$\frac{\partial\psi}{\partial t}=\mp v\frac{\partial\psi}{\partial x}$, $E=hf=\hbar\omega$, $E=hf=\frac{hc}{\lambda}=hc\kappa$,, 波数$\kappa\equiv\frac{1}{\lambda}$,行波平面波函数 $\psi(\vec r)=Ae^{i(\vec k\cdot\vec r\mp\omega t)}$.波速:$\frac{dr_k}{dt}=\pm\frac{\omega}{k}=\pm v$, $\nabla^2\psi=\frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2}$

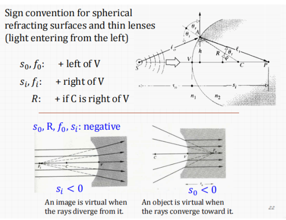
球坐标求导$\nabla^2=\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial}{\partial r}\right)+\frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial}{\partial\theta}\right)+\frac{1}{r^2\sin^2\theta}\frac{\partial^2}{\partial\varphi^2}$球谐波函数$\psi(r,t)=\left(\frac{\mathcal{A}}{r}\right)\cos[k(r\mp vt)]$,$u_{\text{total}}=u_E+u_B=\varepsilon_0E^2=\frac{1}{\mu_0}B^2$, 平行板电容器: $E\cdot S=\frac{\sigma\cdot S}{\varepsilon_0}$, $E=\frac{\sigma}{\varepsilon_0}$, $\mu_E=\frac{1}{2}\varepsilon_0E^2=\frac{\sigma^2}{2\varepsilon_0}$;**脉冲wavetrain的空间长度$l=ct$; 对应能量$\varepsilon=\frac{E}{lS(\text{面积})}=\frac{E}{\pi\frac{d^2}{4}l}$**; $S=\frac{uc\Delta tA}{\Delta tA}=uc=\frac{1}{\mu_0}EB$,$\vec S=\frac{1}{\mu_0}\vec E\times\vec B$,
$\vec S=c^2\epsilon_0\vec E\times\vec B$,$I=\langle S\rangle_T=c^2\varepsilon_0|\vec{E_0}\times\vec{B_0}|\langle\cos^2(\vec k\cdot\vec r-\omega t)\rangle=\frac{c^2\varepsilon_0}{2}|\vec{E_0}\times\vec{B_0}|=\frac{c\varepsilon_0}{2}E_0^2$,**辐射功率:$P=IS$(单位瓦特, 这里的S为截面积)**,电磁球面波径向衰减$E(r,t)=\left(\frac{\mathcal{A}}{r}\right)\cos(kr\mp wt)$光子通量:$\Phi=\frac{AI}{h\nu_0}$.辐射功率$S=uc$,压强$P_r=\frac{S(t)}{c}$,$\langle P_r\rangle=\frac{\langle S(t)\rangle}{c}=\frac{I}{c}$,光压力为$AP_r=\frac{\Delta p}{\Delta t}$($p_v$:momentum per unit volume) $AP_r=\frac{p_vc\Delta tA}{\Delta t}=A\frac{S}{c}$,动量$p_v=\frac{S}{c^2}$,$p=\frac{E}{c}=\frac{h}{\lambda}=\hbar k$.电偶极辐射$\mu=\mu_0\cos\omega t$,$\mu_0=qd$, $E=\frac{\mu_0k^2\sin\theta}{4\pi\varepsilon_0}\frac{\cos(kr-\omega t)}{r}$ Irradiance is : $I(\theta)=\frac{\mu_0^2\omega^4}{32\pi^2c^3\epsilon_0}\frac{\sin^2\theta}{r^2}\Rightarrow$ $I\propto\omega^4$介质中的光速$v=\frac{1}{\sqrt{\epsilon\mu}}$,$n\equiv\frac{c}{v}=\frac{\sqrt{\varepsilon\mu}}{\sqrt{\varepsilon_0\mu_0}}$,非磁性材料中有$\mu\approx\mu_0$相应有$n=\sqrt{\frac{\epsilon}{\epsilon_0}}=K_E\epsilon_0$, $n(\omega)=\sqrt{K_E(\omega)}$ K_E是介电常数(dielectric constant)感生电场:emf$=-\frac{d\Phi}{dt}=\oint_c\vec E d\vec l=-\frac{d}{dt}\iint_A\vec B\cdot d\vec S$,高斯定律$\oiint_A\vec E\cdot d\vec S=\frac{1}{\varepsilon_0}\iiint_V\rho dV$极化Dipole moment$\vec\mu=q_e\vec r$,$\vec P=N\vec\mu=Nq_e\vec r$,P: the resultant dipole moment per unit volume,外部存在电场时, 受迫震荡$q_eE_0\cos\omega t-m_e\omega_0^2x=m_e\frac{d^2x}{dt^2}$,$\omega_0=\sqrt{\frac{k_E}{m_e}}$,设$x(t)=x_0\cos\omega t$, 有$x(t)=\frac{q_e/m_e}{\omega_0^2-\omega^2}E_0\cos\omega t$, 因为$\vec P=Nq_e\vec x$, $P=\frac{Nq_e^2E/m_e}{\omega_0^2-\omega^2}$,$\epsilon=\epsilon_0+\frac{P(t)}{E(t)}=\epsilon_0+\frac{q_e^2N/m_e}{(\omega_0^2-\omega^2)}$,**色散关系$n^2(\omega)=\frac{\varepsilon}{\varepsilon_0}=1+\frac{Nq_e^2}{\varepsilon_0m_e}\sum_j\left(\frac{1}{\omega_0^2-\omega^2}\right)$**,$\omega\approx\omega_0$时, 发生共振。$\sum_j$指一个节点材料中可能有多个$\omega_0$,只有一个$\omega_0$,可以去$\sum_j$.存在阻尼$m_e\gamma\frac{dx}{dt}$时, $m[\ddot x+\gamma\dot x+\omega_0^2x]=q_eE(x,t)$。设$x=x_0e^{-i\omega t}$, $E=E_0e^{-i\omega t}\Rightarrow P=Nq_ex=\frac{Nq_e^2}{m(-\omega^2-i\omega\gamma+\omega_0^2)}E$, $n^2(\omega)=1+\frac{Nq_e^2}{\varepsilon_0m_e}\sum_j\left(\frac{f_i}{\omega_{0j}^2-\omega^2-i\gamma_j\omega}\right)$ 群速度/相速度: $V_{\text{phase}}=\frac{dz}{dt}=\frac{\omega}{k_z}=v$, $V_{\text{group}}=\frac{d\omega}{dk}|_{k=k_o}=\frac{c}{n(\omega)+\omega\frac{dn(\omega)}{d\omega}}$,

