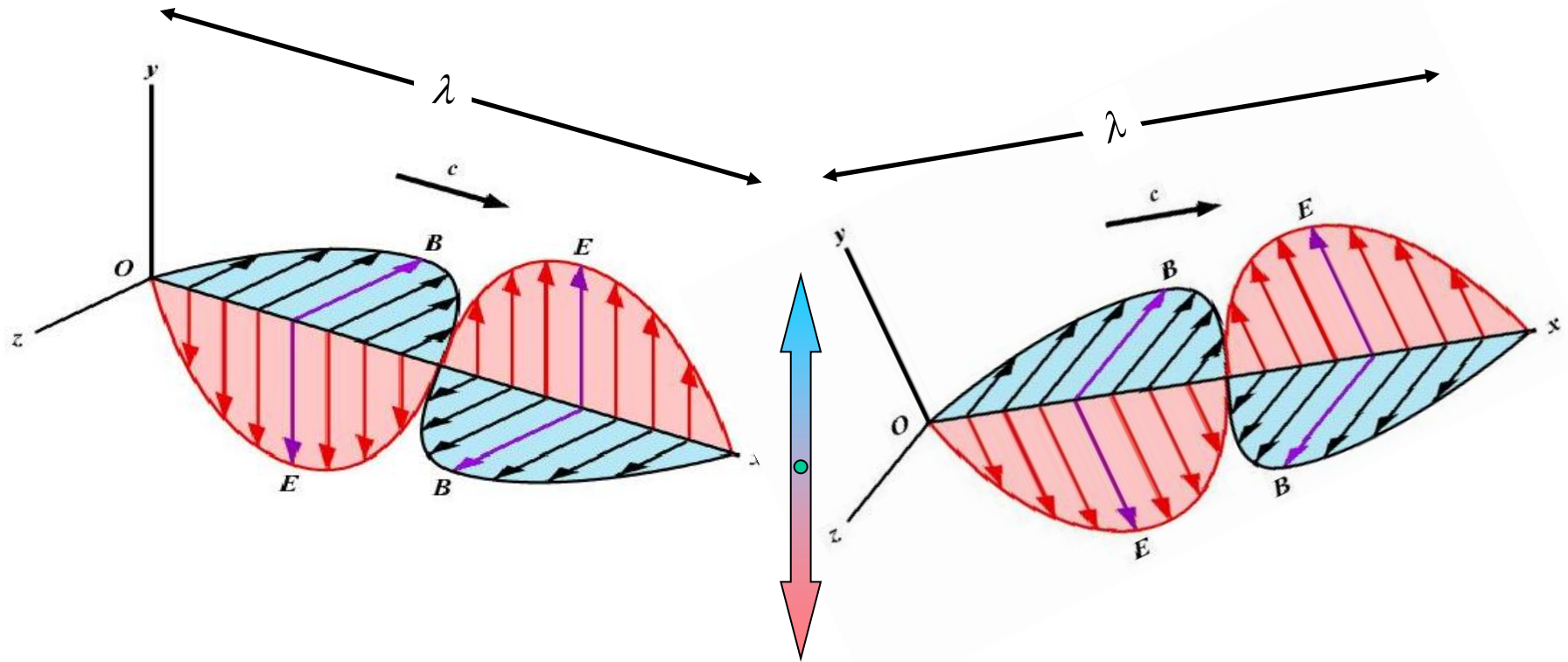


EM sugárzások kölcsönhatásai

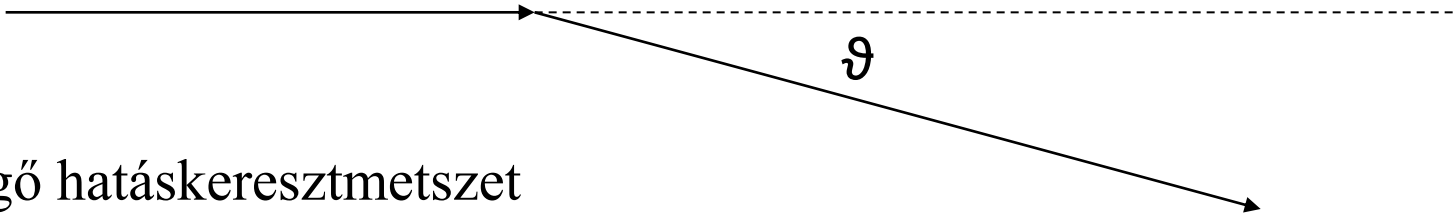
I. Szabad elektron – Thomson szórás

nem polarizált elektromágneses-nyaláb

$$h\nu \ll m_e c^2$$



Harmonikus oszcillátor



szögfüggő hatáskeresztmetszet

(egységnyi térszögbe kisugárzott energiahányad)

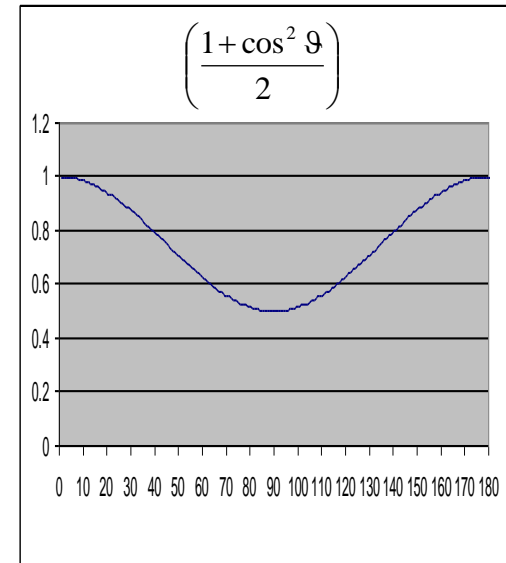
klasszikus elektronsugár

$$\frac{d\sigma_T}{d\Omega} = \left(\frac{e^2}{4\pi\epsilon_0 \cdot m_e c^2} \right)^2 \frac{1 + \cos^2 \vartheta}{2}$$

$$r_0 = \frac{e^2}{4\pi\epsilon_0 m_e c^2} \approx 2,8179 \cdot 10^{-15} m$$

$$\sigma_T = \int_0^\pi \frac{d\sigma_T}{d\Omega} d\Omega = \frac{8}{3} \pi r_0^2$$

