第一章

极化面电荷:

$$\sigma_{\mathbf{P}} = \mathbf{P} \cdot \mathbf{e_n}$$

极化体电荷:

$$\rho_{\mathbf{P}} = -\nabla \cdot \mathbf{P}$$

极化电荷代数和应为0:

$$0 = \oint_S \sigma_{\mathbf{P}} dS + \int_V \rho_{\mathbf{P}} dV$$

在理想电介质中:

$$\mathbf{D} = \varepsilon_0 \mathbf{E} + \mathbf{P} = \varepsilon \mathbf{E}$$

电通量连续性:

$$\mathbf{D_{n2}} - \mathbf{D_{n1}} = \sigma$$

电位连续性、E的切向连续性:

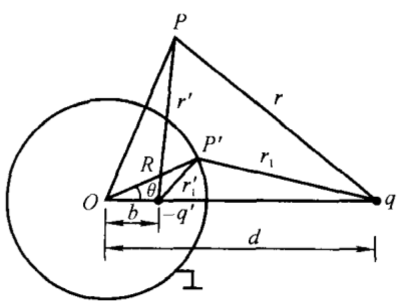
$$E_{1t} = E_{2t}$$

静电场折射定律(理想介质、分界面上无自由电荷):

$$\frac{\tan \alpha_1}{\tan \alpha_2} = \frac{\varepsilon_1}{\varepsilon_2}$$

电像法

导体球



$$b = \frac{R^2}{d}$$

$$q' = \frac{R}{d} q$$

两种理想介质

在$r_1 = r_2$处

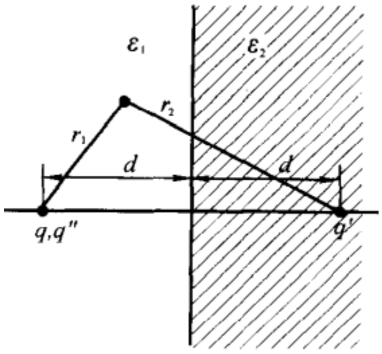


图 1－30　点电荷对无限大介质分界平面的镜像

$$\begin{cases} \frac{q}{\varepsilon_1} + \frac{q'}{\varepsilon_1} = \frac{q''}{\varepsilon_2} \\ q - q' = q'' \end{cases}$$

$$\therefore \begin{cases} q' = \frac{\varepsilon_1 - \varepsilon_2}{\varepsilon_1 + \varepsilon_2} q \\ q'' = \frac{2\varepsilon_2}{\varepsilon_1 + \varepsilon_2} q \end{cases}$$

几个电容公式

同轴夹层线缆

$$C = \frac{2\pi\varepsilon}{\ln(b/a)}$$

同心夹层球

$$C = \frac{4\pi\varepsilon}{\frac{1}{a} - \frac{1}{b}}$$

孤立球

$$C = 4\pi\epsilon_0 a$$

静电场能量

介质各处均匀线性充电，容易想到

$$\begin{aligned} W_e &= \frac{1}{2}\int_V \rho\varphi dV \\ &= \frac{1}{2}\int_S \sigma\varphi dS \end{aligned}$$

静电场能量密度

$$w_e' = \frac{1}{2}\mathbf{D}\cdot\mathbf{E}$$

虚功原理

$$dW = dW_e + fdg$$

不与电源相连

$$0 = dW_e + fdg$$

$$\therefore f = -\frac{\partial W_e}{\partial g}$$

与电源相连,各带电体电位不变

$$dW_e = \frac{1}{2}\sum_k \varphi_k dq_k = \frac{1}{2}dW$$

$$\therefore f = \frac{\partial W_e}{\partial g}$$

第二章

电流密度

$$\mathbf{J} = \rho\mathbf{v}$$

作用于垂直于v的dS

$$dI = \mathbf{J}\cdot d\mathbf{S}$$

面电流密度

$$\mathbf{K} = \sigma\mathbf{v}$$

作用于垂直于v的dl

$$dI = \mathbf{K}\cdot \mathbf{e_n}dl$$

线电流密度

$$I = \tau v$$

四种电流元

$$\mathbf{v}dq = \mathbf{J}dV = \mathbf{K}dS = Id\mathbf{l}$$

欧姆定律微分形式

$$\mathbf{J} = \gamma\mathbf{E}$$

$$\gamma\text{为电导率}$$

焦耳定律微分形式

$$p = \frac{dP}{dV} = \mathbf{J}\cdot\mathbf{E}$$

含源欧姆定律

$$\mathbf{J} = \gamma(\mathbf{E} + \mathbf{E_e})$$

电流连续性方程

$$\oint_S \mathbf{J}\cdot d\mathbf{S} = -\frac{\partial q}{\partial t} = 0$$

衔接条件

$$\mathbf{J_{1n}} = \mathbf{J_{2n}}, \text{体现一个电荷守恒}$$
$$\mathbf{E_{1t}} = \mathbf{E_{2t}}, \text{体现一个保守场}$$
$$\frac{\tan\alpha_1}{\tan\alpha_2} = \frac{\gamma_1}{\gamma_2}, \text{谓之折射定律}$$

第三章

BS定律

$$\begin{aligned}\mathbf{B} &= \frac{\mu}{4\pi}\oint_L \frac{Id\mathbf{l}\times\mathbf{e_R}}{R^2} \\ &= \frac{\mu}{4\pi}\oint_V \frac{\mathbf{J}dV\times\mathbf{e_R}}{R^2} \\ &= \frac{\mu}{4\pi}\oint_S \frac{\mathbf{K}dS\times\mathbf{e_R}}{R^2}\end{aligned}$$
$$B\text{在场点,其余均在源点}$$

安培力

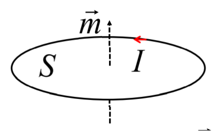
$$d\mathbf{F} = Id\mathbf{l}\times\mathbf{B}$$

安培环路定律

$$\nabla\times\mathbf{H} = \mathbf{J}$$
$$\oint_L \mathbf{H}\cdot d\mathbf{l} = \sum_k I_k$$

有介质

分子磁矩



$$\mathbf{m} = I\mathbf{S}$$

磁力矩

$$\mathbf{T} = \mathbf{m}\times\mathbf{B}$$

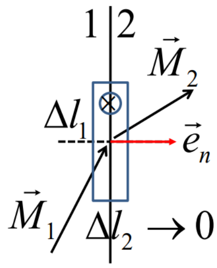
磁化强度

$$\mathbf{M} = \lim_{\Delta V\to 0}\frac{\sum_i \mathbf{m_i}}{\Delta V}$$
$$\text{理想介质中}, \mathbf{M} = \chi_m\mathbf{H}, \chi_m\text{是磁化率}$$

磁化电流

$$I_m = \oint_L \mathbf{J_m}\cdot d\mathbf{l}$$
$$\mathbf{J_m} = \nabla\times\mathbf{M}$$

磁化强度衔接条件



$$(\mathbf{M_1} - \mathbf{M_2})\times\mathbf{e_n} = \mathbf{K_m}$$

磁场强度

$$\mathbf{H} = \frac{\mathbf{B}}{\mu_\mathbf{0}} - \mathbf{M}$$

$$\mathbf{B} = \mu\mathbf{H}(\text{理想介质})$$

$$\nabla\times\mathbf{H} = \mathbf{J}, \text{自由电流密度}, \text{安培环路定律}2.0$$

不存在磁单极子,磁场是无源的

$$\nabla\cdot\mathbf{B} = 0(\text{微分形式})$$

$$\oint_S \mathbf{B}\cdot d\mathbf{S} = 0(\text{积分形式})$$