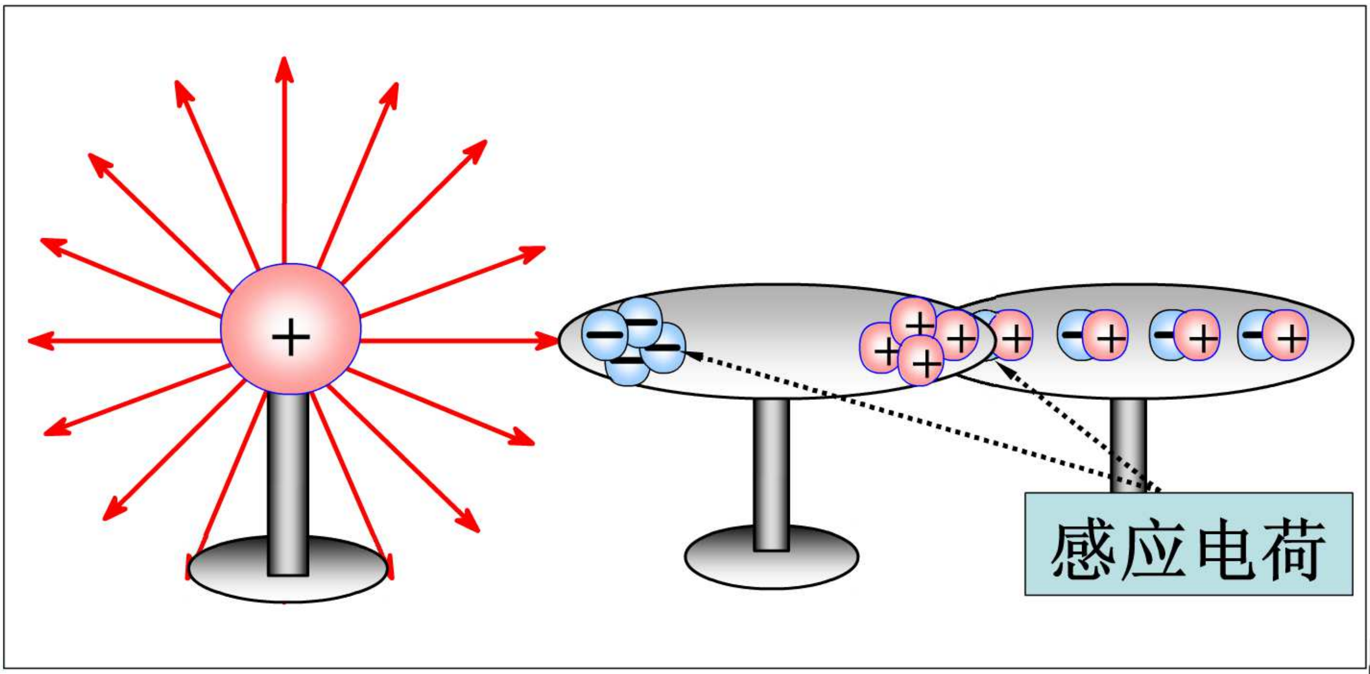
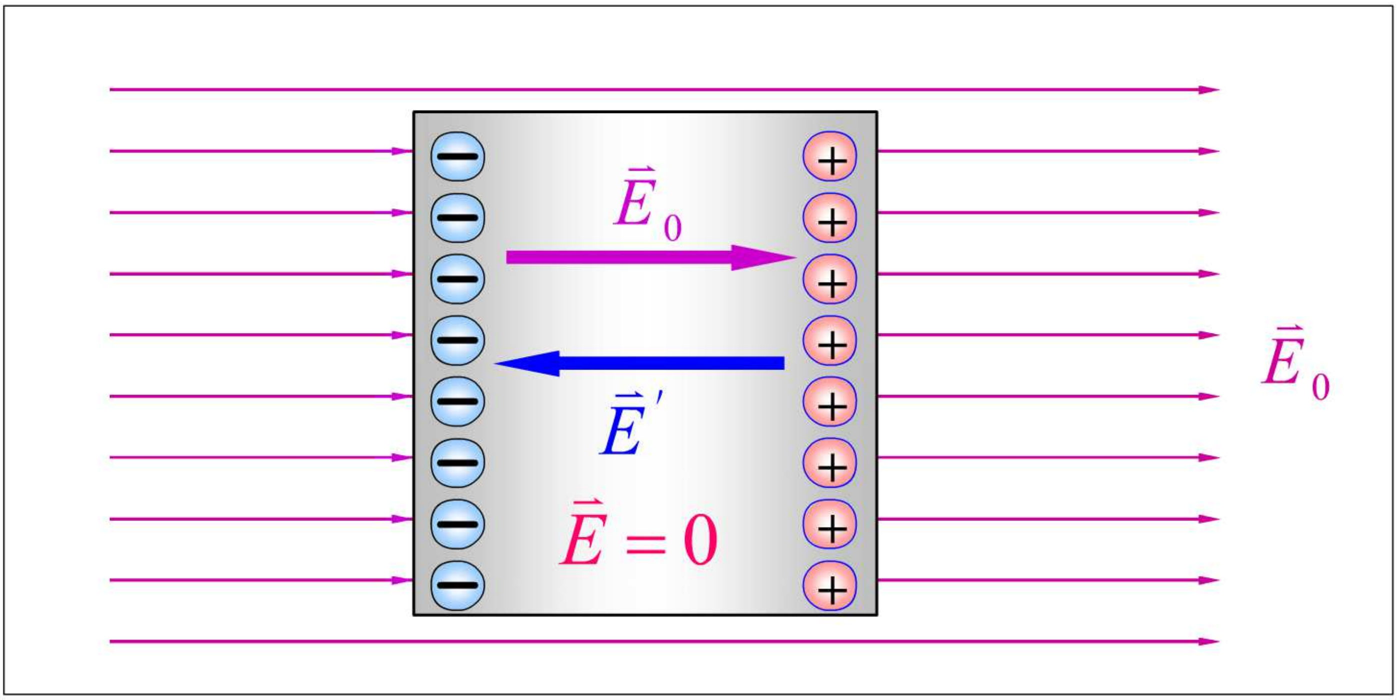
一 静电平衡条件