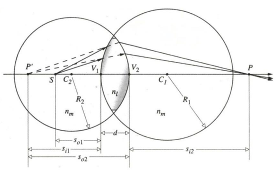
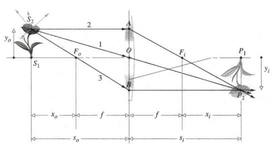
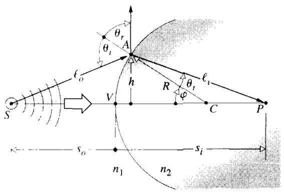
CH3 光传播瑞利散射: 偶极子的在远处产生的辐射电场为$E=\frac{\mu_0k^2\sin\theta}{4\pi\epsilon_0}\frac{\cos(kr-\omega t)}{r}$, 辐射度 Irradiance $I(\theta)=\frac{\mu_0^2\omega^4}{32\pi^2c^3\epsilon_0}\frac{\sin^2\theta}{r^2}$ $I\propto\omega^4$, 当粒子尺度显著大于λ, 该散射称为 Mie scattering (对各个波段均匀散射)。稀薄气体横向散射不受影响。稠密介质/晶体(Dense media)侧向散射相消干涉。

Internal − external reflection: External: 从光疏介质到光密介质 ($n_i<n_t$); Internal: 密→疏($n_i>n_t$)发生半波损失, 相位相差π, 折射定律$n_i\sin\theta_i=n_t\sin\theta_t$。snell's law $\frac{\sin\theta_i}{\sin\theta_t}=\frac{n_t}{n_i}=n_{ti}$。费马定理(修正)光从S点到P点, 穿过光学长度最小的路线。(相对于该路径的变化是静止的$\frac{df}{dx}=0$)

