8/11/2022

$$r_p = \frac{R_p k_p}{k_\parallel - k_p} \qquad \frac{1}{r_p} = \frac{k_\parallel - k_p}{R_p k_p}$$

$$\left.\frac{1}{r_p}\right|_{k_\parallel \approx k_p} = \cancel{\frac{1}{r_p(k_p)}}^{\,0} + \underbrace{\boxed{\left.\frac{\partial(1/r_p)}{\partial k_\parallel}\right|_{k_\parallel = k_p}}}_{\frac{1}{R_p k_p}} (k_\parallel - k_p) + \cdots$$

$$\frac{1}{r_p} = 0 \Rightarrow k_p$$

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fundamentals paper (methods)

- $r_{p,mj} \simeq \dfrac{\varepsilon_j - \varepsilon_m}{\varepsilon_j + \varepsilon_m}$
- $k_{zj} \simeq i k_\parallel$

} neglecting retardation $\lambda_p \ll \lambda_0$, $k_p \gg k$ $\Rightarrow$ obtain k_p

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- $r_p = r_{p1m} + \ldots$ (medium 1)
- $t_{p,mj} \simeq \dfrac{2\sqrt{\varepsilon_j \varepsilon_m}}{\varepsilon_j + \varepsilon_m}$
- $t_{p,jm} \simeq \dfrac{2\sqrt{\varepsilon_j \varepsilon_m}}{\varepsilon_j + \varepsilon_m}$
- $r_{pm1} r_{pm2} \simeq \left. e^{-2ik_{zm}d} \right|_{k_\parallel = k_p}$

} $\rightarrow$ obtain R_p

$$r_p = \frac{R_p k_p}{k_\parallel - k_p} \quad ; \quad \frac{1}{r_p} = \frac{k_\parallel - k_p}{R_p k_p} \leftarrow \delta = k_\parallel - k_p$$

$\frac{1}{\text{for } k_p}$

$$\left.\frac{1}{r_p}\right|_{k_\parallel \simeq k_p} = \cancel{\left.\frac{1}{r_p(k_p)}\right|_{k_p}}^{\,0} + \frac{1}{R_p k_p} \cdot (k_\parallel - k_p)$$

1°) $\frac{1}{r_p} = 0 \longrightarrow k_p$ (orden cero de Taylor)

2°) $\cancel{\frac{1}{R_p k_p}}$ $\frac{1}{r_p} = \frac{1}{R_p k_p}(k_\parallel - k_p) \longrightarrow R_p$

(A) $\delta \to 0$

$$r_p = \frac{\varepsilon_2 k_{z1} - \varepsilon_1 k_{z2} + 4\pi \sigma \xi k / c}{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2} + 4\pi\sigma}$$

$$r_p = \frac{\varepsilon_2 k_{z1} - \varepsilon_1 k_{z2} + 4\pi \sigma k_{z1} k_{z2} / \omega}{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2} + 4\pi\sigma k_{z1} k_{z2} / \omega}$$

$$\frac{1}{r_p} = 0 \rightarrow \left. \varepsilon_2 k_{z1} + \varepsilon_1 k_{z2} + 4\pi \sigma k_{z1} k_{z2} / \omega \right|_{k_\parallel \simeq k_p} = 0$$

$$\cancel{\left(\left[\frac{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2}}{k_{z1} k_{z2}}\right]^2 = \left[\frac{-4\pi\sigma}{\omega}\right]^2\right)}$$

for k_ρ

$$\frac{1}{r_p}=0 \rightarrow \left. \varepsilon_2 k_{z1} + \varepsilon_1 k_{z2} + 4\pi\sigma\, k_{z1} k_{z2}/\omega \right|_{k_\parallel \simeq k_\rho} = 0$$

$$\frac{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2}}{k_{z1} k_{z2}} = -\frac{4\pi\sigma}{\omega}$$

$k_{z1} \simeq k_{z2} \simeq i k_\rho$

$$\frac{k_{z1} k_{z2}}{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2}} = -\frac{\omega}{4\pi\sigma}$$

$$\frac{i k_\rho}{\varepsilon_2 + \varepsilon_1} = -\frac{\omega}{4\pi\sigma}$$

$$k_\rho = -\frac{\omega}{i 2\pi\sigma} \cdot \underbrace{\frac{\varepsilon_2+\varepsilon_1}{2}}_{=\bar{\varepsilon}} = \boxed{\frac{i\omega\bar{\varepsilon}}{2\pi\sigma}} \checkmark$$

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thin film

(B) $$\frac{1}{r_p}=0 \rightarrow 1 - r^{\circ}_{21} r^{\circ}_{23}\, e^{i2k_{z2}d} = 0 \quad \text{(dispersion relation)}$$

$$-\log\left(r^{\circ}_{21} r^{\circ}_{23}\right) = i2k_{z2}d =$$

$$= \cancel{-}\log\left[\frac{(\varepsilon_1-\varepsilon_2)}{(\varepsilon_1+\varepsilon_2)}\frac{(\varepsilon_3-\varepsilon_2)}{(\varepsilon_3+\varepsilon_2)}\right] = \left.\cancel{-}2k_\rho d\right|_{k_\parallel = k_\rho}$$

