INTERFERENCIJA N IZVORA

$$\delta = d\sin\theta, \varphi = \frac{2\pi}{\lambda}\delta; \cos\omega t = \mathrm{Re}\, e^{iwt}$$

$$\overline{E} = \sum_{1}^{N} \overline{E_i} \to E_1 = E_0 e^{i\omega t} \ldots E_N = E_0 e^{i[\omega t + c]} \ldots$$

$$E = E_0 e^{i\omega t}\left[1 + e^{i\varphi} + ..e^{i(N-1)\varphi}\right] \left\| S_N = \frac{e^{iN\varphi}-1}{e^{i\varphi}-1} \right\| \ldots$$

$$E = E_0 e^{i\omega t} \frac{e^{iN\frac{\varphi}{2}}}{e^{i\frac{\varphi}{2}}} \frac{e^{iN\frac{\varphi}{2}} - e^{-iN\frac{\varphi}{2}}}{e^{i\frac{\varphi}{2}} - e^{-i\frac{\varphi}{2}}} \ldots = E_0 e^{i\left[\omega t + (N-1)\frac{\varphi}{2}\right]} \frac{\sin N\frac{\varphi}{2}}{\sin\frac{\varphi}{2}}$$

$$E = E(\theta) e^{i\left[\omega t + (N-1)\frac{\varphi}{2}\right]} - amplituda$$

$$I = \frac{1}{2}\sqrt{\frac{\varepsilon_0}{\mu_0}} E(\theta)^2 \ldots = I_0 \frac{\sin^2 N\frac{\varphi}{2}}{\sin^2\frac{\varphi}{2}} = I_0 \frac{\sin^2 Ny}{\sin^2 y}$$

$$\varphi = 0 \to y = 0 \to \lim_{y\to 0} \frac{\sin^2 Ny}{\sin^2 y} = N^2 \to I = N^2 I_0$$

PLANCKOV ZAKON ZRAČENJA

$$E \sim \frac{1}{\lambda} \to f(\lambda, T) = \frac{c}{4}\frac{8\pi}{\lambda^4}\frac{hc}{\lambda}\frac{1}{e^{\frac{hc}{\lambda kT}}-1}$$

$$\boxed{f_{ct}(\lambda, T) = \frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{\frac{hc}{\lambda kT}}-1}}, E = h\nu$$

f_{ct} – spektralna gust, h – Planckova konst.

c – brzina svj.vakum, k – Boltzman.konst.

ZAKON RADIOAKTIVNOG RASPADA

-brzina kojom se radioaktivni materijal raspada:

$$-\frac{dN}{dt} \to aktivnost\left[Bq = s^{-1}\right](\text{bekerel})$$

$$-\frac{dN}{dt} = \lambda N;\ \lambda - \text{konstanta raspada}$$

$$\int_{N_0}^{N} \frac{dN}{N} = \int_{t=0}^{t} -\lambda dt \to N = N_0 e^{-\lambda t}$$

N_0 - početni broj jezgri(t=0)

N- broj neraspadnutih jegri preostao nakon t

- ako je $\left(-\frac{dN}{dZ}\right)_0$ početna aktivnost uzoraka:

$$-\frac{dN}{dt} = \lambda N;\ -\frac{dN}{dt} = \lambda N_0 e^{-\lambda t} = \left(-\frac{dN}{dt}\right)_0 e^{-\lambda t}$$

vrijeme poluraspada:

$$t = T_{1/2};\ N = \frac{N_0}{2};\ T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0,693}{\lambda}$$

srednje vrijeme života τ jezgre:

$$\tau = \frac{\int_{N_0}^{0} tdN}{\int_{N_0}^{0} dN} = \frac{\int_0^{\infty} N_0 \lambda t e^{-\lambda t} dt}{N_0} = \frac{1}{\lambda};$$

$$\tau = t \to N = \frac{N_0}{e}$$

COMPTONOV EFEKT

-pri sudaru fotona i elektrona, fot. izgubi dio svoje E i smanji mu se frek., a λ poveća

-m=masa elek.; ν =frek.fot.prije sudara; ν' =nakon sud.