反射折射系数: $r_\perp\equiv\left(\frac{E_{0r}}{E_{0i}}\right)_\perp=\frac{n_i\cos\theta_i-n_t\cos\theta_t}{n_i\cos\theta_i+n_t\cos\theta_t}=\frac{\sin(\theta_i-\theta_t)}{\sin(\theta_i+\theta_t)}$, $r_{||}=\left(\frac{E_{0r}}{E_{0i}}\right)_{||}=\frac{n_t\cos\theta_i-n_i\cos\theta_t}{n_i\cos\theta_t+n_t\cos\theta_i}$, $t_\perp\equiv\left(\frac{E_{0t}}{E_{0i}}\right)_\perp=\frac{2n_i\cos\theta_i}{n_i\cos\theta_i+n_t\cos\theta_t}$,$t_{||}=\left(\frac{E_{0t}}{E_{0i}}\right)=\frac{2n_i\cos\theta_i}{n_i\cos\theta_t+n_t\cos\theta_i}$。布鲁斯特角(极化角$\theta_p$)$(\theta_i+\theta_t)=90°$,$r_\|=\frac{\tan(\theta_i-\theta_t)}{\tan(\theta_i+\theta_t)}=0$ 全反射: $\theta_i=90°$,此时入射角$\theta_p'=90°-\theta_p$,Reflectance(R):$R\equiv\frac{I_rA\cos\theta_r}{I_iA\cos\theta_i}=\frac{I_r}{I_i}=\left(\frac{E_{0r}}{E_{0i}}\right)^2=r^2$,Transmittance(T):$T\equiv\frac{I_tA\cos\theta_t}{I_iA\cos\theta_i}=\left(\frac{n_t\cos\theta_t}{n_i\cos\theta_i}\right)t^2$,$R+T=1$, $R_\perp+T_\perp=1$, $R_\|+T_\|=1$.$n_{ti}=\frac{\sin^2\theta_i}{\sin^2\theta_t}$,$\left(\frac{i}{t}\right)$衰逝波: $n_{||}=\left(\frac{E_{0r}}{E_{0i}}\right)=\frac{n_t\cos\theta_i-n_i\cos\theta_t}{n_i\cos\theta_t+n_t\cos\theta_i}$,$\vec E_t=\vec E_{0t}\exp i(\vec k_t\cdot\vec r-\omega t)$, $\vec k_t\cdot\vec r=k_{tx}x+k_{ty}y$, $k_{ty}=ik_t\left(\frac{\sin^2\theta_i}{n_{ti}^2}-1\right)^{\frac{1}{2}}=i\beta$, $k_{tx}=\frac{k_t}{n_{ii}}\sin\theta_i\Rightarrow\vec E_t=\exp(-\beta y)\exp i\left(\frac{k_{tx}\sin\theta_i}{n_{ti}}-\omega t\right)$, $\beta=k_t\left(\frac{\sin^2\theta_i}{n_{ti}^2}-1\right)^{\frac{1}{2}}$; 金属中的电磁波$\vec E=\vec E_0e^{i(\tilde kz-\omega t)}$, $\tilde k=k+i\kappa$, $\vec E=\vec E_0e^{-i(kz-\omega t)}$,$k\equiv\omega\sqrt{\frac{\varepsilon\mu}{2}}\left[\sqrt{1+\left(\frac{\sigma}{\varepsilon\omega}\right)^2}+1\right]^{1/2}$,$\kappa=\sqrt{\frac{\varepsilon\mu}{2}}\left[\sqrt{1+\left(\frac{\sigma}{\varepsilon\omega}\right)^2}-1\right]^{1/2}$, 趋肤深度$d=\frac{1}{\kappa}$, 色散: 金属除了吸收自由电子, 还会吸收特定频率的束缚电子$n^2(\omega)=1-\frac{Nq_e^2}{\varepsilon_0m_e\omega^2}\Rightarrow n^2(\omega)=1-\frac{\omega_p^2}{w^2}$,$\omega_p=\sqrt{\frac{Nq_e^2}{\varepsilon_0m_e}}$ $n^2(\omega)=1+\frac{Nq_e^2}{\varepsilon_0m_e}\left[\underbrace{\frac{f_e}{-\omega^2+i\gamma_e\omega}}_{\text{free electrons}}+\underbrace{\sum_j\frac{f_i}{\omega_{0j}^2-\omega^2+i\gamma_j\omega}}_{\text{bound electrons}}\right]$