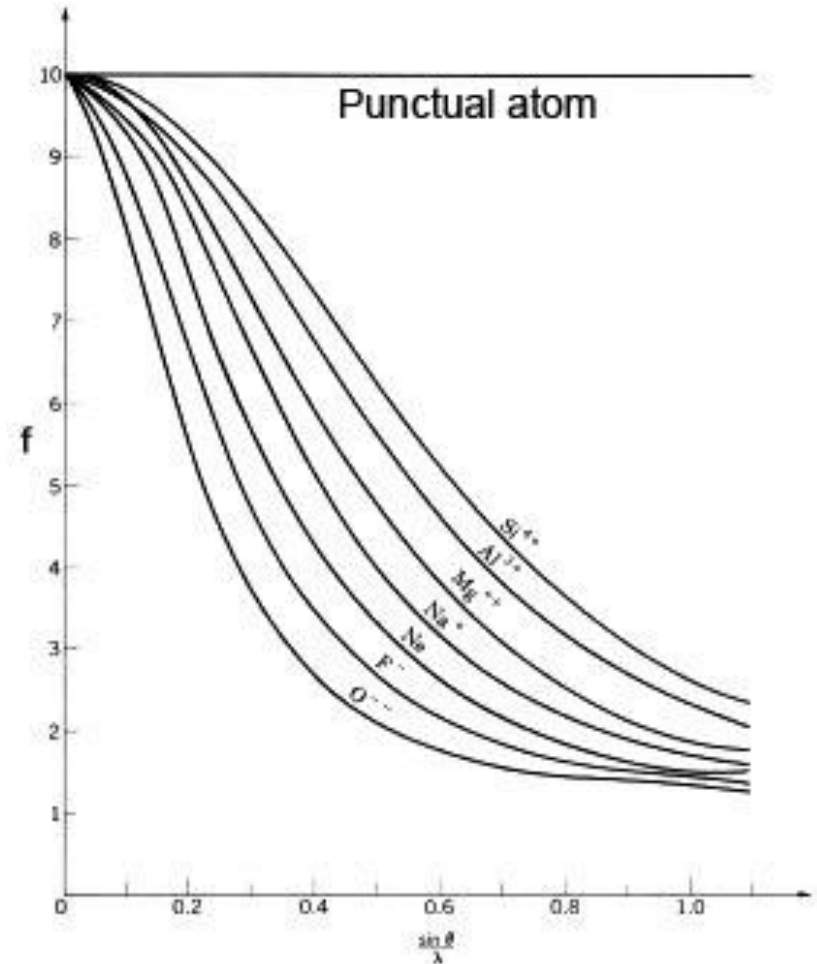
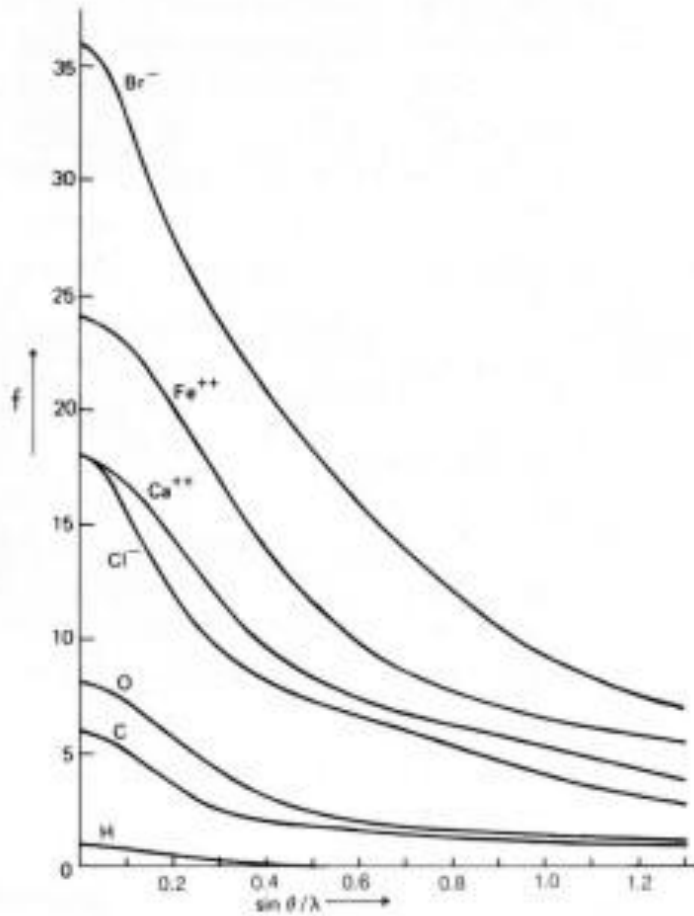
$$I(R) = I_0 \left(\frac{e^4}{4\pi\epsilon_0 \cdot R^2 \cdot (m_e c^2)^2} \right) \left(\frac{1 + \cos^2 \vartheta}{2} \right)$$