1 静电感应



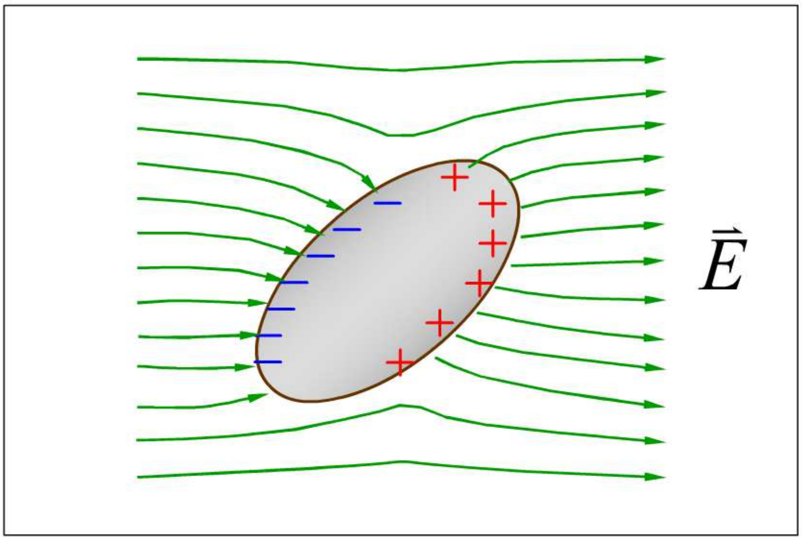
2 静电平衡



静电平衡条件：

（1）导体内部任何一点处的电场强度为零；

（2）导体表面处电场强度的方向，都与导体表面垂直.

