2.10.2013

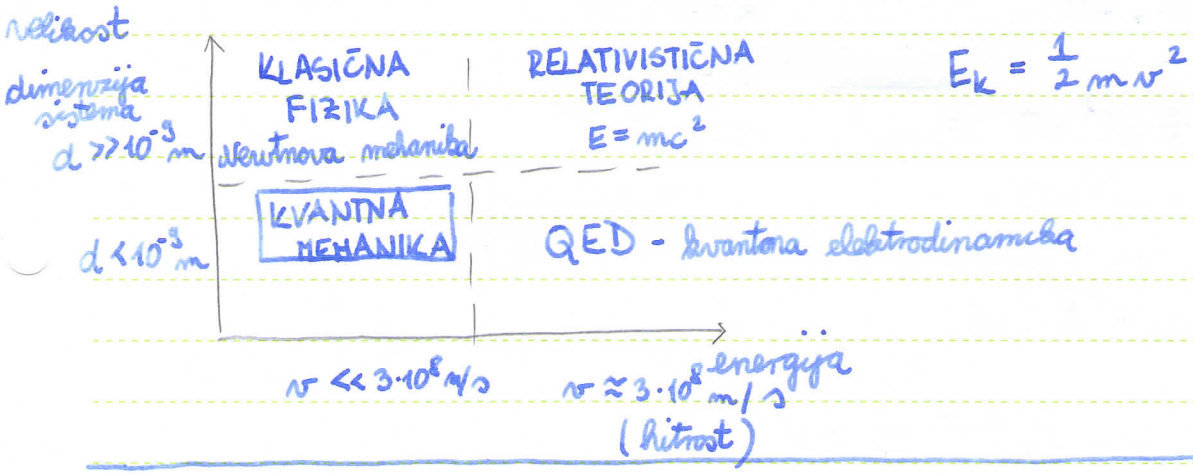
STRUKTURA ATOMOV IN MOLEKUL

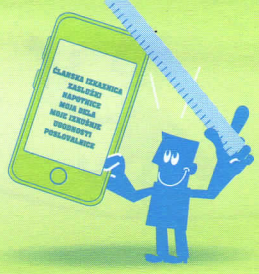
Predavanja: ob sredah 8^{15} - 2 uri predavanj, 1 ura seminarja
ob petkih -

Dva kolokvija oz. pisni izpit + ustni izpit:
VSE GRADIVO imaš lahko s seboj; na ustnem le učbenik

Učbeniki: Ilc: STRUKTURA ATOMOV IN MOLEKUL

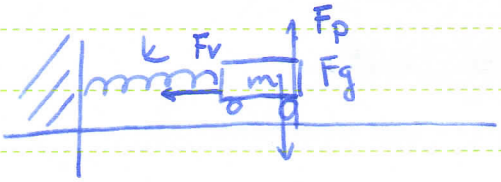
Znanje MAT in FIZ-e.





Newtonovi zakoni:

1) sile so = 0, če telo miruje ali se giblje enakomerno hitro
2) $F = m \cdot a$
3) akcija = reakcija



$y: F_p = F_g$

$x: -F = m \cdot a \rightarrow -kx = m\ddot{x}$

$F_v = k \cdot x$

$x \rightarrow v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$

$a = \ddot{x}$

$m\ddot{x} = -kx$ po Newtonu

$$m\ddot{x} + kx = 0 \quad / : m$$

$$\ddot{x} + \frac{k}{m}x = 0$$

$x = e^{\lambda t}$

$\dot{x} = \lambda e^{\lambda t}$

$\ddot{x} = \lambda^2 e^{\lambda t}$

$$\lambda^2 e^{\lambda t} + \frac{k}{m} e^{\lambda t} = 0 \qquad \boxed{\frac{k}{m} = \omega^2}$$

$$\lambda^2 + \omega^2 = 0$$

$$\lambda_{1,2} = \pm i\omega$$

rešitev: $x = A' e^{i\omega t} + B' e^{-i\omega t}$

$x = A\cos\omega t + B\sin\omega t \rightarrow$ iz Eulerjeve formule

$\dot{x} = -A\omega\sin\omega t + B\omega\cos\omega t$

$x(0) = x_0$ $\quad x_0 = A\cos 0 + B\sin 0$

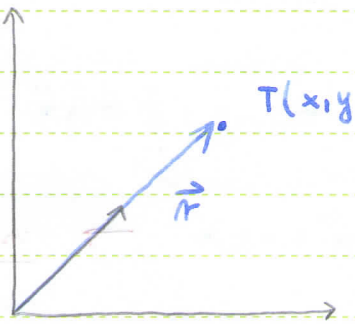
$\dot{x}(0) = 0$ $\quad 0 = -A\omega\sin 0 + B\omega\cos 0$

