Lecture 4

2021年9月25日 20:36

Electric Currents

电流

电流是单位时间内导线中通过的电荷

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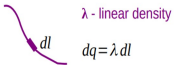
$$i=\frac{\Delta Q}{\Delta t}=\frac{\sum_i q_i}{\Delta t}$$

以速度v沿导线移动的线电荷

$$i=\frac{\Delta Q}{\Delta t}\rightarrow\frac{dq}{dt}\rightarrow\lambda\frac{dl}{dt}=\lambda v$$

$$\boxed{\vec{I}=\lambda\vec{v}}$$



表面电流密度Surface Current Density

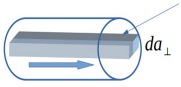
$$\vec{K}=\frac{d\vec{I}}{dl_\perp}$$

$$\boxed{\vec{K}=\sigma\vec{v}}$$

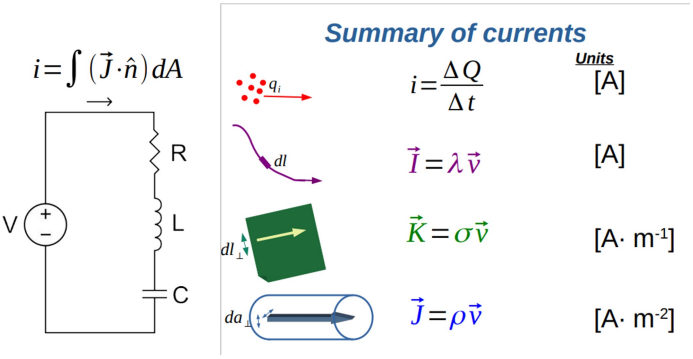
体积电流密度，J Volume current density，J

电荷流动分布在一个三维区域，

$$\vec{J}=\frac{d\vec{I}}{da_\perp}$$



$$\boxed{\vec{J}=\rho\vec{v}}$$



Current as flux of volume current

电流为体积电流的通量

通过任意表面的总电流是通过该表面的体积电流的总通量:

$$\boxed{\int_A(\vec{J}\cdot\hat{n})dA=i}$$

是什么推动产生了电流?

电场力

$$\vec{F}_E=q\vec{E}$$

施加在每一个电荷上的电场力

$$\vec{f}_E=\frac{\vec{F}}{q}=\vec{E}$$

所以

电导率

conductivity

(do NOT confuse it with charge surface density)

$$\vec{J} = \sigma \vec{f}_E = \sigma \vec{E}$$

Ohm’ s Law

欧姆定律

$$i = \frac{V}{R}$$

zz

$$R = \frac{L}{\sigma A}$$

length
conductivity
area

电流会变大吗?

Joule’ s Law

焦耳定律

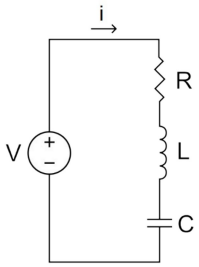
$$p = \frac{\Delta W}{\Delta t} = \frac{Q \Delta V}{\Delta t} = i \cdot V_{21} = i^2 \cdot R$$

Electromotive force (ε, emf)

电动势

$$\oint \vec{f} \cdot d\vec{l} \equiv \mathscr{E}$$

$$\mathscr{E} = V$$



Summary

Current

$$\int_A (\vec{J} \cdot \hat{n}) dA = i$$

Ohm’ s Law

$$\vec{J} = \sigma \vec{E} = \sigma \frac{\vec{F}}{q} = \sigma \vec{f}$$

EMF

$$\oint \vec{f} \cdot d\vec{l} \equiv \mathscr{E} = V$$