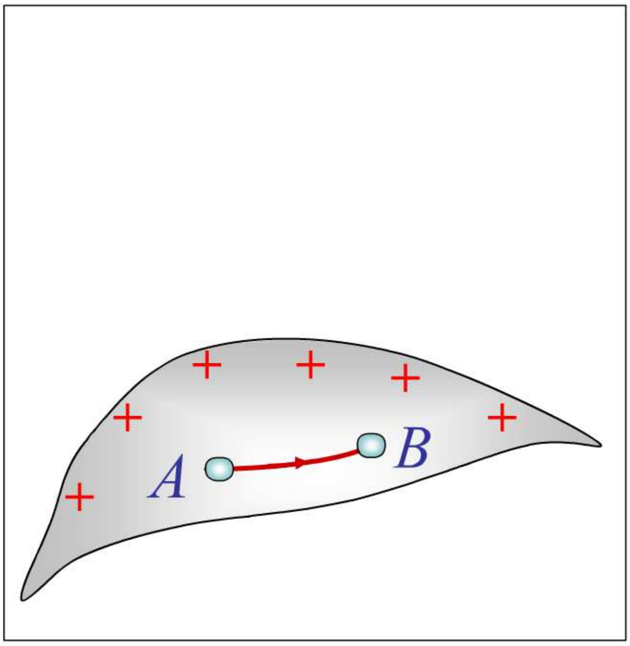


推论： 导体为等势体

导体内各点电势相等

$$\because \vec{E}=0$$

$$\therefore U_{AB}=\int_{AB}\vec{E}\cdot \mathrm{d}\vec{l}=0$$



推论： 导体为等势体

导体内各点电势相等

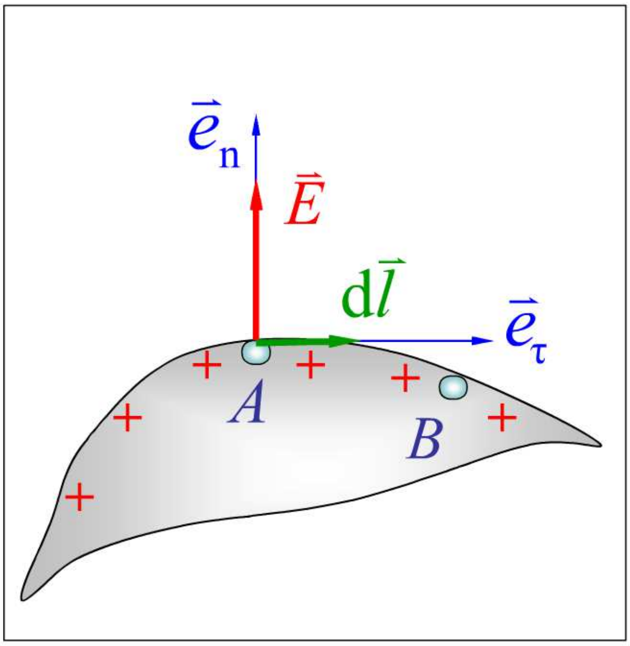
$\because \vec{E}=0$

$\therefore U_{AB}=\int_{AB}\vec{E}\cdot \mathrm{d}\vec{l}=0$

导体表面为等势面

$\because \vec{E}\perp \mathrm{d}\vec{l}$

$\therefore U_{AB}=\int_{AB}\vec{E}\cdot \mathrm{d}\vec{l}=0$



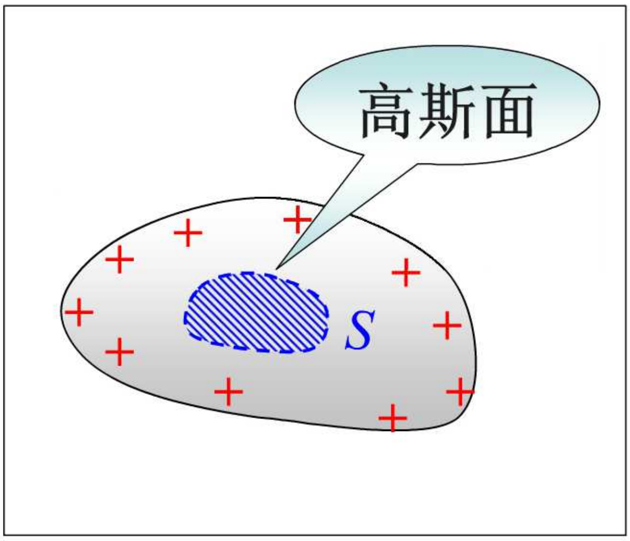
二　静电平衡时导体上电荷的分布

1　实心导体

$$\because \vec{E}=0$$

$$\oint_S \vec{E}\cdot d\vec{S}=0=\frac{q}{\varepsilon_0}$$

$$\therefore q=0$$



结论： 导体内部无净电荷，
电荷只分布在导体表面.

