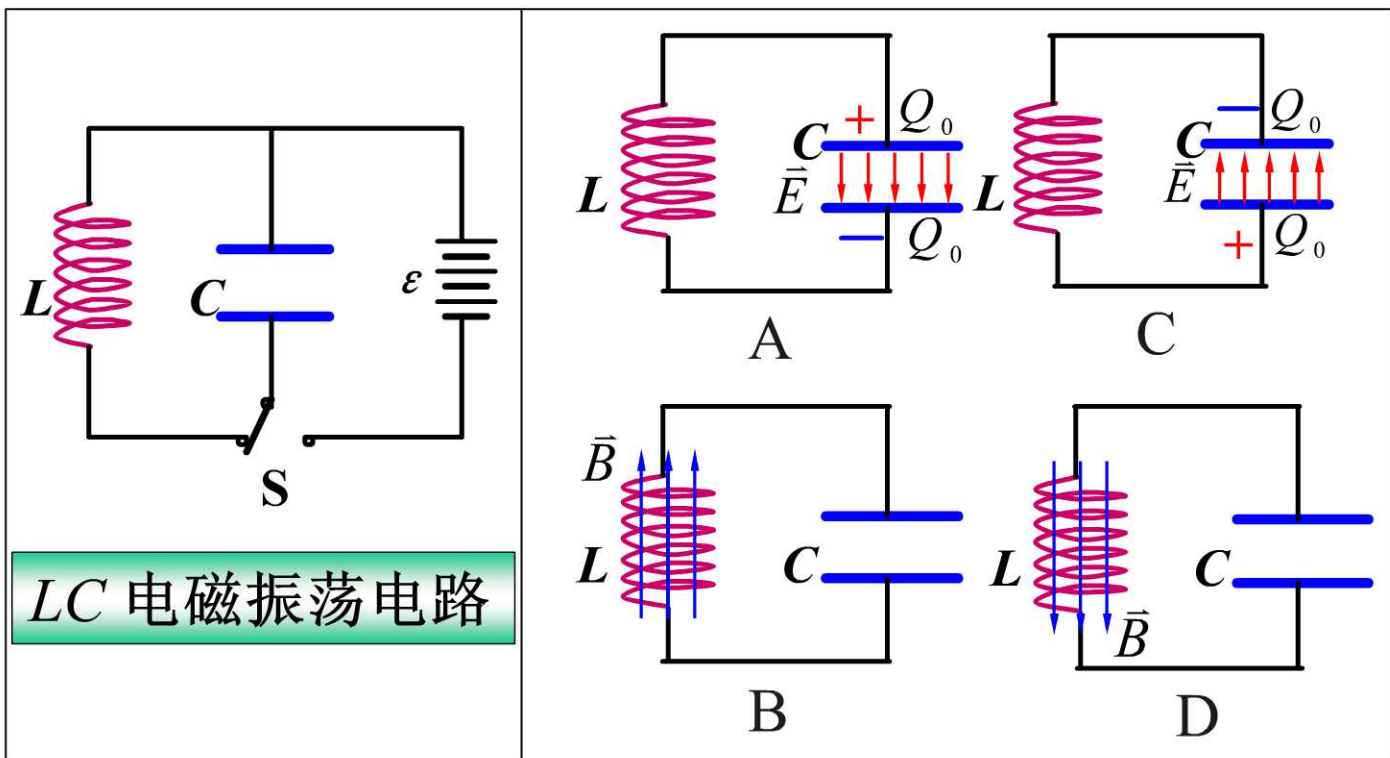
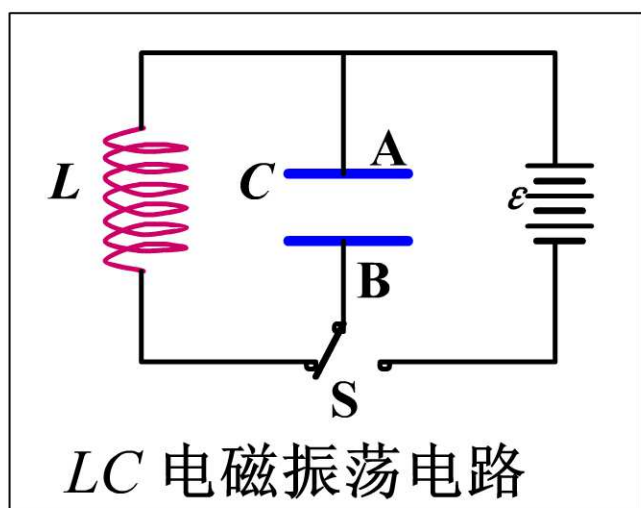


