

1. Superpositionsprinzip

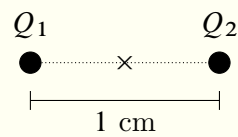
$$q = -1.0 * 10^{-9} \text{ C}; \quad Q = 8.0 * 10^{-6} \text{ C}; \quad k = \frac{1}{4\pi\epsilon_0}; \quad \vec{F} = k \frac{q_1 q_2}{r^2} \vec{r}$$

$$(a) \quad d = 0.01 \text{ m}; \quad r = \frac{d}{2}; \quad Q_1 = Q; \quad Q_2 = -Q$$

$$\vec{F}_1 = k \frac{qQ_1}{r^2} \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$\vec{F}_2 = k \frac{qQ_2}{r^2} \begin{pmatrix} -1 \\ 0 \end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 = \underline{\underline{\begin{pmatrix} -5.75 \\ 0 \end{pmatrix} \text{ N}}}$$



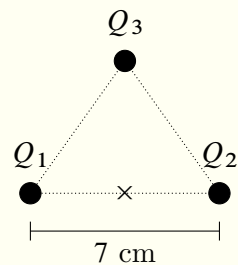
$$(b) \quad d = 0.07 \text{ m}; \quad r = \frac{d}{2}; \quad h = \sqrt{3}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = -Q$$

$$\vec{F}_1 = k \frac{qQ_1}{r^2} \begin{pmatrix} 1 \\ 0 \end{pmatrix}$$

$$\vec{F}_2 = k \frac{qQ_2}{r^2} \begin{pmatrix} -1 \\ 0 \end{pmatrix}$$

$$\vec{F}_3 = k \frac{qQ_3}{h^2} \begin{pmatrix} 0 \\ -1 \end{pmatrix}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = \underline{\underline{\begin{pmatrix} -0.12 \\ 0.020 \end{pmatrix} \text{ N}}}$$



(c) $d = 0.03 \text{ m}; \quad r = \frac{d}{2}; \quad s = \sqrt{5}r; \quad Q_1 = Q_3 = Q; \quad Q_2 = Q_4 = -Q$

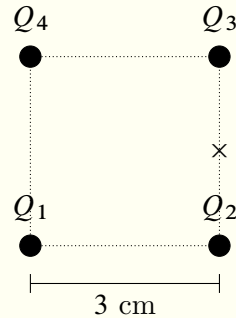
$$\vec{F}_1 = k \frac{qQ_1}{s^2} \begin{pmatrix} d \\ r \end{pmatrix} \frac{1}{s}$$

$$\vec{F}_2 = k \frac{qQ_2}{r^2} \begin{pmatrix} 0 \\ 1 \end{pmatrix}$$

$$\vec{F}_3 = k \frac{qQ_3}{r^2} \begin{pmatrix} 0 \\ -1 \end{pmatrix}$$

$$\vec{F}_4 = k \frac{qQ_4}{s^2} \begin{pmatrix} d \\ -r \end{pmatrix} \frac{1}{s}$$

$$\vec{F}_{ges} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 = \begin{pmatrix} 0 \\ 0.58 \end{pmatrix} \text{ N}$$



2. Sonnenwind und Ladungsneutralität

$$m = 10^{16} \text{ kg}; \quad k = \frac{1}{4\pi\epsilon_0}; \quad \vec{F} = k \frac{q_1 q_2}{r^2} \vec{r}$$

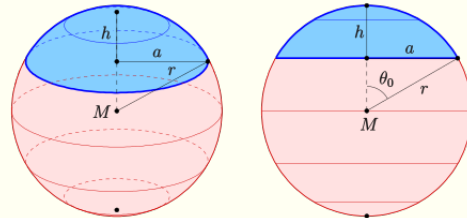
(a) $d = 1 \text{ AU}; \quad a = r_{Earth}; \quad r = \sqrt{d^2 + a^2}; \quad \theta_0 = \arctan\left(\frac{a}{d}\right)$

$$A = 4\pi d^2$$

$$O = 2\pi r^2 (1 - \cos(\theta_0))$$

$$\frac{O}{A} = \frac{r^2(1 - \cos(\theta_0))}{2d^2} = 4.54 * 10^{-10}$$

$$M = m \frac{O}{A} = \underline{\underline{4.54 * 10^6 \text{ kg}}}$$



(b) $m_P = m_{Proton}; \quad q_e = q_{elementary}; \quad m_a = m_{Earth}$

$$N_1 = \frac{M}{m_P}$$

(Amount of Protons reaching Earth)

$$N_2 = \frac{m}{m_P}$$

(Amount of Protons leaving Sun)

$$Q_1 = N_1 q_e$$

(Total Charge of Earth)

$$Q_2 = -N_2 q_e$$

(Total Charge of Sun)

$$F_C = k \frac{|Q_1 Q_2|}{d^2}$$

(Coulomb Force felt by Earth)

$$a_{\perp} = \frac{F_C}{m_a}$$

(Centripetal Accel. felt by Earth)

$$T = 2\pi \sqrt{\frac{d}{a_{\perp}}} = \underline{\underline{4.59 * 10^5 \text{ s}}}$$

- (c) If the solar wind consisted of electrons the observed effect would be the same, only of an entirely different order of magnitude, as the mass of an electron is 10^4 times smaller than the protons mass. Performing the same calculations outlined above I come to the conclusion that a purely electron-based stream of particles would lead to an orbital period of just over 4 minutes. Thank god we have a magnetic field shielding us ...

3. Millikan Versuch

$$r = 1.64 * 10^{-6} \text{ m}; \quad \rho = 851 \text{ kg/m}^3$$

(a) $V_{\text{Sphere}} = \frac{4}{3} \pi r^3; \quad m = V * \rho$

$$m = \frac{4}{3} \pi r^3 \rho = \underline{\underline{1.57 * 10^{-14} \text{ kg}}}$$

(b) $E_0 = \frac{F_C}{q} = 1.92 \text{ N/C}; \quad F_G = mg$

$$F_G = F_C$$

$$q = \frac{mg}{E_0}$$

$$= 8.03 * 10^{-14} \text{ C} = \underline{\underline{5.01 * 10^5 q_e}}$$