$x_0 = A$

$0 = B\omega \Rightarrow B = 0$

$x = x_0 \cos \omega t$ nihanje nihala (gibalna enačba)

$T(x, y, z)$



$\vec{r}(t)$

$\vec{v} = \dot{\vec{r}}$

$\vec{a} = \ddot{\vec{r}}$

$\vec{F} = m\ddot{\vec{r}}$

$v = -x_0 \omega \sin \omega t$ in $x = x_0 \cos \omega t$

Hamiltonov opis : $H = \sum$ vseh energij

IMPULZI - gibalna količina

 $\rightarrow H = W_k + W_{pr}$

$\dot{\vec{q}}_i = \frac{\partial H}{\partial \vec{p}_i}$

$\dot{\vec{p}}_i = -\frac{\partial H}{\partial \vec{q}_i}$

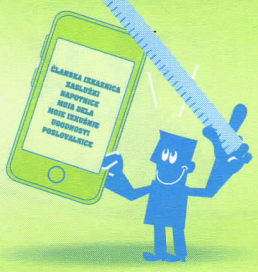
sferični koordinatni sistem : primer Zemlje (točka - oddaljenost od središča + 2 kota)

$H = \frac{1}{2} m v^2 + \frac{1}{2} k x^2 =$

$= \frac{p^2}{2m} + \frac{1}{2} k x^2$

gibalna količina :

$G = p$



$\dot{x} = \frac{\partial p}{\partial m} = \frac{p}{m}$ parcialna → po p-ju

$\dot{p} = -\frac{1}{2} k 2x = -kx$ odvoda → po q-ju

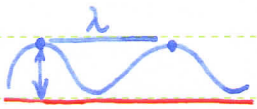
$\dot{x} = \frac{p}{m} \Rightarrow p = m\dot{x} \overset{\text{odvajamo}}{\Rightarrow} \dot{p} = m\ddot{x}$

$\dot{p} = -kx$

$m\ddot{x} = -kx \rightarrow \underline{m\ddot{x} = -kx}$

po Hamiltonu (težje)

VALOVANJE:



transverzalno valovanje (svetloba)

$s(x,t) = s_0 e^{-i(kx-\omega t)}$

valovni vektor $k = \frac{2\pi}{\lambda}$ → $\lambda = \frac{2\pi}{k}$

$\omega = 2\pi\nu$ → $\nu = \frac{\omega}{2\pi}$

$\nu\lambda = c \Rightarrow \boxed{\frac{\omega}{k} = c}$

[illegible] longitudinalno valovanje (zvok)

$\boxed{\frac{\partial^2 u}{\partial t^2} = c^2 \nabla^2 u}$

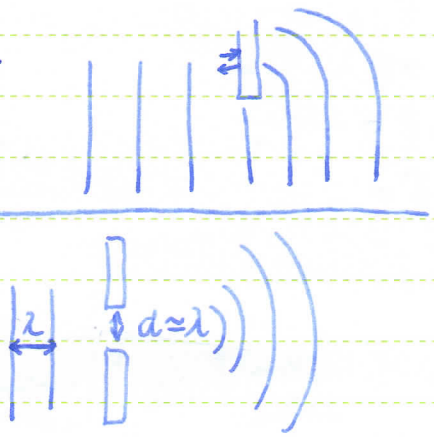
$\vec{\nabla} = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)$

$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

$\frac{\partial^2 u}{\partial t^2} = c^2\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right)$ parcialna diferencialna enačba

lastnosti valovanja:
- odboj
- lom
- interferenca
- uklon

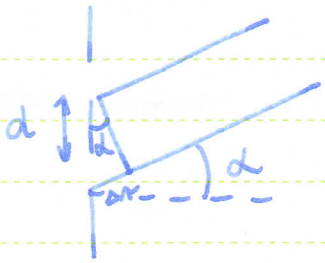
uklon:



interferenca:

$|r_1 - r_2| = N\lambda$ ojačitev → $|r_1 - r_2| = N\lambda$

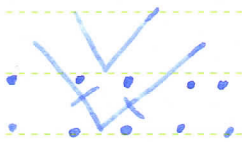
$|r_1 - r_2| = \frac{2N+1}{2}\lambda$ oslabitev → $|r_1 - r_2| = \frac{2N+1}{2}\lambda$



$\Delta r = N\lambda$

$\Delta r = d \sin\alpha$

$\boxed{d \sin\alpha = N\lambda}$



elektro-magnetno polje

Maxwellove enačbe (v dif. obliki):

① $\vec{\nabla}\vec{E} = \frac{\rho_e}{\varepsilon_0}$

② $\vec{\nabla}\vec{B} = 0$

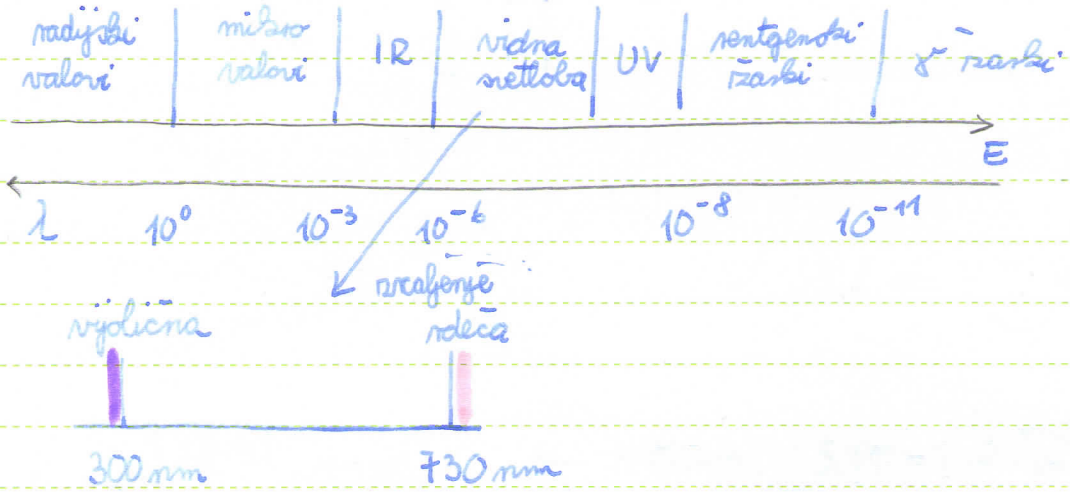
③ $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

④ $\vec{\nabla} \times \vec{B} = -\mu_0 \vec{j}_e + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$

$\Rightarrow$

$\nabla^2 \vec{E} = \frac{1}{c^2} \frac{\partial^2 \vec{E}}{\partial t^2}$ $\quad c_0 = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$

$\nabla^2 \vec{B} = \frac{1}{c^2} \frac{\partial^2 \vec{B}}{\partial t^2}$



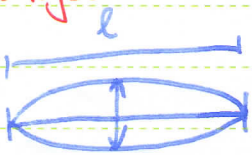
razvrščanje vidne svetlobe: preskok elektronov glede na energijske nivoje

mikrovalovka: rotirajo dipolov → T se povečа zaradi trenja in gibanja

γ-žarki: sprememba energije jedra

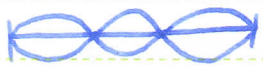
PEK SAIM, 2. pred., 4. 10. 13

stoječe valovanje:



$\Rightarrow \lambda_1 = 2l \Rightarrow \nu_1 = \frac{c}{\lambda_1} = \frac{c}{2l}$

$\Rightarrow \lambda_2 = l \Rightarrow \nu_2 = \frac{c}{l} = 2\nu_1$



$\Rightarrow \lambda_3 = \frac{2}{3}l \Rightarrow \nu_3 = \frac{3c}{2l} = 3\nu_1$