一 振荡电路 无阻尼自由电磁振荡



二 无阻尼电磁振荡的振荡方程



$$-L \frac{di}{dt} = V_A - V_B = \frac{q}{C}$$

$$i = dq/dt \quad \frac{d^2q}{dt^2} = -\frac{1}{LC}q$$

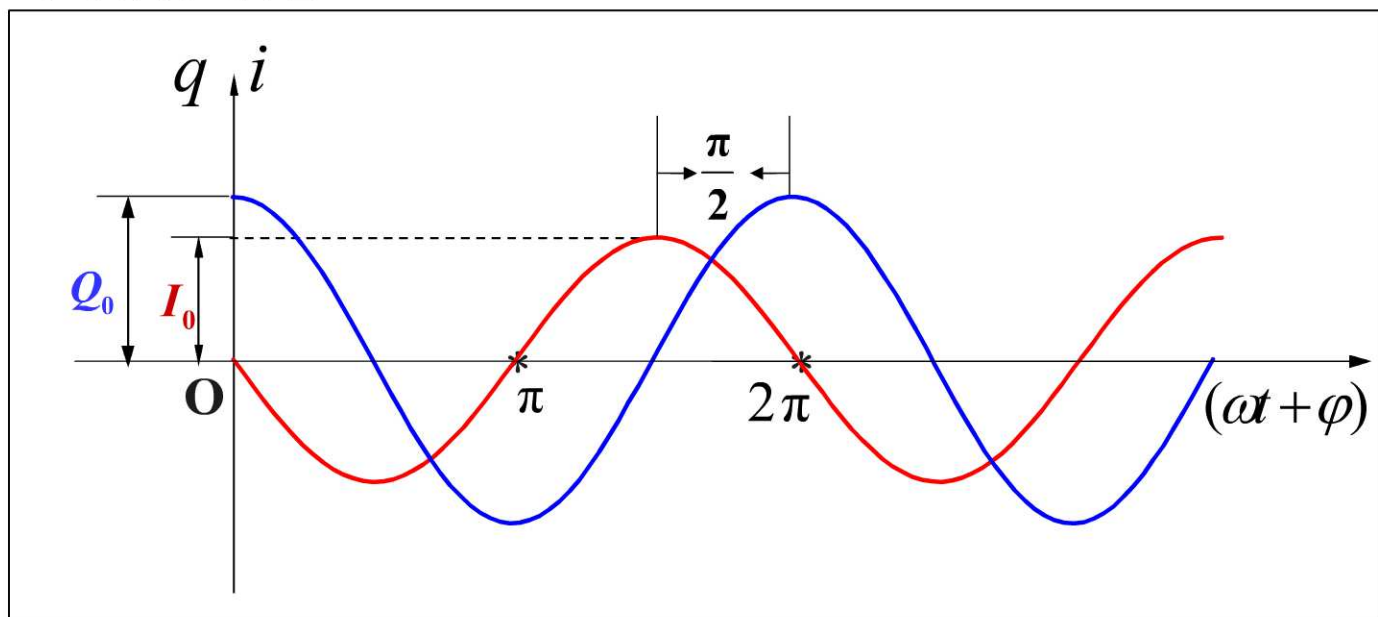
$$\omega^2 = 1/LC \quad \frac{d^2q}{dt^2} = -\omega^2q$$

$$q = Q_0 \cos(\omega t + \varphi) \quad T = 2\pi\sqrt{LC}$$

$$i = \frac{dq}{dt} = -\omega Q_0 \sin(\omega t + \varphi) = I_0 \cos(\omega t + \varphi + \frac{\pi}{2})$$



无阻尼自由振荡中的电荷和电流随时间的变化



$$q = Q_0 \cos(\omega t + \varphi) \quad i = I_0 \cos\left(\omega t + \varphi + \frac{\pi}{2}\right)$$



三 无阻尼电磁振荡的能量

$$E_e = \frac{q^2}{2C} = \frac{Q_0^2}{2C} \cos^2(\omega t + \varphi)$$

$$E_m = \frac{1}{2} Li^2 = \frac{1}{2} LI_0^2 \sin^2(\omega t + \varphi) = \frac{Q_0^2}{2C} \sin^2(\omega t + \varphi)$$

$$E = E_e + E_m = \frac{1}{2} LI_0^2 = \frac{Q_0^2}{2C}$$

◆ 在无阻尼自由电磁振荡过程中，电场能量和磁场能量不断的相互转化，其总和保持不变。



- 例** 在 LC 电路中, 已知 $L = 260 \mu\text{H}$, $C = 120 \text{pF}$ 初始时两极板间的电势差 $U_0 = 1 \text{V}$, 且电流为零. 求:
- (1) 振荡频率;
 - (2) 最大电流;
 - (3) 电容器两极板间的电场能量随时间变化的关系;
 - (4) 自感线圈中的磁场能量随时间变化的关系;
 - (5) 证明在任意时刻电场能量与磁场能量之和总是等于初始时的电场能量.



已知: $L = 260 \mu\text{H}$, $C = 120 \text{pF}$, $t = 0$, $U_0 = 1 \text{V}$, $i_0 = 0$

求: (1) ν ; (2) 最大电流

解 (1) 振荡频率: $\nu = \frac{1}{2\pi\sqrt{LC}}$

$$\nu = 9.01 \times 10^5 \text{ Hz}$$

(2) 最大电流

$$\left. \begin{array}{l} \text{当 } t = 0 \text{ 时} \\ q_0 = Q_0 \cos \phi = CU_0 \\ i_0 = -\omega Q_0 \sin \phi = 0 \end{array} \right\}$$

$$\rightarrow I_0 = \omega Q_0 = \omega CU_0 = \sqrt{\frac{C}{L}} U_0 = 0.679 \text{ mA}$$



已知: $L = 260 \mu\text{H}$, $C = 120 \text{pF}$, $t = 0$, $U_0 = 1 \text{V}$, $i_0 = 0$

(3) 电容器两极板间的电场能量随时间变化的关系;

$$E_e = \frac{1}{2} C U_0^2 \cos^2 \omega t = (0.60 \times 10^{-10} \text{J}) \cos^2 \omega t$$

(4) 自感线圈中的磁场能量随时间变化的关系;

$$E_m = \frac{1}{2} L I_0^2 \sin^2 \omega t = (0.60 \times 10^{-10} \text{J}) \sin^2 \omega t$$



已知: $L = 260 \mu\text{H}$, $C = 120 \text{ pF}$, $t = 0$, $U_0 = 1 \text{ V}$, $i_0 = 0$

(5) 证明在任意时刻电场能量与磁场能量之和总是等于初始时的电场能量.

$$E_e + E_m = 0.60 \times 10^{-10} \text{ J} = E_{e0} = \frac{1}{2} C U_0^2$$