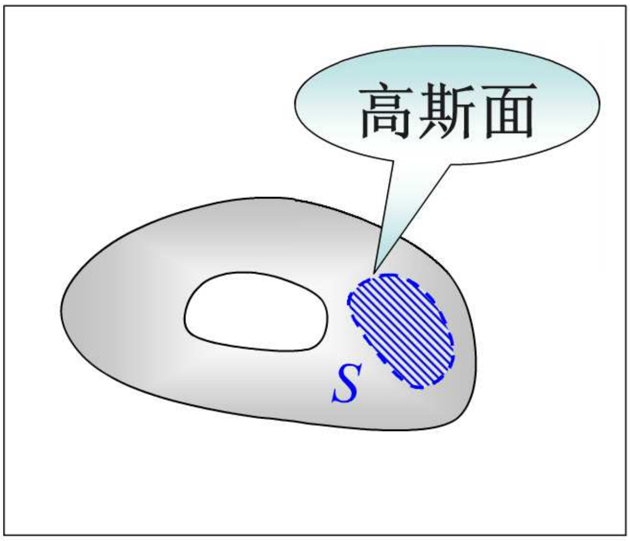
2 空腔导体

◆ 空腔内无电荷时

$$\oint_S \vec{E}\cdot \mathrm{d}\vec{S} = 0 \qquad \sum_i q_i = 0$$

电荷分布在表面

内表面？
外表面？

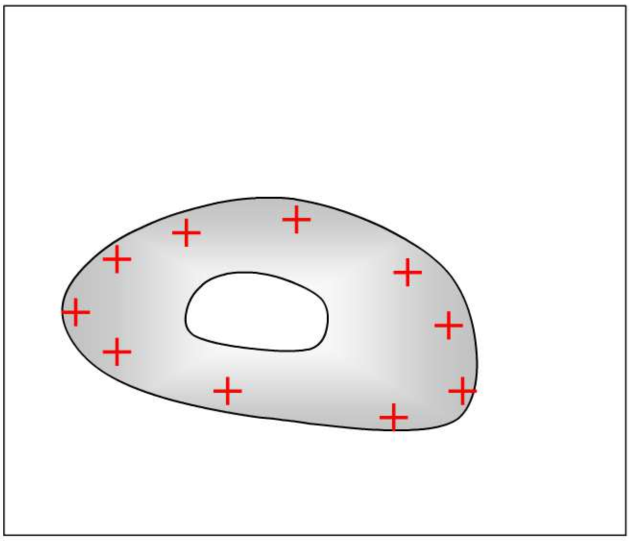


若内表面带电，必等量异号

$$\oint_S \vec{E}\cdot \mathrm{d}\vec{S} = \frac{\sum q_i}{\varepsilon_0} = 0$$

$$U_{AB} = \int_{AB} \vec{E}\cdot \mathrm{d}\vec{l} \neq 0$$

与导体是等势体矛盾

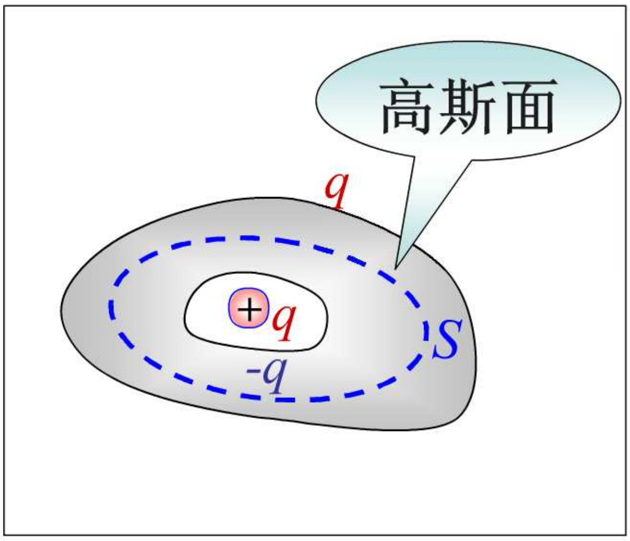


结论：空腔内无电荷时，电荷分布在外表面，内表面无电荷.

◈ 空腔内有电荷时

$$\oint_S \vec{E} \cdot \mathrm{d}\vec{S} = 0$$

$$\sum q_i = 0$$



结论: 空腔内有电荷+q时，空腔内表面有感应电荷-q，外表面有感应电荷+q.