CH4几何光学 进入球透明介质OPL$=n_1\sqrt{R^2+(s_0+R)^2-2R(s_0+R)\cos\varphi}+n_2\sqrt{R^2+(s_i-R)^2+2R(s_i-R)\cos(\varphi)}$,$\frac{d(\text{OPL})}{d\varphi}=0$.$\frac{n_1R(s_0+R)\sin\varphi}{2l_0}-\frac{n_2R(s_i-R)\sin\varphi}{2l_i}=0$,$\frac{n_1}{l_0}+\frac{n_2}{l_i}=\frac{1}{R}\left(\frac{n_2s_i}{l_i}-\frac{n_1s_0}{l_0}\right)$;旁轴近似: $s_i=l_i$, $s_0=l_0\Rightarrow\frac{n_1}{l_0}+\frac{n_2}{l_i}=\frac{1}{R}(n_2-n_1)$注意, 如果光线已经出了球体, 需要按照超出值代入s_0再计算一遍$\left(\frac{n}{s_0}+\frac{1}{s_i}\right)=\frac{1}{-R}(1-n)$.$\frac{n_1}{s_0}+\frac{n_2}{s_i}=\frac{n_2-n_1}{R}$$s_i=\infty$ $\Rightarrow\frac{n_1}{s_0}+\frac{n_2}{\infty}=\frac{n_2-n_1}{R}$ 此时物象在焦点处, $s_0\equiv f_0$,$f_0=\frac{n_1}{n_2-n_1}R$,当$s_0=\infty$, $s_i=f_i=\frac{n_2}{n_2-n_1}R$, **圆锥曲线上一点A,作垂线与准线于D, 有$\frac{L_{AD}}{L_{AF}}=e$**,当$\frac{n_{\text{空气}}}{n_{\text{介质}}}=e$时, 焦点出发的点光源会变成平行光。

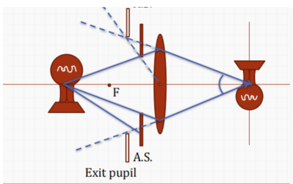


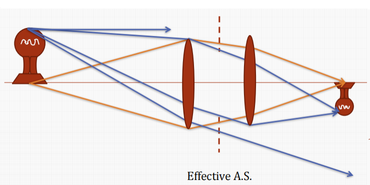




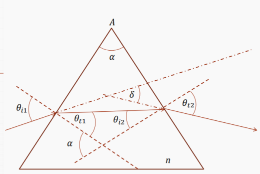
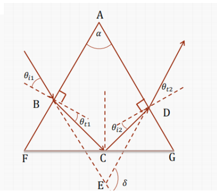
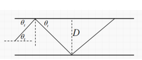
s_0, f_0	: +	when left of V
x_0	: +	left of F_0
s_i, f_i	: +	right of V
x_i	: +	right of F_i
R	: +	if C is right of V
y_0, y_i	: +	above optical axis

Gaussina lens formula $\frac{1}{s_o}+\frac{1}{s_i}=\frac{1}{f}$ where $\frac{1}{f}=(n_l-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$,Newtonian form of the lens equation:$x_0x_i=f^2$过有平行平面边界的介质的光线会发生横向位移, 但与穿入传出的光传播方向平行。偏移量(垂直于传播方向)$a=\frac{d\sin(\theta_i-\theta_t)}{\cos\theta_t}$,薄薄膜而言, $d\approx0$

横向放大量 M_T (垂直于光轴的放大倍数)$M_T\equiv\frac{y_i}{y_0}=-\frac{s_i}{s_0}=-\frac{x_i}{f}=-\frac{f}{x_0}$;纵向$M_L\equiv\frac{dx_i}{dx_0}=-\frac{f^2}{x_o^2}=-M_T^2$, $x_ox_i=f^2$.多个凸透镜: $s_{i2}=\frac{f_2d-f_2s_{o1}f_1/(s_{o1}-f_1)}{d-f_2-s_{o1}f_1/(s_{o1}-f_1)}$,$M_T=M_{T_1}M_{T_2}=\frac{f_1s_{i2}}{d(s_{o1}-f_1)-s_{o1}f_1}$, $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$





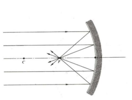
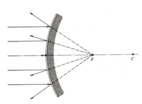




孔径光阑(Aperture stops) Vignetting 渐晕Relative Aperture 相对孔径: 辐照度或通量密度(单位时间内单位面积的能量) 与入口瞳孔面积成正比, 与图像面积成反比$I\propto\left(\frac{D}{f}\right)^2$, $\frac{D}{f}$被称为相对孔径. 孔径的大小可以通过仰角判断: $\theta=\arctan\left(\frac{h}{d}\right)$,**h为成像的高度, d从物体到障碍的距离如果前面有透镜需要考虑M_T**透镜-光圈-透镜, 入射考虑第一个透镜, 出射光瞳考虑第二个, 光圈的像位置为光瞳位置, 光瞳直径为像的大小。