$k_{z2} \simeq k_{z1} \simeq i k_\rho$ $\qquad$ $k_{z2} \simeq i k_\rho$

$$k_\rho = \frac{1}{2d}\log\left[\frac{\Delta\varepsilon_{12}}{\bar{\varepsilon}_{12}} \cdot \frac{\Delta\varepsilon_{32}}{\bar{\varepsilon}_{32}}\right] \checkmark$$

$$\lambda/d = \frac{2\pi}{k_\rho d} = \frac{2\pi}{\log[\ldots]} \cdot 2 = \boxed{4\pi \log^{-1}[\ \ldots\ ]}$$

(c) anisotropic film

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for k_ρ

$$-\log\left(r^0_{21} r^0_{23}\right) = i 2 k_{z2} d \qquad k_{z2} = \sqrt{\varepsilon^{\parallel} k^2 - \left(\frac{\varepsilon^{\parallel}}{\varepsilon_\perp}\right) k_{\parallel}^2} \simeq i \sqrt{\frac{\varepsilon_\parallel}{\varepsilon_\perp}}\, k_\rho$$

$k_{z2} \simeq k_{z1} \simeq i k_\rho$

$$\cancel{-\log\left[\frac{\Delta\varepsilon_{12}}{\bar\varepsilon_{12}} \cdot \frac{\Delta\varepsilon_{32}}{\bar\varepsilon_{32}}\right]} = -$$

$$\cancel{-}\log\left[\frac{\Delta\varepsilon_{12}}{\bar\varepsilon_{12}} \cdot \frac{\Delta\varepsilon_{32}}{\bar\varepsilon_{32}}\right] = \cancel{-}2\sqrt{\frac{\varepsilon_\parallel}{\varepsilon_\perp}}\, k_\rho d$$

$$k_\rho = \frac{1}{2d}\sqrt{\frac{\varepsilon_\perp}{\varepsilon_\parallel}}\,\log\left[\frac{\Delta\varepsilon_{12}}{\bar\varepsilon_{12}}\, \frac{\Delta\varepsilon_{32}}{\bar\varepsilon_{32}}\right]$$

$$\frac{\lambda_\rho}{d} = \frac{2\pi}{k_\rho d} = \frac{2\pi\cdot 2}{\log[\ldots]}\sqrt{\frac{\varepsilon_\parallel}{\varepsilon_\perp}} = \boxed{4\pi\sqrt{\frac{\varepsilon_\parallel}{\varepsilon_\perp}}\,\log^{-1}[\ldots]}$$

for R_ρ

(MAL)

(A) $d \to 0$

$$\frac{1}{r_p} = \frac{k_{\parallel} - k_p}{R_p k_p} \quad \leftarrow k_p = \frac{i\omega \bar{\varepsilon}}{2\pi\sigma}$$

$$\frac{\varepsilon_2 k_{z1} + \varepsilon_1 k_{z2} + 4\pi\sigma k_{z1} k_{z2}/\omega}{\varepsilon_2 k_{z1} - \varepsilon_1 k_{z2} + 4\pi\sigma k_{z1} k_{z2}/\omega} = \frac{k_{\parallel} - k_p}{R_p k_p}$$

$$\frac{\partial(1/r_p)}{\partial k_{\parallel}} = \frac{1}{R_p k_p}$$

$k_z \simeq i k_p$

$$k_z = \sqrt{\varepsilon_i k^2 - k_{\parallel}^2}$$

$$k_z' = -\frac{2k_{\parallel}}{\sqrt{\quad}} \simeq -\frac{2k_p}{ik_p} = +2i$$

$$\varepsilon_2 k_{z1}' + \varepsilon_1 k_{z2}' + 4\pi\sigma (k_{z1}' k_{z2} + k_{z1} k_{z2}')/\omega = \frac{1}{R_p k_p}$$

$$(\varepsilon_2 + \varepsilon_1) 2i + 4\pi\sigma\, 2i \underbrace{(k_{z2} + k_{z1})}/\omega = \frac{1}{R_p k_p}$$

$$k_z' \simeq \frac{-2ik_p}{\sqrt{\varepsilon_i k}} = \frac{-2ik_p}{\sqrt{\varepsilon_i' k}}$$

$$k_p = \frac{i\omega\varepsilon}{2\pi\sigma}$$

$$4\pi\sigma \cdot \frac{2i}{2ik_p} \cdot \frac{1}{\omega} = \frac{1}{R_p \cancel{k_p}}$$

$$\cancel{4\pi\sigma\, k_p} \cdot \frac{\cancel{4\pi\sigma}}{\cancel{\omega}} \underbrace{k_{z1} k_{z2}}_{\simeq B?} = \frac{1}{R_p k_p} = \frac{1}{R_p} \cdot \frac{2\pi\sigma}{i\omega\varepsilon}$$

$$\cancel{\frac{\partial(1/r_p)}{\partial k_{\parallel}}} \qquad (\varepsilon_2 i + \varepsilon_1 i) - 8\pi\sigma k_p/\omega = \frac{1}{R_p k_p}$$