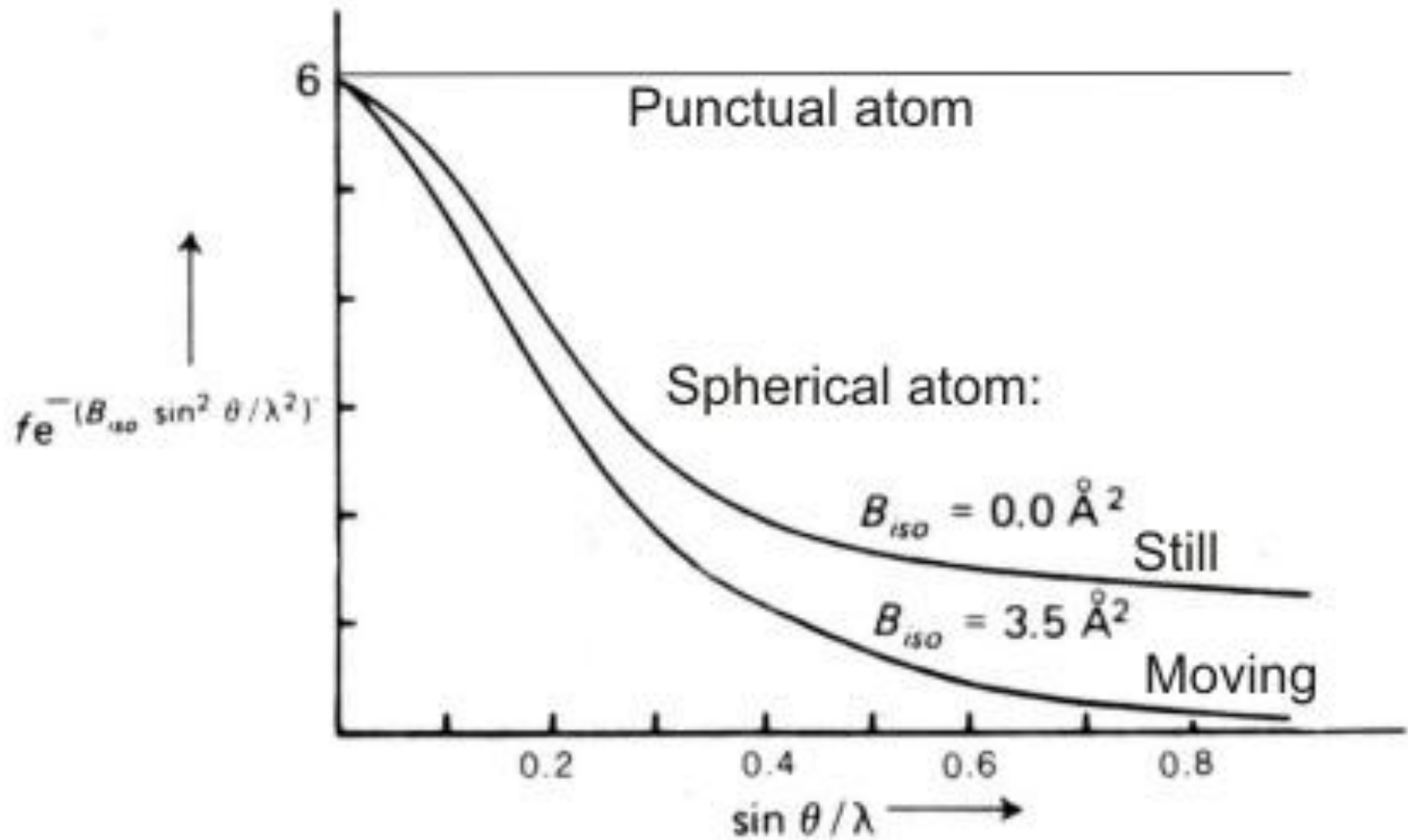
II. Kötött elektron – Rayleigh szórás

$\sigma_R = \sigma_T \cdot f^2(x, Z)$ - szórási faktor

$x = \frac{\sin(\vartheta)}{\lambda}$ – momentum transzfer



Hőmozgás hatása



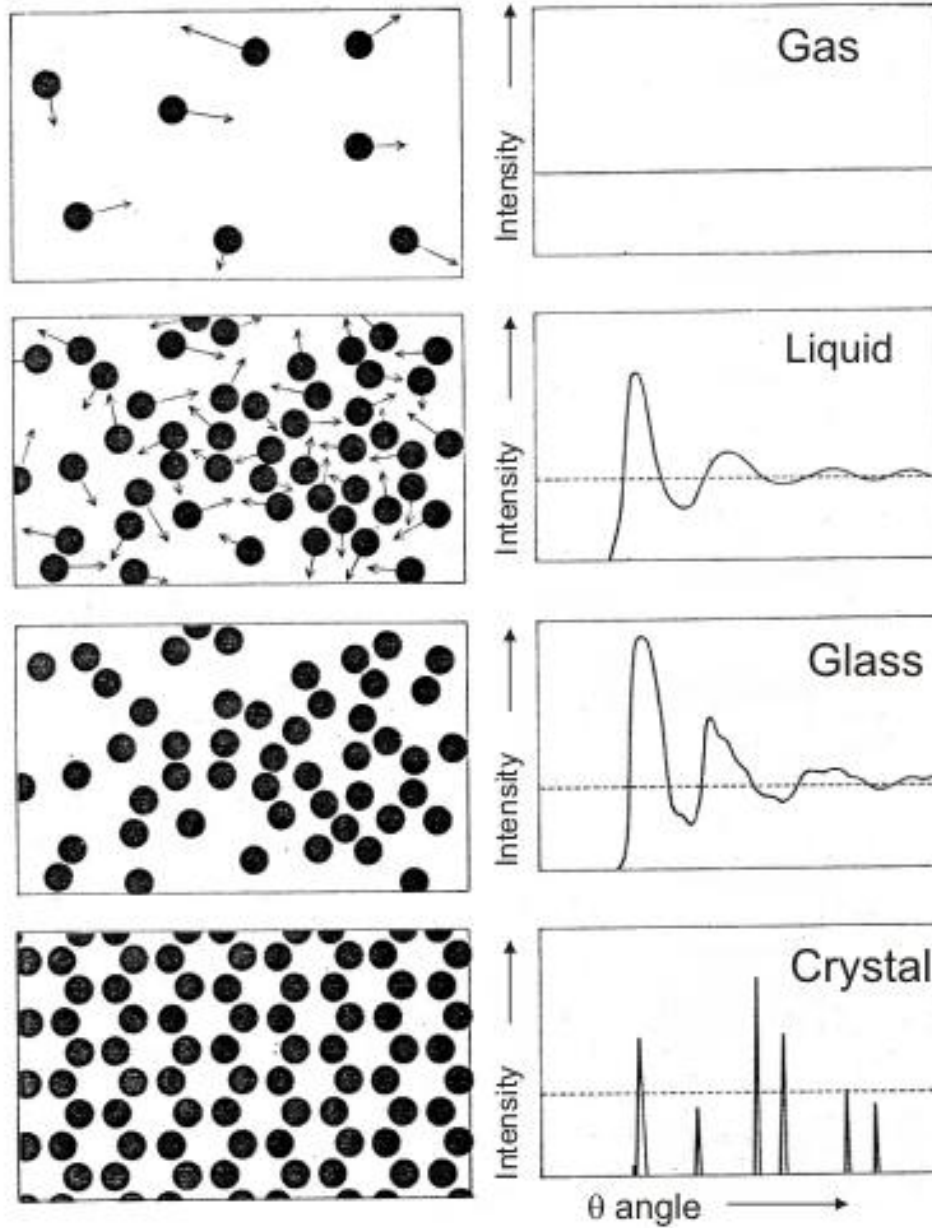
Szórás egyedi molekuláról (gáz molekula-polarizálhatóság α)