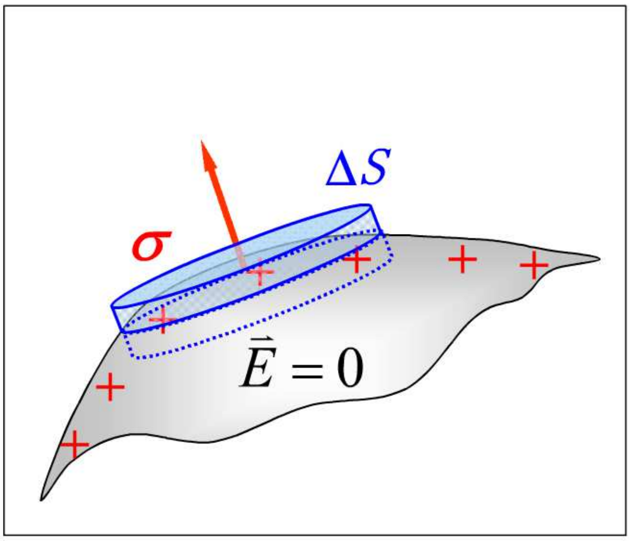
3 导体表面附近场强与电荷面密度的关系

作扁圆柱形高斯面

$$\oint_S \vec{E}\cdot \mathrm{d}\vec{S} = E\Delta S$$

$$= \sigma \Delta S / \varepsilon_0$$

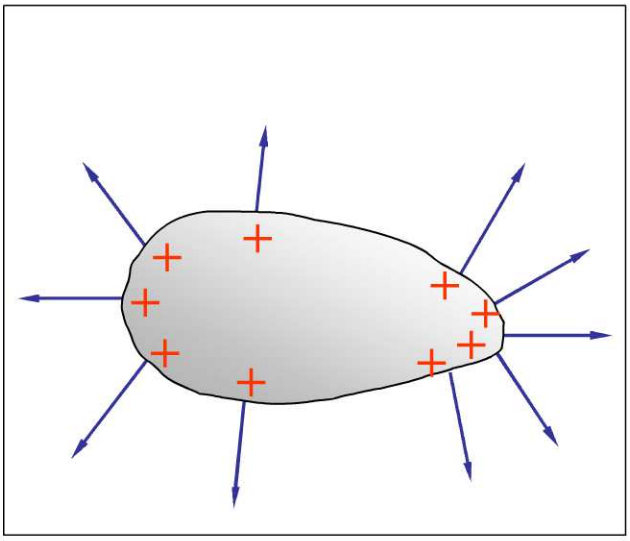
$$E = \frac{\sigma}{\varepsilon_0}$$



4 导体表面电荷分布规律

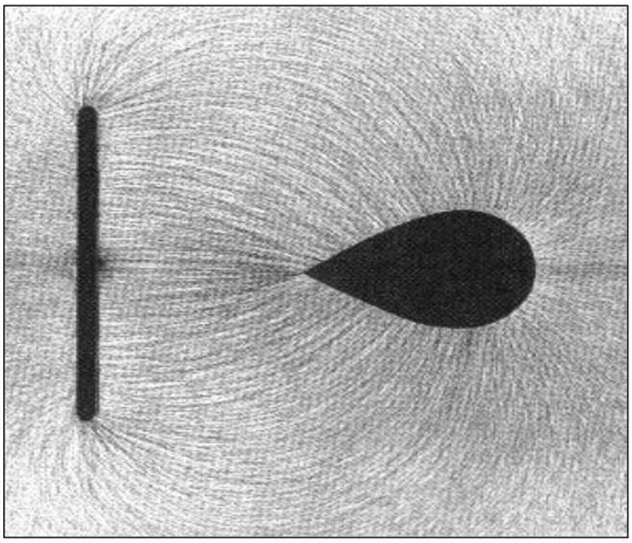
$$E=\frac{\sigma}{\varepsilon_0}$$

$$\sigma\uparrow E\uparrow;\sigma\downarrow,E\downarrow$$



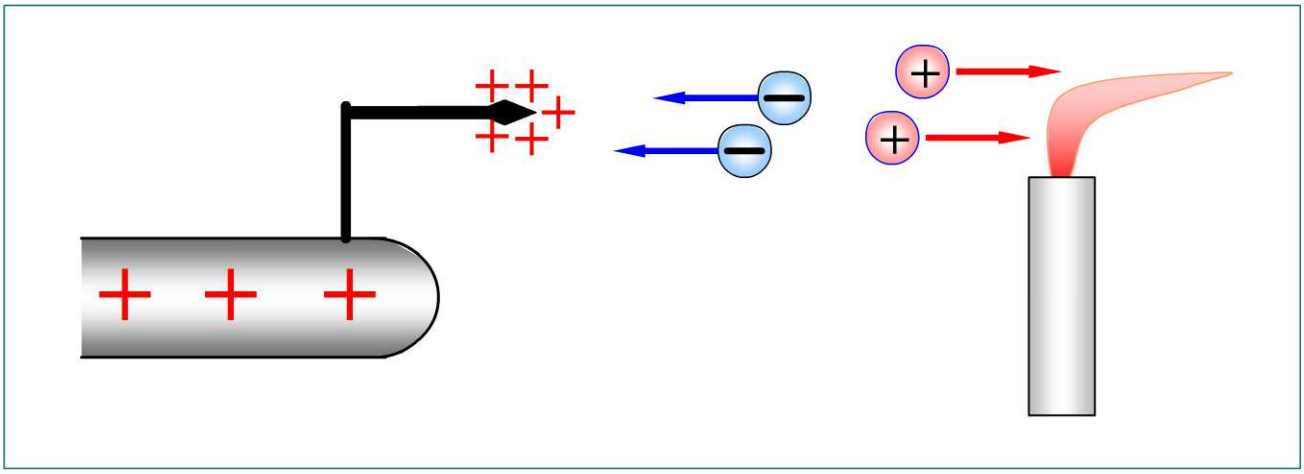
尖端放电现象

带电导体尖端附近的电场特别大，可使尖端附近的空气发生电离而成为导体产生放电现象.