非平面镜: 球面镜$\frac{1}{s_0}+\frac{1}{s_i}=-\frac{2}{R}$,$s_o, s_i$在镜子一侧都为正; $M_T\equiv\frac{y_i}{y_o}=-\frac{s_i}{s_o}$;色散棱镜: $\delta=\theta_{i1}+\sin^{-1}[\sin\alpha(n^2-\sin^2\theta_{i1})^{1/2}-\sin\theta_{i1}\cos\alpha]-\alpha$,$n=\frac{\sin\theta_{i1}}{\sin\theta_{t1}}=\frac{\sin\frac{(\delta_m+\alpha)}{2}}{\sin\frac{\alpha}{2}}$

TABLE 4.4 Sign Convention for Spherical Mirrors

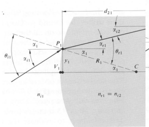
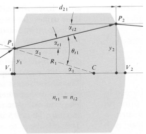
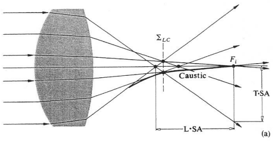
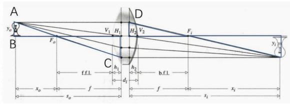
Quantity	Sign +	Sign −
s_o	Left of V, real object	Right of V, virtual object
s_i	Left of V, real image	Right of V, virtual image
f	Concave mirror	Convex mirror
R	C right of V, convex	C left of V, concave
y_o	Above axis, erect object	Below axis, inverted object
y_i	Above axis, erect image	Below axis, inverted image

反射棱镜：Reflecting prisms.$\delta=\theta_{i1}+\theta_{t2}+\alpha$;光纤Fiberoptics:$\frac{\sin\theta_i}{\sin\theta_t}=\frac{n_f}{n_a}$ $n_a=1, l=n_f L\left(n_f^2-\sin^2\theta_i\right)^{-\frac{1}{2}}$反射次数$N=\frac{l}{D/\sin\theta_t}\pm1=\frac{L\sin\theta_i}{D\left(n_f^2-\sin^2\theta_i\right)^{1/2}}\pm1$

光纤允许的最大角度$\boldsymbol{\sin\theta_{\max}=\frac{1}{n_i}\left(n_f^2-n_c^2\right)^{\frac{1}{2}}n_f}$为纤芯的折射率，$n_c$为外覆层折射率Numer aperture （NA）:$n_i\sin\theta_{\max}$;多模态色散Lowest order mode $t_{\min}=\frac{L}{v_f}=\frac{L}{c/n_f}=\frac{Ln_f}{c}$,$t_{\max}=\frac{l}{v_f}=\frac{L/\cos\theta_t}{c/n_f}=\frac{Ln_f/n_c}{c/n_f}=\frac{Ln_f^2}{cn_c}$,**intermodal delay**$\boldsymbol{\Delta t=\frac{Ln_f}{c}\left(\frac{n_f}{n_c}-1\right)}$ Attenuation 衰减$dB=-10\log_{10}(P_o/P_{\text{in}})$

CH5厚透镜$\frac{1}{s_0}+\frac{1}{s_i}=\frac{1}{f}$，$M_T=\frac{y_i}{y_o}=-\frac{x_i}{f}=-\frac{f}{x_o}$,$\frac{1}{f}=(n_l-1)\left[\frac{1}{R_1}-\frac{1}{R_2}+\frac{(n_l-1)d_l}{n_lR_1R_2}\right]$,$h_1=-\frac{f(n_l-1)d_l}{n_lR_2}$,$h_2=-\frac{f(n_l-1)d_l}{n_lR_1}$屈光度（dioptric power）$\mathcal{D}\equiv\frac{1}{f}$,两个距离很近的一对透镜：$\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$ $\mathcal{D}=\mathcal{D}_1+\mathcal{D}_2$.棱镜组