(B)

for R_p

$$r_p = r_{p,1m} + \frac{t_{p,1m}\, t_{p,m1}\, r_{p,m2}\, e^{2ik_{zm}d}}{1 - r_{p,m1} r_{p,m2}\, e^{2ik_{zm}d}}$$

aproximations from Methods

$$r_p = \frac{\varepsilon_m - \varepsilon_1}{\varepsilon_m + \varepsilon_1} + \cancel{t_{p,1m}} \frac{2\varepsilon_1\varepsilon_m}{(\varepsilon_1+\varepsilon_m)^2} \cdot \frac{(\varepsilon_2 - \varepsilon_m)}{(\varepsilon_2+\varepsilon_m)} \cdot \frac{e^{2ik_{zm}d}}{1 - e^{-2ik_{zm}d} \,\Big|\, e^{2ik_{zm}d}}$$

$k_{\parallel} = k_p$
$k_{zm} \simeq ik_p$

$$r_p = \frac{1}{\varepsilon_m + \varepsilon_1}\left[\varepsilon_m - \varepsilon_1 + \frac{2\varepsilon_1\varepsilon_m(\varepsilon_2 - \varepsilon_m)}{(\varepsilon_1+\varepsilon_m)(\varepsilon_2+\varepsilon_m)} \cdot \frac{e^{2ik_{zm}d}}{1 - e^{+2k_pd}\, e^{2ik_{zm}d}}\right]$$

$k_{zm} \simeq ik_{\parallel}$

$$r_p = \frac{\varepsilon_m - \varepsilon_1}{\varepsilon_m + \varepsilon_1}\left[1 + \frac{2\varepsilon_1\varepsilon_m(\varepsilon_2 - \varepsilon_m)}{\varepsilon_m^2 - \varepsilon_1^2\,(\varepsilon_2+\varepsilon_m)} \cdot \frac{e^{-2k_{\parallel}d}}{1 - e^{2k_pd}\, e^{-2k_{\parallel}d}}\right]$$

multiply by $e^{2k_{\parallel}d}$

$$r_p = \underbrace{\frac{\varepsilon_m - \varepsilon_1}{\varepsilon_m + \varepsilon_1}}_{\simeq 1}\left[1 + \frac{2\varepsilon_1\varepsilon_m}{\varepsilon_m^2 - \varepsilon_1^2} \underbrace{\left(\frac{\varepsilon_2 - \varepsilon_m}{\varepsilon_2+\varepsilon_m}\right)}_{\simeq 1} \frac{1}{\underset{\simeq 1+2k_{\parallel}d}{e^{2k_{\parallel}d}} - \underset{\simeq 1+2k_pd}{e^{2k_pd}}}\right] =$$

$$\frac{1}{r_p} \simeq \frac{\varepsilon_m^2 - \varepsilon_1^2}{\cancel{2}\varepsilon_1\varepsilon_m} \cdot \cancel{2}d(k_{\parallel} - k_p) = \frac{k_{\parallel} - k_p}{R_p k_p}$$

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Por R_p

$$\frac{1}{r_p} = \frac{(\varepsilon_m^2 - \varepsilon_1^2)}{\varepsilon_1 \varepsilon_m} d \cancel{(k_4 - k_p)} = \frac{\cancel{k_4 - k_p}}{R_p k_p}$$

$$\rightarrow R_p = \frac{\varepsilon_1 \varepsilon_m}{\varepsilon_m^2 - \varepsilon_1^2} \cdot \frac{1}{d} \cdot \frac{1}{k_p} = \boxed{\frac{\varepsilon_1 \varepsilon_m}{\varepsilon_m^2 - \varepsilon_1^2} \cdot \frac{1}{d} \cdot \cancel{\frac{2\pi}{k_p}} \cdot \frac{\lambda_p}{2\pi}}$$

$k_p = \frac{2\pi}{\lambda_p}$

tengo un "−" y 1/2 de diferencia

C Lo mismo que B reemplazando ε_m por $\sqrt{\varepsilon_x \varepsilon_z}$

$$\rightarrow \boxed{R_p = \frac{\varepsilon_1 \sqrt{\varepsilon_x \varepsilon_z}}{\varepsilon_x \varepsilon_z - \varepsilon_1^2} \cdot \frac{1}{d} \cdot \frac{\lambda_p}{2\pi}}$$

mismas diferencias que B