$$I = I_0 \frac{8\pi^4 \alpha^2}{\lambda^4 R^2} (1 + \cos^2 \theta).$$

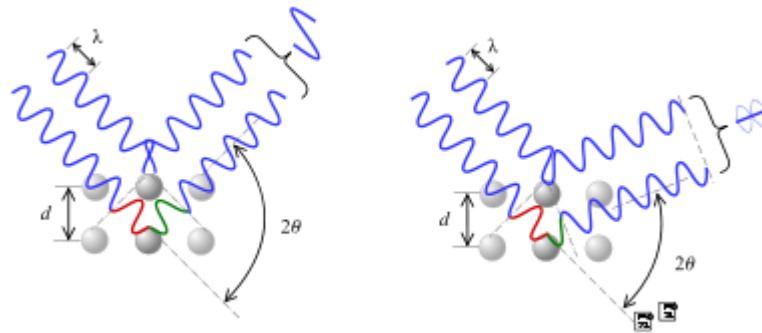
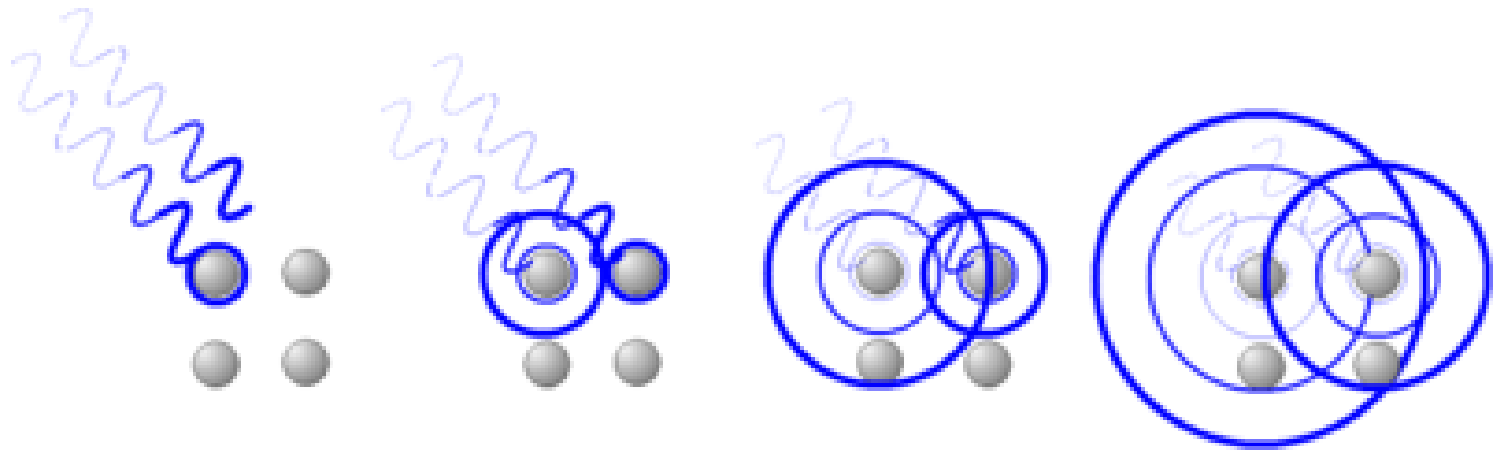
Szórás egyedi részecskéről ($d \ll \lambda$)

$$I = I_0 \frac{1 + \cos^2 \theta}{2R^2} \left(\frac{2\pi}{\lambda}\right)^4 \left(\frac{n^2 - 1}{n^2 + 2}\right)^2 \left(\frac{d}{2}\right)^6$$

Szórás több atomról



Bragg diffrakció



$$n\lambda = 2d \sin\Theta$$

Nagyszögű röntgen szórás ($>5^\circ$) - WAXS

$d < \text{nm}$

- Röntgen kristallográfia
- Makromolekula kristallográfia

Kisszögű röntgen szórás ($\sim 0^\circ$) - SAXS

$d \sim \text{nm} - \mu\text{m}$

kolloid rendszerek, pórusos anyagok vizsgálata

Részecskék dinamikus fényszórása

Monokromatikus, koherens fény (lézer)
Hőmozgás miatt az intenzitás ingadozik

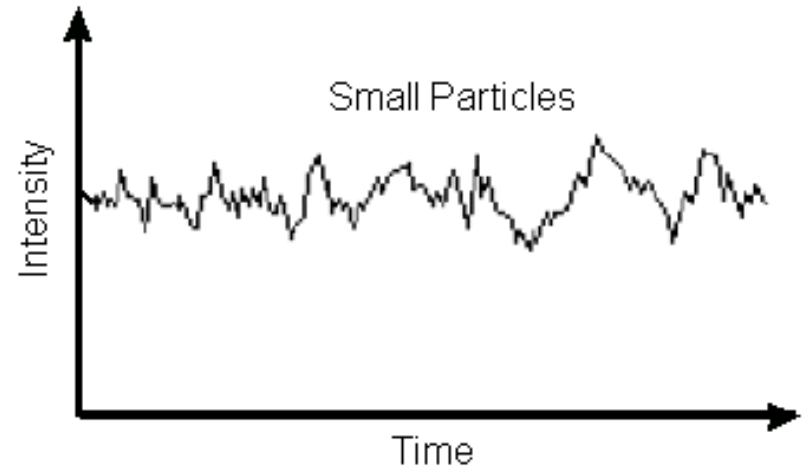
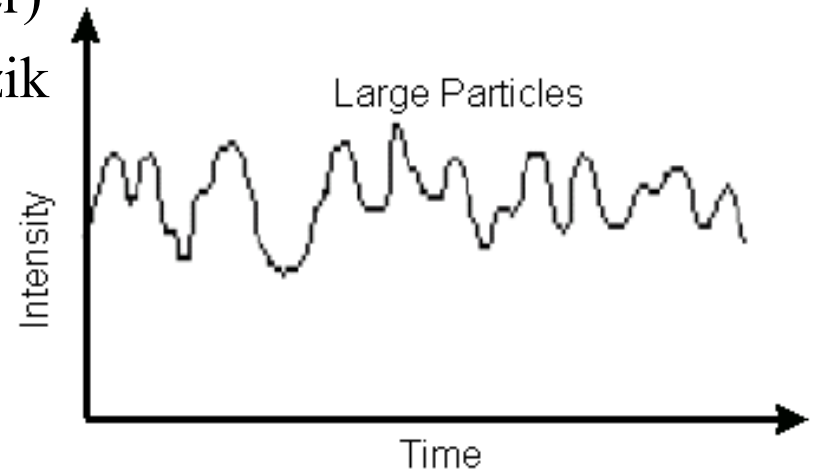
$$g^2(q; \tau) = \frac{\langle I(t)I(t + \tau) \rangle}{\langle I(t) \rangle^2}$$