在第一个表面上有 $\begin{aligned}n_{t1}\alpha_{t1}&=n_{i1}\alpha_{i1}-\mathcal{D}_1y_{i1}\\ y_{t1}&=0+y_{i1}\end{aligned}$ $\Rightarrow$ Matrix form $\begin{bmatrix}n_{t1}\alpha_{t1}\\ y_{t1}\end{bmatrix}=\begin{bmatrix}1&-\mathcal{D}_1\\0&1\end{bmatrix}\begin{bmatrix}n_{i1}\alpha_{i1}\\ y_{i1}\end{bmatrix}$ $r_{t1}\equiv\begin{bmatrix}n_{t1}\alpha_{t1}\\ y_{t1}\end{bmatrix}$ $r_{i1}=\begin{bmatrix}n_{i1}\alpha_{i1}\\ y_{i1}\end{bmatrix}$，Refraction matrix $\boldsymbol{\mathcal{R}_1\equiv\begin{bmatrix}1&-\mathcal{D}_1\\0&1\end{bmatrix}}$，同理：$\begin{aligned}n_{i2}\alpha_{i2}&=n_{t1}\alpha_{t1}+0\\ y_{i2}&=d_{21}\alpha_{t1}+y_{c1}\end{aligned}$ $\Rightarrow\boldsymbol{\mathcal{T}_{21}\equiv\begin{bmatrix}1&0\\ \frac{d_{21}}{n_{t1}}&1\end{bmatrix}}$ $r_{i2}=\mathcal{T}_{21}r_{t1}=\mathcal{T}_{21}\mathcal{R}_1r_{i1}$

相差Aberrations$\frac{n_1}{s_o}+\frac{n_2}{s_i}=\frac{n_2-n_1}{R}+h^2\left[\frac{n_1}{2s_o}\left(\frac{1}{s_o}+\frac{1}{R}\right)^2+\frac{n_2}{2s_i}\left(\frac{1}{R}-\frac{1}{s_i}\right)^2\right]$边缘光线汇聚点距离旁轴近似的光线汇聚点的前面，SA is positive,反之亦然。

CH6波的叠加同频率波的叠加$E_1=E_{01}\sin(\omega t+\alpha_1)$，$E_2=E_{02}\sin(\omega t+\alpha_2)\Rightarrow E_0^2=E_{01}^2+E_{02}^2+2E_{01}E_{02}\cos(\alpha_2-\alpha_1)$，$\tan\alpha=\frac{E_{01}\sin\alpha_1+E_{02}\sin\alpha_2}{E_{01}\cos\alpha_1+E_{02}\cos\alpha_2}$,其中$\alpha_1(x_1,\epsilon_1)=-(kx_1+\epsilon_1)$，$\alpha_2(x_2,\epsilon_2)=-(kx_2+\epsilon_2)$多波的叠加$E=\sum_{i=1}^{n}E_{0i}\cos(\alpha_i\pm\omega t)$,$E_0^2=\sum_{i=1}^{N}E_{0i}^2+2\sum_{j>i}^{N}\sum_{i=1}^{N}E_{0i}E_{0j}\cos(\alpha_i-\alpha_j)$，$\tan\alpha=\frac{\sum_{i=1}^{n}E_{0i}\sin\alpha_i}{\sum_{i=1}^{n}E_{0i}\cos\alpha_i}$,相干光（$\alpha_i=\alpha_j$）$E_0^2=N^2E_{01}^2$.非相干光$I=\langle E_0^2\rangle==\sum_{i=1}^{n}\langle E_{0i}^2\rangle=NE_{01}^2$

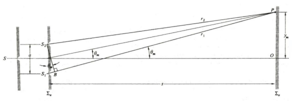
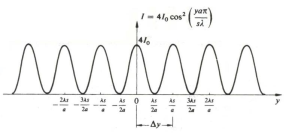
拍：$E_1=E_{01}\cos(k_1x-\omega_1t)$,$E_2=E_{01}\cos(k_2x-\omega_2t)\Rightarrow E=2E_{01}\cos\frac{[(k_1+k_2)x-(\omega_1+\omega_2)t]}{2}\times\cos\frac{[(k_1-k_2)x-(\omega_1-\omega_2)t]}{2}$,irradiance: $E_0^2(x,t)=4E_{01}^2(x,t)\cos^2(k_mx-\omega t)=2E_{01}^2(x,t)[1+\cos(2k_mx-2\omega_mt)]$平均频率/波数$\bar\omega\equiv\frac{1}{2}(\omega_1+\omega_2)$，$\bar k\equiv\frac{1}{2}(k_1+k_2)$，调制频率/波束$\omega_m\equiv\frac{1}{2}(\omega_1-\omega_2)$，$k_m\equiv\frac{1}{2}(k_1-k_2)$,拍频$2\omega_m$ or $(\omega_1-\omega_2)$相/群速度：$v=-\frac{(\partial\varphi/\partial t)_x}{(\partial\varphi/\partial x)_t}=\frac{\bar\omega}{\bar k}$，$v_g=\frac{d\omega}{dk}$