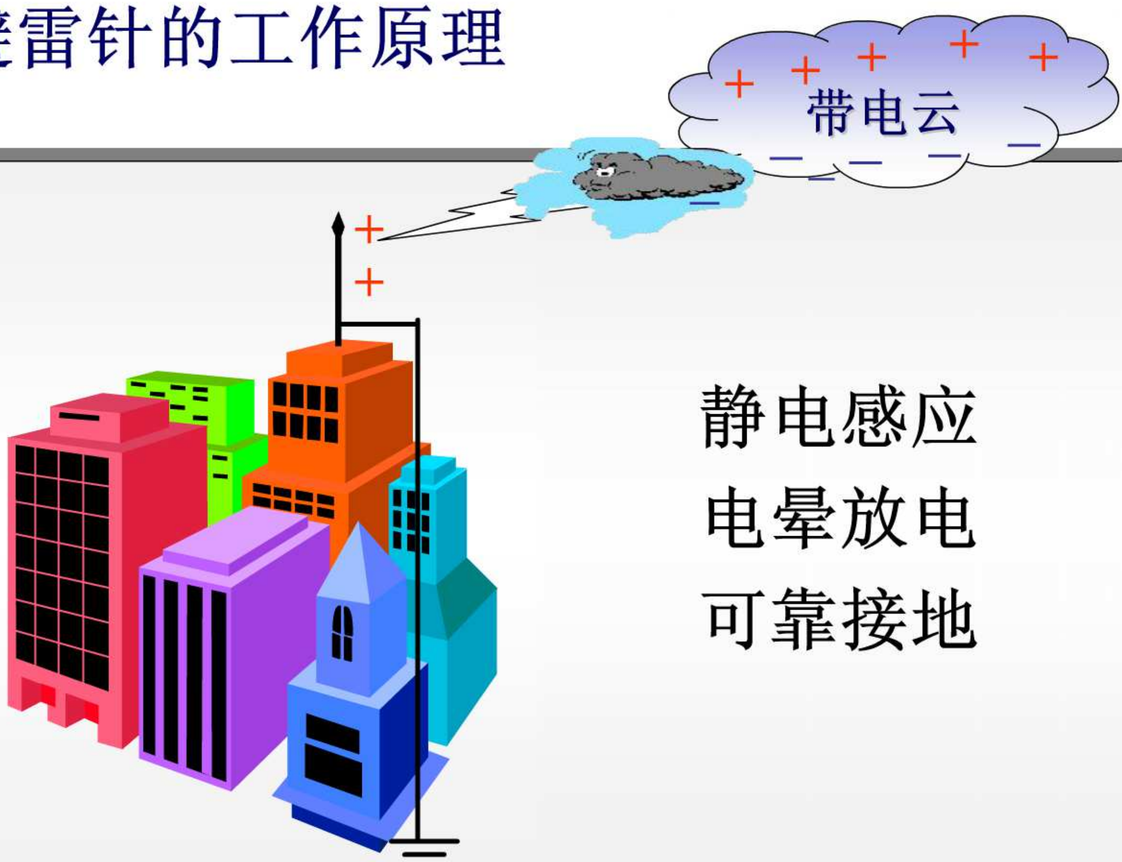


$\sigma \uparrow E \uparrow$

< 电风实验 >



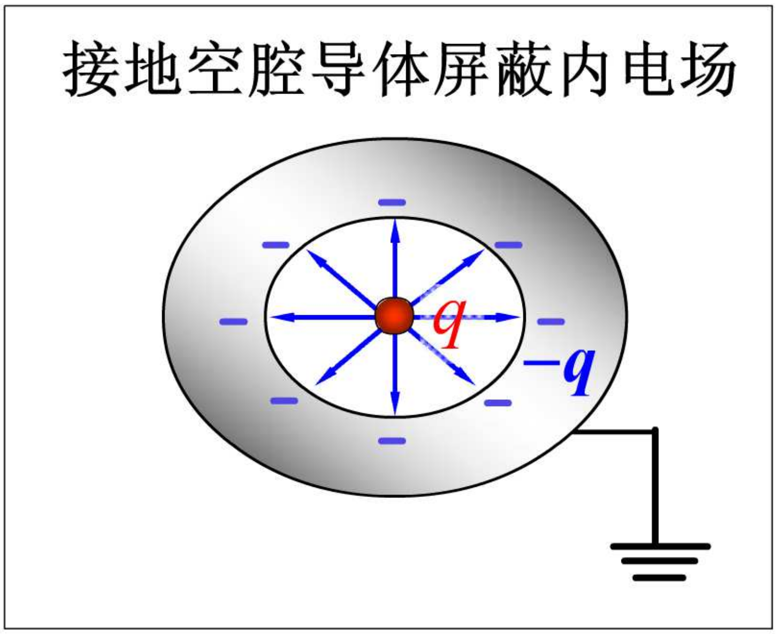
避雷针的工作原理



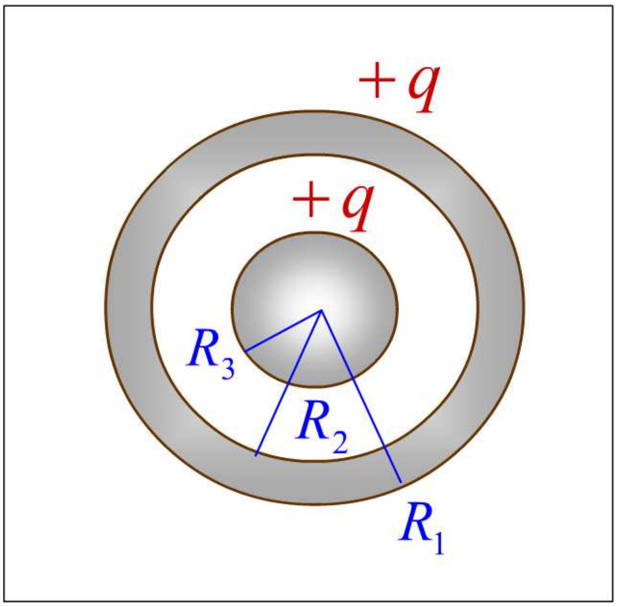
静电感应
电晕放电
可靠接地

三 静电屏蔽

2 屏蔽内电场



例 有一外半径R_1=10 cm，内半径R_2=7 cm的金属球壳，在球壳中放一半径R_3=5 cm的同心金属球，若使球壳和球均带有$q=10^{-8}$ C的正电荷，**问**两球体上的电荷如何分布？球心电势为多少？