$$g^2(q; \tau) = 1 + \beta [g^1(q; \tau)]^2$$

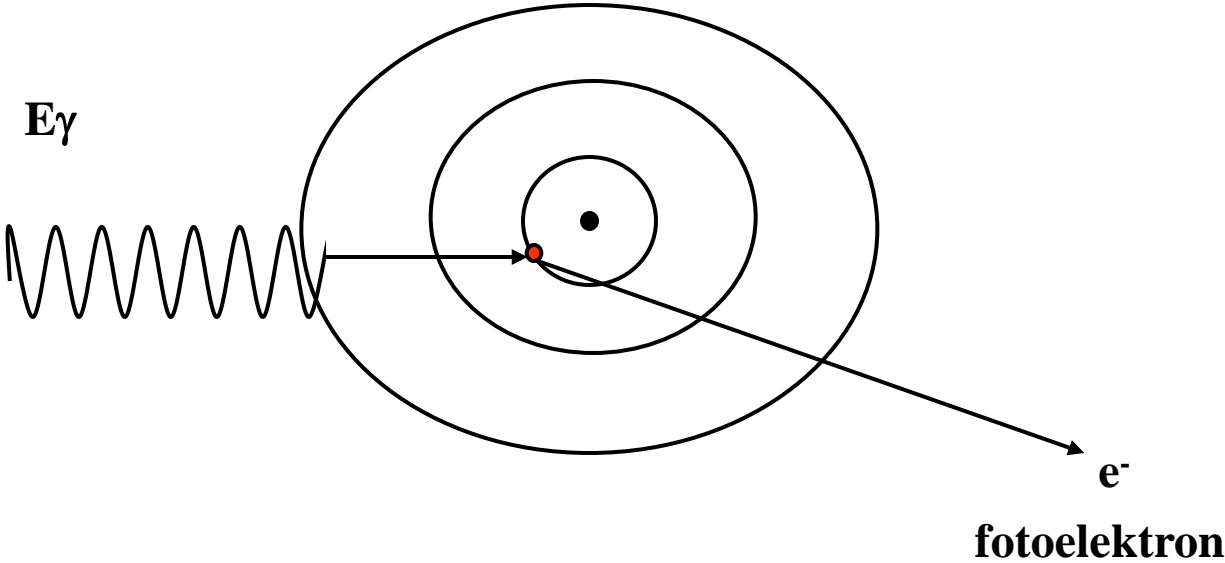
$$g^1(q; \tau) = \exp(-\Gamma\tau)$$

$$\Gamma = q^2 D_t \quad D = \frac{k_B T}{6\pi \eta r}$$

$$q = \frac{4\pi n_0}{\lambda} \sin\left(\frac{\theta}{2}\right)$$