$$h\nu + m_0c^2 = h\nu' + mc^2$$

$$i: (mv)^2 = (h\frac{\nu}{c})^2 + (h\frac{\nu'}{c})^2 - 2\frac{h^2\nu\nu'}{c^2}\cos\vartheta$$

$$ii: (mc)^2 = (m_0c)^2 + 2m_0h(\nu - \nu') + \frac{h^2}{c^2}\nu^2 -$$

$$-2\frac{h^2}{c^2}\nu\nu' + \frac{h^2}{c^2}\nu'^2$$

$$i - ii: m^2(c^2 - v^2) = m_0^2c^2 - 2\frac{h^2}{c^2}\nu\nu'(1-\cos\vartheta) +$$

$$+2m_0h(\nu - \nu')$$

$$m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}; m^2c^2 - m^2v^2 = m_0^2c^2$$

$$\to \Delta\lambda = \lambda' - \lambda = \frac{h}{m_0c}(1-\cos\vartheta) = \frac{2h}{m_0c}\sin^2\frac{\vartheta}{2}$$

BOHROV MODEL ATOMA

Elektron ne može kružiti oko jezgre po bilo kojoj stazi, nego po točno određenim *kvantiziranim stazama*. Dozvoljene staze su one čija je količina gibanja= višekratniku Planckove konstante/2 π (h/2 π). Bohrov kvantni uvjet:

$$L = r_n m_e v_n = nh = 2\pi r_n m_e v_n (n = 1, 2, \ldots)$$

Atom zrači ili apsorbira zračenje, kada prelazi iz 1. u 2. stazu.

$$h\nu = E_m - E_n \Rightarrow \nu = \frac{E_m - E_n}{h}$$

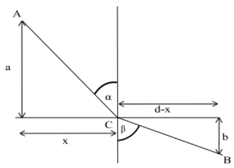
-kada prelazi iz višeg u nižu stazu: $E_m > E_n$, razlika se emitira u obliku svjetlosnog kvanta

- u suprotnom, E se apsorbira $\Delta E = E_m - E_n$

2. postulat: pri skoku elek. zrači ili apsorbira foton čija je frekv1.

$$h\nu = E_m - E_n$$

FERMATOV PRINCIP I LOM SVJETLOSTI



$$t_{AB} = t_{AC} + t_{CB} = \frac{\overline{AC}}{v_1} + \frac{\overline{CB}}{v_2} = \frac{\sqrt{a^2+x^2}}{v_1} + \frac{\sqrt{b^2+(d-x)^2}}{v_2}$$

$$\frac{dt_{AB}}{dx} = \frac{1}{v_1}\cdot\frac{2x}{2\sqrt{a^2+x^2}} + \frac{1}{v_2}\cdot\frac{2(d-x)(-1)}{2\sqrt{b^2+(d-x)^2}} = 0$$

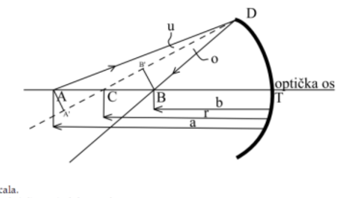
$$\sin\alpha = \frac{x}{\sqrt{a^2+x^2}} \qquad \sin\beta = \frac{d-x}{\sqrt{b^2+(d-x)^2}}$$

$$\frac{\sin\alpha}{v_1} = \frac{\sin\beta}{v_2} \Rightarrow \frac{n_1}{c}\sin\alpha = \frac{n_2}{c}\sin\beta$$

$$n_1\sin\alpha = n_2\sin\beta$$

$$\boxed{\frac{\sin\alpha}{\sin\beta} = \frac{n_2}{n_1}}$$

JEDNADŽBA SFERNOG



T - Tjeme zrcala.
C - Središte zakrivljenosti plohe zrcala.

$$\triangle AA'C \cong \triangle BB'C$$

$$\triangle AA'D \cong \triangle BB'D$$

ZRCALA

$$\frac{\overline{AA'}}{\overline{AC}} = \frac{\overline{BB'}}{\overline{BC}} \quad i \quad \frac{\overline{AA'}}{\overline{AD}} = \frac{\overline{BB'}}{\overline{BD}} \quad \Rightarrow \quad \frac{\overline{AD}}{\overline{AC}} = \frac{\overline{BD}}{\overline{BC}}$$

Ograničimo se samo na zrake za koje vrijedi Gaussova aproksimacija, odnosno:

$$\overline{AD} \cong \overline{AT} \ \ i \ \ \overline{BD} \cong \overline{BT}$$