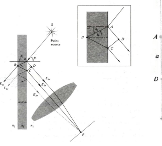
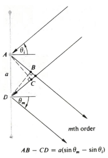
傅里叶变换（周期）$f(x)=\frac{A_0}{2}+\sum_{m=1}^{\infty}A_m\cos mkx+\sum_{m=1}^{\infty}B_m\sin mkx$,$A_m=\frac{2}{\lambda}\int_0^{\lambda}f(x)\cos mkx\,dx$,$B_m=\frac{2}{\lambda}\int_0^{\lambda}f(x)\sin mkx\,dx$,

非周期性波$f(x)=\frac{2}{a}+\int_{-\infty}^{\infty}A(k)\cos kx\,dk$,$A(k)=\int_{-\infty}^{\infty}f(x)\cos kx\,dx$，$B(k)=\int_{-\infty}^{\infty}f(x)\sin kx\,dx$

相干距离**Coherence time** $\Delta v\sim\frac{1}{\Delta t}$ **Coherence length** $\Delta x_c=c\Delta t_c$

CH7干涉衍射$I=\langle\vec E_1^2+\vec E_2^2+2\vec E_1\cdot\vec E_2\rangle_T=I_1+I_2+I_{12}$,$I_{12}=\vec E_{01}\cdot\vec E_{02}\cos\delta$;$\vec E_{01}$ and $\vec E_{02}$ 互相垂直，则$I_{12}=0$,$\vec E_{01}$ and $\vec E_{02}$ 平行$I=I_1+I_2+2\sqrt{I_1I_2}\cos\delta$,$I_1+I_2<I<I_{\max}$干涉条件：1频率相同，2相干；菲涅尔-阿拉戈定律：E方向正交不会发生干涉。

双缝衍射第m条干涉条纹的位置为$\boldsymbol{y_m\approx\frac{s}{a}m\lambda}$，角度为$\boldsymbol{\theta_m\approx\frac{y_m}{s}=\frac{m\lambda}{a}}$，（两激光辐照度相同时）Phase difference: $\delta=k(r_1-r_2)$,$I=4I_0\cos^2\frac{ya\pi}{s\lambda}$

等倾干涉：$\Lambda=2n_f d\cos\theta_t$;$n_1=n_2=n$（肥皂泡薄膜）,出现半波损失($n_1>n_f>n_2$不会)$d\cos\theta_t=\frac{\lambda_f}{4}2m$,$\theta_t\approx0$ 薄膜干涉，$\boldsymbol{\left(m+\frac{1}{2}\right)\lambda_0=2n_fd_m\Longrightarrow d_m=\left(m+\frac{1}{2}\right)\frac{\lambda_f}{2}}$(亮条纹),Haidinger's Fringes/牛顿环第 m 阶干涉相消发生在：$\boldsymbol{2n_fd_m=m\lambda_0}\Rightarrow x_m=[m\lambda_fR]^{\frac{1}{2}}$第 m 阶干涉相长$x_m=\left[\left(m+\frac{1}{2}\right)\lambda_fR\right]^{\frac{1}{2}}$

等倾干涉时，条纹宽度随倾角变化$\boldsymbol{\alpha\approx\frac{\lambda_f}{2\Delta x}=\frac{\lambda_0}{2\Delta x}}$,$\Delta x$为两相邻亮条纹水平距离。**一定要注意在介质中时，光程与折射率，波长之间的关系**

