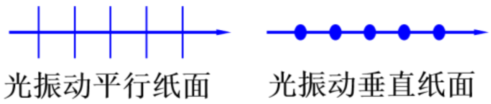
条纹最高级数 $|k_{max}| < \frac{b+b'}{\lambda}$

布拉格公式

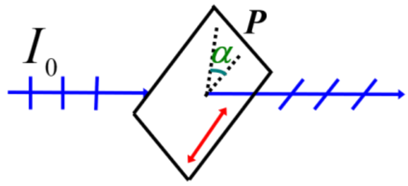


$2d \sin\theta = k\lambda$

偏振光

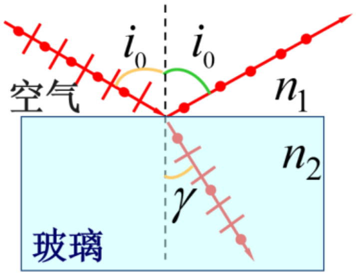


马吕斯定律



$I = I_0 \cos^2 \alpha$

布儒斯特定律



当$\tan i_0 = \frac{n_2}{n_1}$时，反射光为完全偏振光，且振动面垂直入射面，折射光为部分偏振光