Zbog toga jednadžba dobiva oblik:

$$\frac{\overline{AC}}{\overline{AT}} = \frac{\overline{BC}}{\overline{BT}}$$

$\overline{AT} = a$ - Predmetna duljina.
$\overline{BT} = b$ - Slikovna duljina.
$\overline{CT} = r$ - Polumjer zakrivljenosti zrcala.
Koristeći te oznake, jednadžba dobiva oblik:

$$\frac{a}{a-r} = \frac{b}{r-b}$$

$$a(r-b) = b(a-r)$$

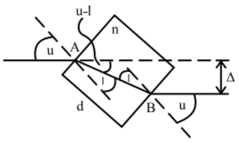
$$ar - ab = ba - br$$

Sve dijelimo sa abr

$$\frac{1}{b} - \frac{1}{r} = \frac{1}{r} - \frac{1}{a}$$

$$\boxed{\tfrac{1}{b} + \tfrac{1}{a} = \tfrac{2}{r}}$$

PLANPARALELNA PLOČA



n - Indeks loma sredstva od kojeg je načinjena ploča.
d - Debljina ploče.
u - Upadni kut.
l - Kut loma

$$\sin(u-l) = \frac{\Delta}{\overline{AB}} \quad \cos l = \frac{d}{\overline{AB}}$$

$$\Delta = \overline{AB}\sin(u-l) = \frac{d}{\cos l} \cdot \sin(u-l)$$

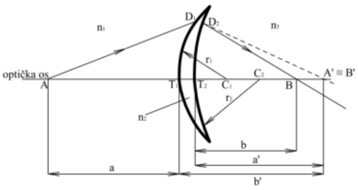
Snellov zakon loma: $\frac{\sin u}{\sin l} = n, \sin l = \frac{\sin u}{n} \Rightarrow \cos l = \sqrt{1 - \frac{\sin^2 u}{n}}$

$$\sin(u-l) = \sin u \cos l - \cos u \sin l$$

$$\Delta = \frac{d}{\cos l}(\sin u \cos l - \cos u \sin l) = d\left(\sin u - \cos u \frac{\sin u}{n \cos l}\right) =$$

$$= d \sin u \left(1 - \frac{\cos u}{n\sqrt{1 - \frac{\sin^2 u}{n^2}}}\right) = d \sin u \left(1 - \frac{\cos u}{\sqrt{n^2 - \sin^2 u}}\right)$$

JEDNADŽBA TANKE LEĆE



Imamo svijetli predmet u točki A.
$\overline{AT_1} = a$ - Predmetna udaljenost.
$\overline{T_2B} = b$ - Slikovna udaljenost.
$\overline{T_1B'} = b'$
$b' \rightarrow a' + \overline{T_1T_2}$
$\overline{T_1B'} = a'$
$b' = a' + \overline{T_1T_2} = b'$

Lom na prvoj sfernoj granici:

$A \xrightarrow{n_1} D_1 \xrightarrow{n_2} B'$

Uz Gaussove aproksimacije imamo:

$$\frac{n_1}{a} + \frac{n_2}{b'} = \frac{n_2 - n_1}{r_1}$$

Lom na drugoj sfernoj granici:

$B' \xrightarrow{n_2} D_2 \xrightarrow{n_3} B$

Uz Gaussove aproksimacije imamo:

$$\frac{n_2}{a'} + \frac{n_3}{b} = \frac{n_3 - n_2}{r_2}$$

Tanka leća $\rightarrow \overline{T_1T_2} \approx 0, |b'| = |a'|$
$A' \equiv B'$ desno od sferne granice $a' < 0, b' > 0, a' = -b'$.

$$\frac{n_1}{a} + \frac{n_2}{b'} = \frac{n_2 - n_1}{r_1} \Rightarrow \frac{n_2}{b'} = \frac{n_2 - n_1}{r_1} - \frac{n_1}{a}$$

$$\frac{-n_2}{b'} + \frac{n_3}{b} = \frac{n_3 - n_2}{r_2} \Rightarrow \frac{n_2}{b'} = \frac{n_3}{b} - \frac{n_3 - n_2}{r_2}$$

$$\frac{n_2 - n_1}{r_1} - \frac{n_1}{a} = \frac{n_3}{b} - \frac{n_3 - n_2}{r_2}$$

$$\boxed{\frac{n_1}{a} + \frac{n_3}{b} = \frac{n_2 - n_1}{r_1} + \frac{n_3 - n_2}{r_2}}$$