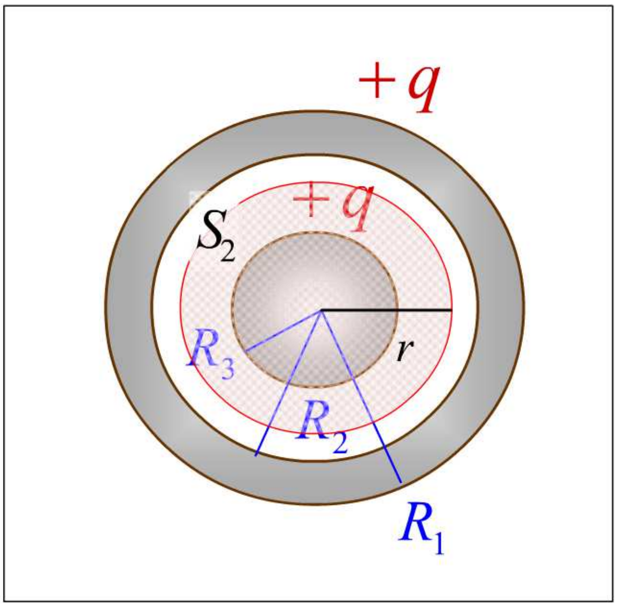
解 作球形高斯面 S_1

$$E_1 = 0 \quad (r < R_3)$$

作球形高斯面 S_2

$$\oint_{S_2} \vec{E}_2 \cdot \mathrm{d}\vec{S} = \frac{q}{\varepsilon_0}$$

$$E_2 = \frac{q}{4\pi\varepsilon_0 r^2} \quad (R_3 < r < R_2)$$

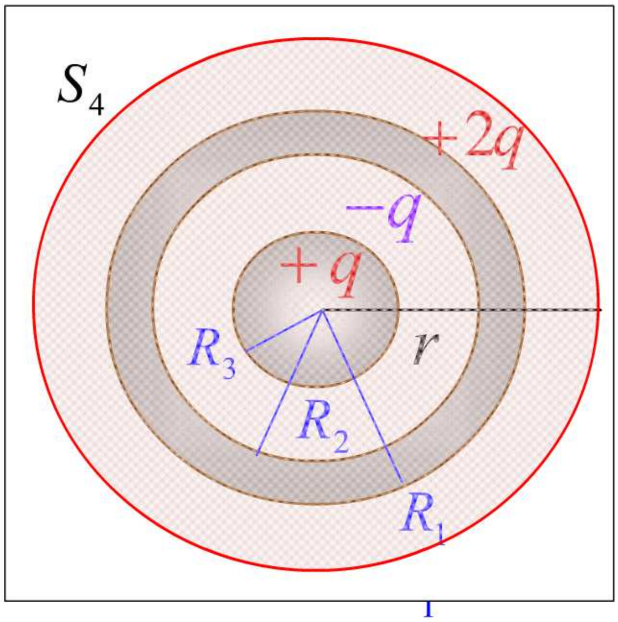


$$\oint_{S_3} \vec{E}_3 \cdot d\vec{S} = 0$$

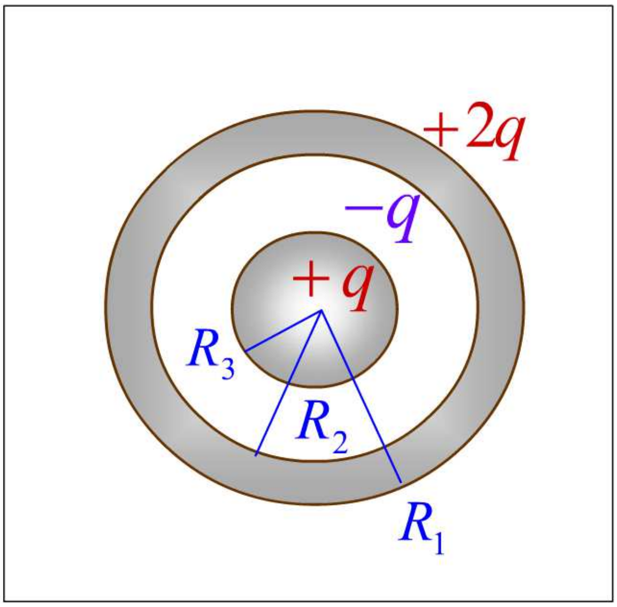
$$E_3 = 0 \quad (R_1 < r < R_2)$$

$$\oint_{S_4} \vec{E}_4 \cdot d\vec{S} = \frac{2q}{\varepsilon_0}$$

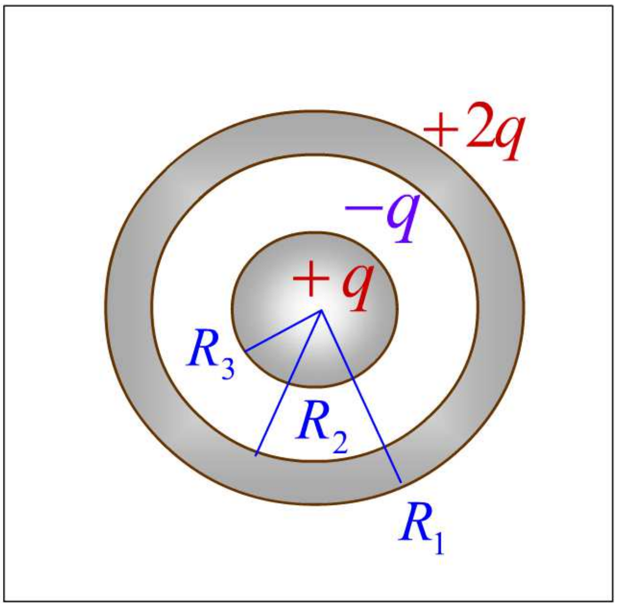
$$E_4 = \frac{2q}{4\pi\varepsilon_0 r^2} \quad (r > R_1)$$



$$
\begin{cases}
E_1 = 0 & (r < R_3) \\
E_2 = \dfrac{q}{4\pi\varepsilon_0 r^2} & (R_3 < r < R_2) \\
E_3 = 0 & (R_1 < r < R_2) \\
E_4 = \dfrac{2q}{4\pi\varepsilon_0 r^2} & (r > R_1)
\end{cases}
$$



$$V_o = \int_0^{\infty} \vec{E} \cdot \mathrm{d}\vec{l}$$
$$= \int_0^{R_3} \vec{E}_1 \cdot \mathrm{d}\vec{l} + \int_{R_3}^{R_2} \vec{E}_2 \cdot \mathrm{d}\vec{l}$$
$$+ \int_{R_2}^{R_1} \vec{E}_3 \cdot \mathrm{d}\vec{l} + \int_{R_1}^{\infty} \vec{E}_4 \cdot \mathrm{d}\vec{l}$$
$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{R_3} - \frac{1}{R_2} + \frac{2}{R_1}\right)$$
$$= 2.31 \times 10^3\ \mathrm{V}$$



R_1=10 cm，R_2=7 cm
R_3=5 cm，q=10^{-8} C