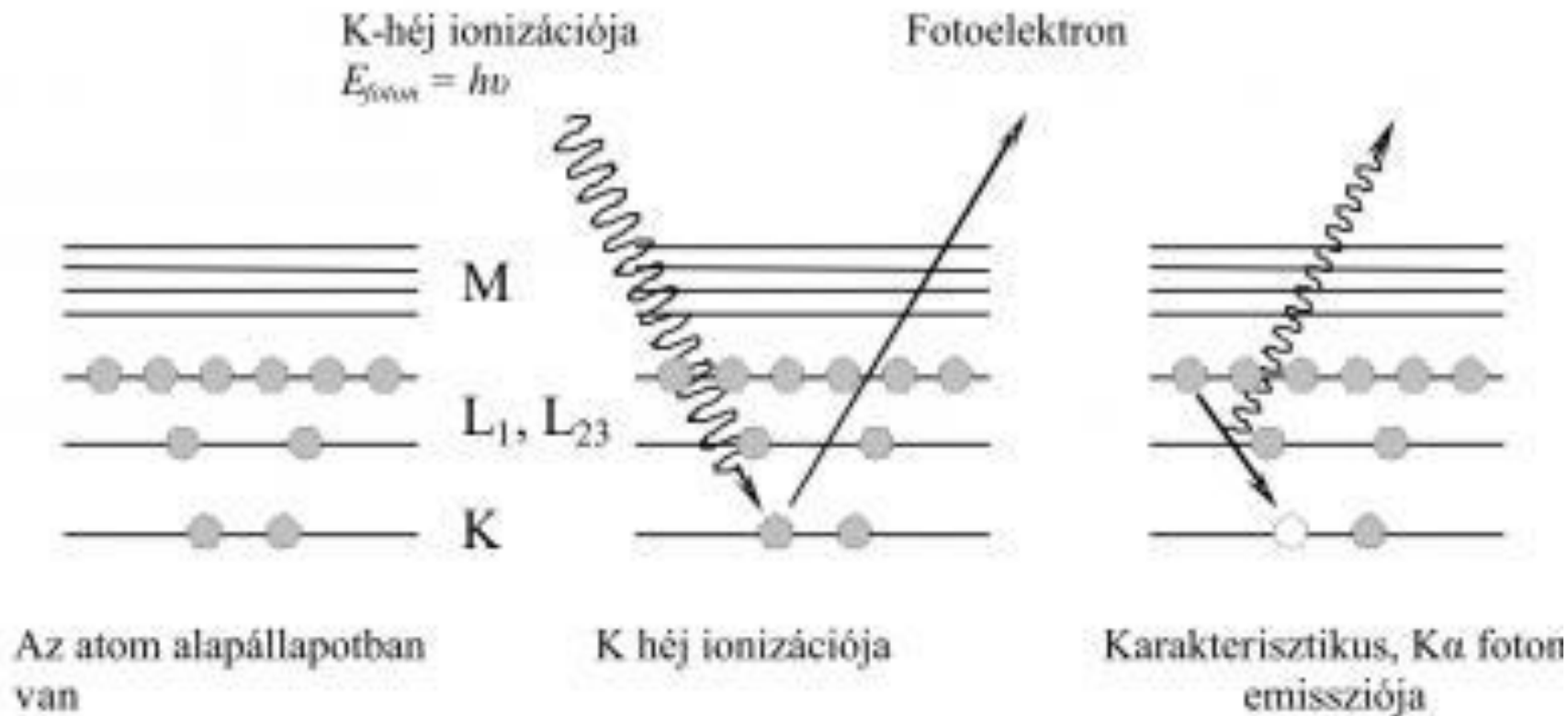
Fotoeffektus



$$p \sim Z^3$$

$$E_e = E_\gamma - E_i$$

$$p \sim E^{-3}$$



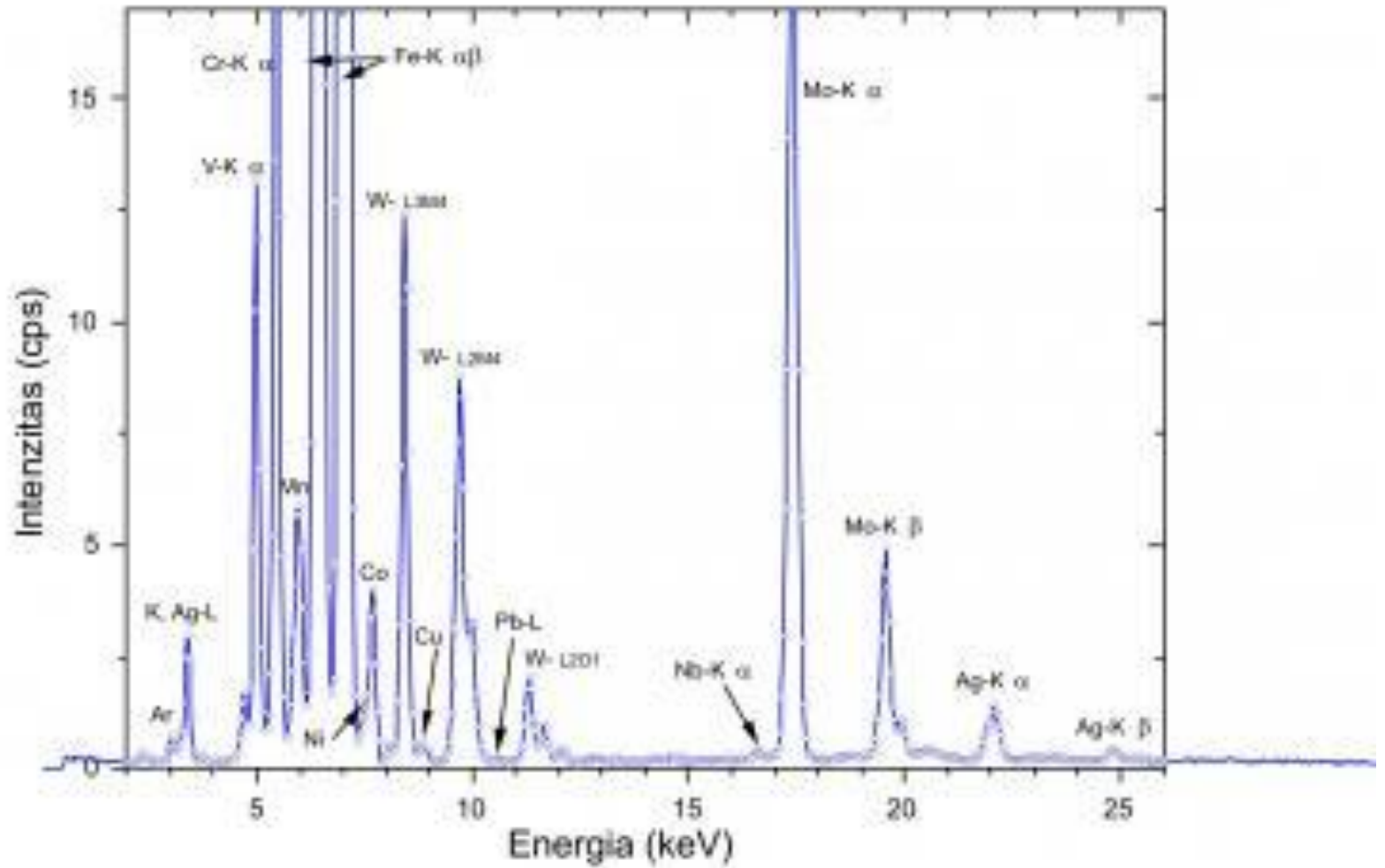
Mosley-törvény:

$$E_K = a(Z - b)^2$$

Xc / Auger-folyamat:

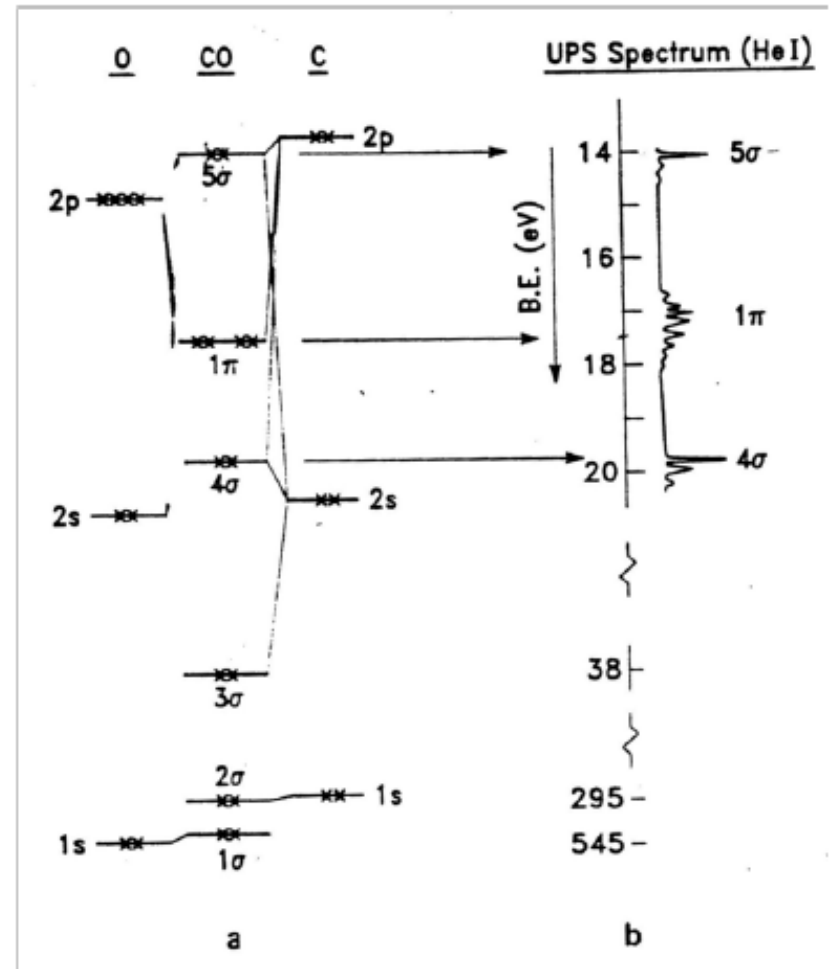
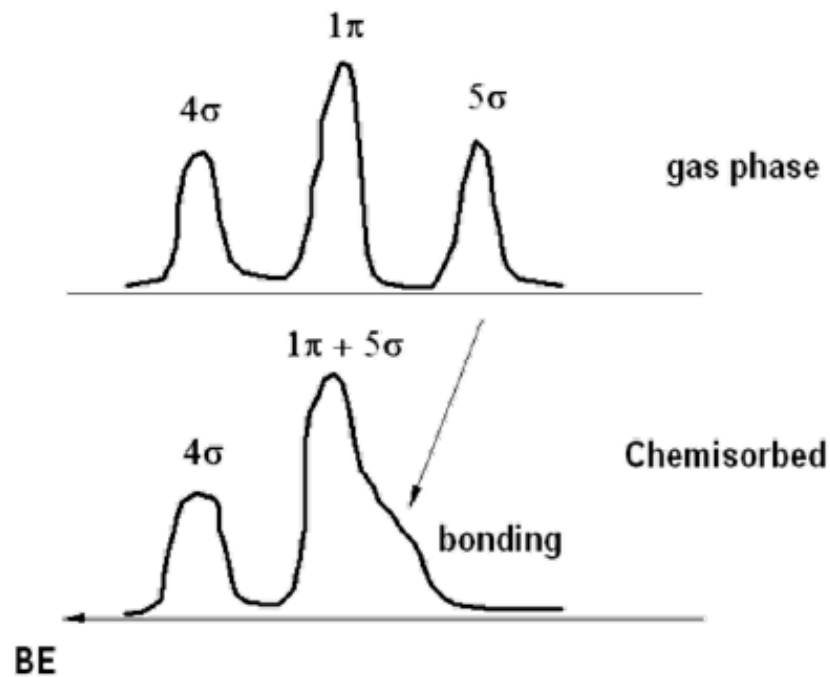
$$\omega = \frac{\sum_{i=1}^n n_{K_i}}{N_K}$$