$\Rightarrow \lambda_4 = \frac{l}{2} \Rightarrow \nu_4 = \frac{4c}{2l} = 4\nu_1$

$\boxed{c = \lambda\nu}$ $\quad c = \sqrt{\frac{F}{\rho}}$

$\boxed{c^2 \frac{\partial^2 u}{\partial x^2} = \frac{\partial^2 u}{\partial t^2}}$ $\quad u(x,t) = X(x)T(x)$

$\frac{\partial u}{\partial x} = \dot{X}T$

$\frac{\partial^2 u}{\partial x^2} = \ddot{X}T$

$\frac{\partial u}{\partial t} = X\cdot\dot{T}$

$\frac{\partial^2 u}{\partial t^2} = X\cdot\ddot{T}$

$c^2 \ddot{X} T = X \cdot \ddot{T} \quad / : (XT) \quad u = XT$

$c^2 \frac{\ddot{X}T}{XT} = \frac{X\ddot{T}}{XT}$

$\frac{c^2 \frac{\ddot{X}}{X}}{f(x)} = \frac{\frac{\ddot{T}}{T}}{g(t)} = -\omega^2$

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1) $c^2 \frac{\ddot{x}}{x} = -\omega^2 / \cdot x \qquad \frac{\ddot{T}}{T} = -\omega^2$

$c^2 \ddot{x} = -\omega^2 x$

$c^2 \ddot{x} + \omega^2 x = 0 \; / : c^2$

$\ddot{x} + \frac{\omega^2}{c^2} x = 0$

$u(0,t) = 0 \Rightarrow X(0)T(t) = 0 \quad / : T(t)$

$u(l,t) = 0 \Rightarrow X(l) \cdot T(t) = 0 \; / : T(t)$

$\Downarrow$

$X(0) = 0$

$X(l) = 0$

$$\boxed{X = A \cos \frac{\omega}{c} x + B \sin \frac{\omega}{c} x}$$

$X(0) = A \cos \frac{\omega}{c} 0 + B \sin \frac{\omega}{c} 0 = 0 \Rightarrow \boxed{A = 0}$

$X(l) = B \sin \frac{\omega l}{c} = 0$

1) $B = 0$ ni fizikalna rešitev → ni valovanja, saj je $u = 0$

2) $\sin \frac{\omega l}{c} = 0$

$\frac{\omega l}{c} = n\pi \; ; \; n \in \mathbb{N}$

$\omega_n \; (\text{odvisen od } n \in \mathbb{N}) = \frac{n\pi c}{l}$

$\omega = 2\pi\nu \Rightarrow \nu_n = \frac{\omega}{2\pi} = \frac{n\pi c}{2\pi l} = \boxed{\frac{nc}{2l}}$

DOKAZ ZA STRUNE

$n = 1 \Rightarrow \nu_1 = \frac{c}{2l}$

$n = 4 \Rightarrow \nu_4 = \frac{2c}{l} = 4\nu_1$

$X_n = B \sin \frac{n\pi x}{l}$

n-ta možna frekvenca

$\frac{\ddot{T}_n}{T_n} = -\omega^2 \qquad \ddot{T}_n = -\omega^2 T_n \Rightarrow \ddot{T}_n + \omega^2 T_n = 0$

$T_n = C \sin \omega_n t + D \cos \omega_n t$

$u_n = B \sin \frac{n\pi x}{l} \cdot (C \sin \omega_n t + D \cos \omega_n t)$

$u_n = \sin \frac{n\pi x}{l} \left(\frac{B \cdot C}{A'} \sin \omega_n t + \frac{BD}{B'} \cos \omega_n t \right)$

ENOTE:

meter - m

$1\ mm = 10^{-3}\ m$

$1\ Å = 10^{-10}\ m$

$W\ [J = Nm = \frac{kg\,m^2}{s^2}]$

sekunda - s

1 eV (elektronski volt)

↓

amper - A

energija, ki jo dobi e^-, ko prepotuje napetost 1 volta (V)

kilogram - kg

množina snovi - mol

$1\ eV = 1 \cdot 1{,}6 \cdot 10^{-19}\ AsV = \frac{1}{4}\ 1{,}6 \cdot 10^{-19}\ J$

$1\ \frac{kcal}{mol}$ $\quad 1\ cal = 4{,}1686\ J$

↓

energija, ki 1 g vode segreje za 1°C (pri 14'5°C - 15'5°C pri 1 atm)