3200103514 叶奕含

P1.4.1

(a) $\bar{S} = \bar{E} \times \bar{H} = \hat{r} \frac{\omega k^3 q^2 l^2}{16\pi^2 \varepsilon_0 r^2} \sin^2\theta \cos^2(kr - \omega t)$

$\langle \bar{S} \rangle = \frac{1}{2\pi} \int_0^{2\pi} d(\omega t)\, \bar{E} \times \bar{H} = \hat{r} \frac{\omega k^3 q^2 l^2}{32\pi^2 \varepsilon_0 r^2} \sin^2\theta$

(b) $P = \oiint dS \cdot \hat{r} \cdot \langle \bar{S} \rangle = \int_0^{\pi} d\theta \cdot 2\pi r^2 \sin\theta \cdot \frac{\omega k^3 q^2 l^2}{32\pi^2 \varepsilon_0 r^2} \sin^2\theta = \frac{\omega k^3 q^2 l^2}{12\pi \varepsilon_0}$

(c) $R_{rad} = \frac{2P}{I_0^2} = \frac{2}{\omega^2 q^2} \cdot \frac{\omega k^3 q^2 l^2}{12\pi \varepsilon_0} = \frac{k^3 l^2}{6\pi \varepsilon_0 \omega}$

(d) $\theta = \frac{\pi}{2}$ $\quad E_0 = -\frac{k^2 q l}{4\pi \varepsilon_0 r}$ $\quad \therefore ql = -\frac{4\pi \varepsilon_0 r}{k^2} E_0$

$P = \frac{2\pi}{3\eta_0} (E_0 r)^2 = \frac{1}{180} (25 \times 10^{-3} \times 15 \times 10^3)^2 = 781.25\ W$

P1.6.1

$\oiint_{\Delta S} (\nabla \times \bar{E}) d\bar{S} = \oiint_{\Delta S} (-\frac{\partial \bar{B}}{\partial t}) d\bar{S}$

$\Rightarrow \oint_{\Delta l} d\bar{l} \cdot \bar{E} = -\frac{\partial \bar{B}}{\partial t} \hat{s}\, \Delta l \Delta d$

$\Rightarrow \Delta l (\hat{s} \times \hat{n})(\bar{E_1} - \bar{E_2}) = -\frac{\partial \bar{B}}{\partial t} \hat{s} \Delta l \Delta d$

$\Rightarrow (\hat{s} \times \hat{n}) \cdot (\bar{E_1} - \bar{E_2}) = -\frac{\partial \bar{B}}{\partial t} \hat{s}\, \Delta d$

$\Rightarrow \cancel{\hat{s}} \cdot (\hat{n} \times (\bar{E_1} - \bar{E_2})) = \cancel{\hat{s}} (-\frac{\partial \bar{B}}{\partial t} \Delta d)$

$\because \Delta d \to 0 \quad \therefore \hat{n} \times (\bar{E_1} - \bar{E_2}) = -\lim_{\Delta d \to 0} \frac{\partial \bar{B}}{\partial t} \cdot \Delta d = 0$

$\oiint_{\Delta S} (\nabla \times \bar{H}) = \oiint_{\Delta S} (\frac{\partial \bar{D}}{\partial t} + \bar{J})$

同理可得 $\hat{n} \times (\bar{H_1} - \bar{H_2}) = \lim_{\Delta d \to 0} (\frac{\partial \bar{D}}{\partial t} + \bar{J}) \Delta d = \lim_{\Delta d \to 0} \bar{J} \Delta d \begin{cases} \text{导线} \Rightarrow & = 0 \\ \text{面电流} \Rightarrow & = \bar{J_s} \end{cases}$

P1.6.2

$\iiint dV\, \nabla \times \bar{H} \approx A \hat{z} \times (\bar{H}_{z>0} - \bar{H}_{z<0})$

$= A \Delta z \frac{\partial \bar{D}}{\partial t} + A \Delta z \bar{J}$

$\Delta z \to 0 \quad \therefore \Delta z \frac{\partial \bar{D}}{\partial t} \to 0$ $\qquad$ $\bar{J}$ 无界. $\quad \Delta z \bar{J} = \bar{J_s}$

$\therefore \iiint dV\, \nabla \times \bar{H} \approx A \cdot \bar{J_s}$

P1.6.3

$\iiint dV (\nabla \cdot \bar{D}) = \iiint dV \rho$

$\oiint d\bar{S} \cdot \bar{D} = \iiint dV \rho$

$\lim_{\Delta S \to 0} \hat{n} \Delta S \cdot (\bar{D_1} - \bar{D_2}) = \lim_{\substack{\Delta S \to 0 \\ \Delta d \to 0}} \Delta S \Delta d \rho$

$\therefore \hat{n} (\bar{D_1} - \bar{D_2}) = \lim_{\Delta d \to 0} \rho \Delta d = \rho_s$ $\qquad$ 体电荷密度