CH8 衍射$\tilde E=E_0(r)e^{i(kR-\omega t)}\left[\frac{\sin(N\delta/2)}{\sin(\delta/2)}\right]$,$R=\frac{1}{2}(N-1)d\sin\theta+r_1$,$\boldsymbol{I=I_0\left[\frac{\sin^2(N\delta/2)}{\sin^2(\delta/2)}\right]}=I_0\frac{\sin^2\left[N\left(\frac{kd}{2}\right)\sin\theta\right]}{\sin^2\left[\left(\frac{kd}{2}\right)\sin\theta\right]}$;最小值0 在 $\sin\frac{N\delta}{2}=0$,但$\sin\frac{\delta}{2}\neq0$处取得$\frac{\delta}{2}=\pm\frac{\pi}{N},\pm\frac{2\pi}{N},\pm\frac{3\pi}{N},\dots,\pm\frac{(N-1)\pi}{N},\pm\frac{(N+1)\pi}{N}$次大的峰值在$\sin\frac{N\delta}{2}=\pm1$处取得，此时$\frac{\delta}{2}=\pm\frac{\pi}{2N},\pm\frac{3\pi}{2N},\pm\frac{5\pi}{2N},\dots$;$\frac{dI}{d\beta}=0$处，$\frac{dI}{d\beta}=I(0)\frac{2\sin\beta(\beta\cos\beta-\sin\beta)}{\beta^3}=0$;β=±1.43π,±2.46π,±3.47π;N缝光栅：$\boldsymbol{I(\theta)=I_0\left(\frac{\sin\beta}{\beta}\right)^2\left(\frac{\sin N\alpha}{\sin\alpha}\right)^2}$，双缝$I(\theta)=I_0\left(\frac{\sin\beta}{\beta}\right)^2\left(\frac{\sin2\alpha}{\sin\alpha}\right)^2=4I_0\left(\frac{\sin\beta}{\beta}\right)^2\cos^2\alpha$;$\boldsymbol{\alpha=\left(\frac{ka}{2}\right)\sin\theta;\ \beta\equiv\left(\frac{kb}{2}\right)\sin\theta}$

Grating:$\boldsymbol{a(\sin\theta_m-\sin\theta_i)=m\lambda}$ a是相邻狭缝的距离,Airy disk:$\Delta\theta\approx\sin\Delta\theta=\frac{q_1}{f}=1.22\frac{\lambda}{D}$; $q_1=\frac{3,83R}{ka}=1.22\frac{R\lambda}{2a}=1.22\frac{f\lambda}{D}$

CH9 极化/偏振 两个线偏振光$\vec E_x(z,t)=iE_{0x}\cos(kz-\omega t)$,$\vec E_y(z,t)=jE_{0y}\cos(kz-\omega t+\epsilon)$,$\epsilon=n\pi$时$E$为线偏振，$\epsilon=-\frac{\pi}{2}+2m\pi$,$E_{0x}=E_{0y}$,右旋（面向光传来的方向，电场矢量顺时针旋转）；$\epsilon=-\frac{\pi}{2}+2m\pi\cdots$,左旋；$E_{0x}\neq E_{0y}$，且$\varepsilon$随机，会合成椭圆偏光。

双折射：$n_o=\frac{c}{v_\perp}$,$n_e=\frac{c}{v_{//}}$，$\Delta n=(n_o-n_e)$**方解石的双折射系数是正的，石英的是负值**；o光与光轴确定的平面为o主平面；主截面(principal section):「光轴」和晶体「表面法线」共同确定的平面；极化程度：$V=\frac{I_{\max}-I_{\min}}{I_{\max}+I_{\min}}$.**玻片：**$\Lambda=d(|n_o-n_e|)$,$\Delta\varphi=\frac{2\pi}{\lambda_0}d(|n_o-n_e|)$，全波片$\Delta\varphi=2\pi$半波片$d(|n_o-n_e|)=\frac{(2m+1)\lambda_0}{2}$,$\frac{1}{4}$玻片$d(|n_o-n_e|)=\frac{(4m+1)\lambda_0}{4}$, $m=0,1,2\dots$补偿器$\beta=\frac{\pi d}{\lambda_0}(n_L-n_R)$；$\beta=VBd$; 马吕斯定律：$I(\theta)=I(0)\cos^2\theta$,

第一个滤波器：各向同性，同样通过所有状态；第二滤光片：线性偏振片，透射轴水平；第三个滤波器：线性偏振镜，透射轴在 45；第四滤光片：对 L(右旋) 态不透明的圆偏振片。$S_0=2I_0$; $S_1=2(I_1-I_0)$; $S_3=2(I_2-I_0)$; $S_3=2(I_3-I_0)$ I_0,I_1,I_2,I_3 are transmitted irradiances of these four filters.$S_0^2=S_1^2+S_2^2+S_3^2$. 极化程度$V=\sqrt{(S_1^2+S_2^2+S_3^2)/S_0^2}$; Jones vector:$E=\begin{bmatrix}E_{0x}(t)e^{i\varphi_x}\\ E_y(t)e^{i\varphi_y}\end{bmatrix}$