XPS



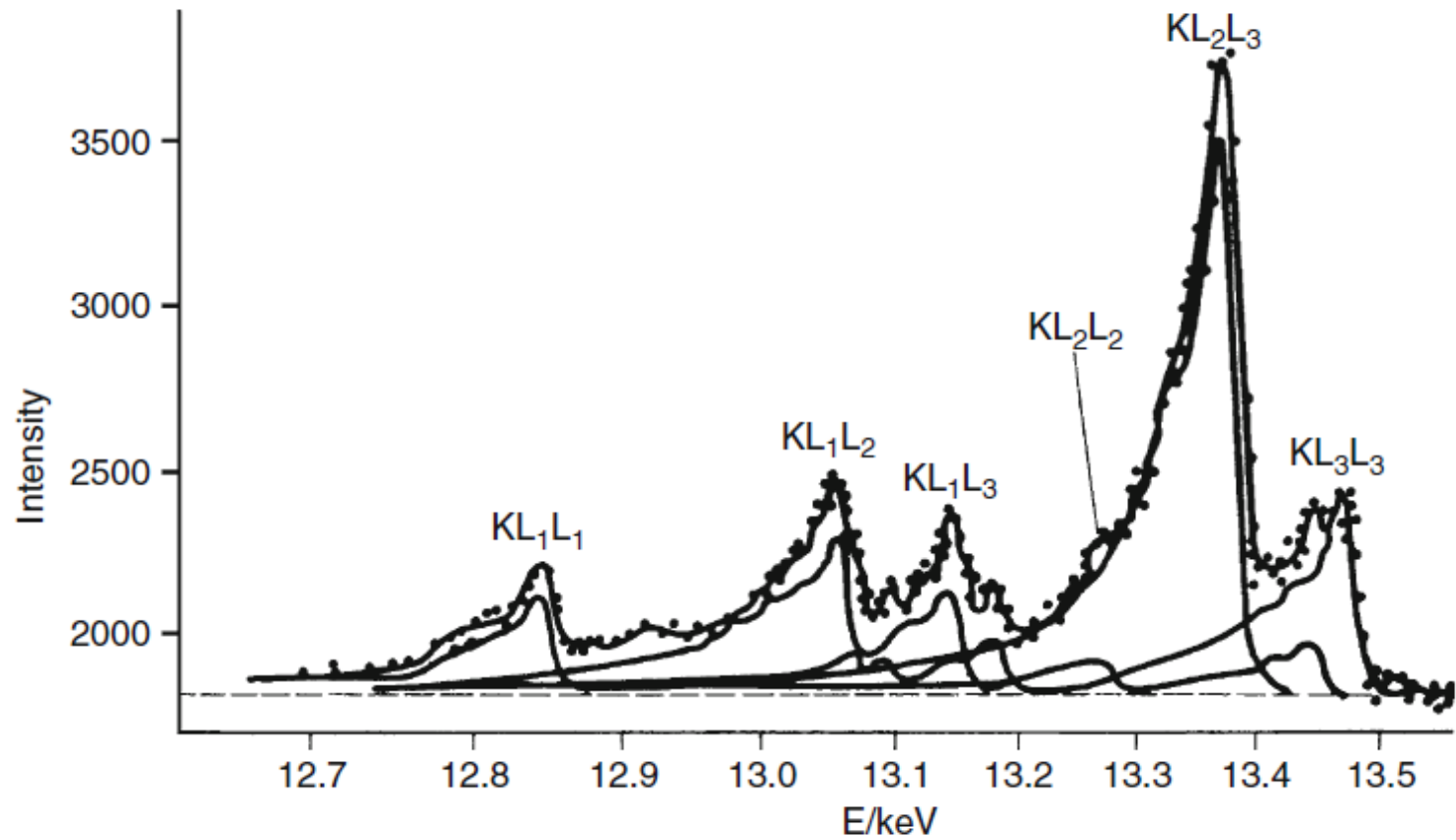
UPS

Schematic orbital for CO

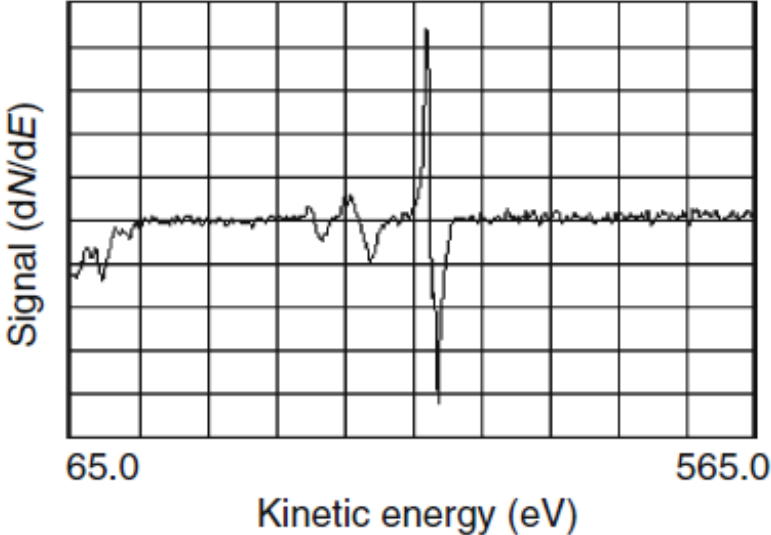
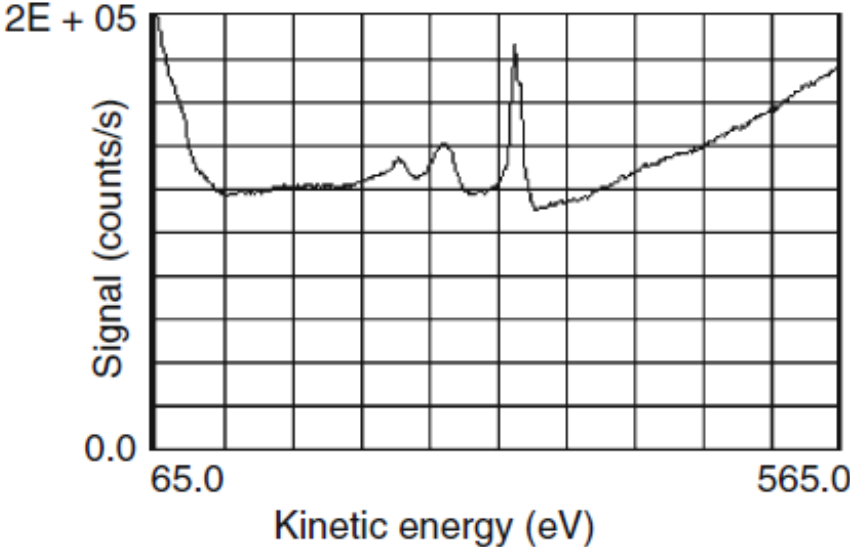


AES

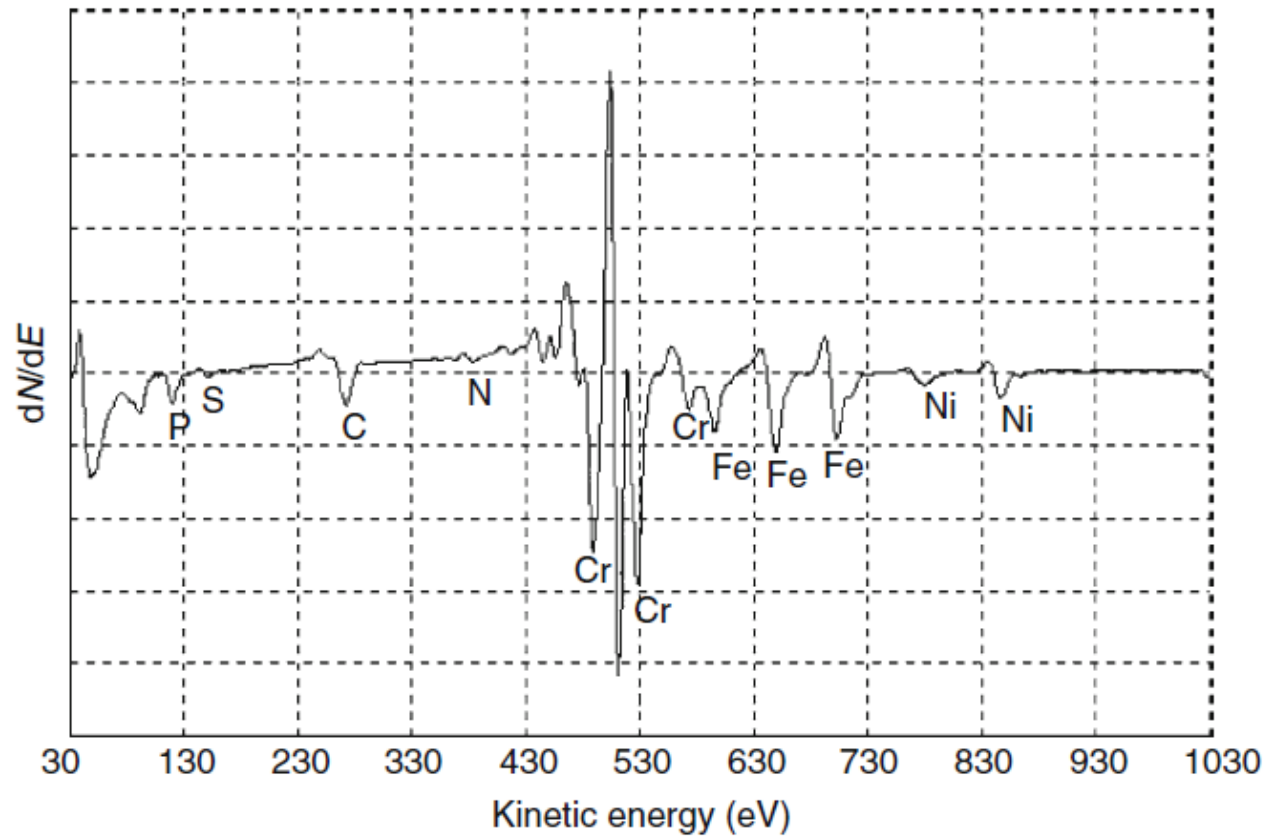
Zr



Pd

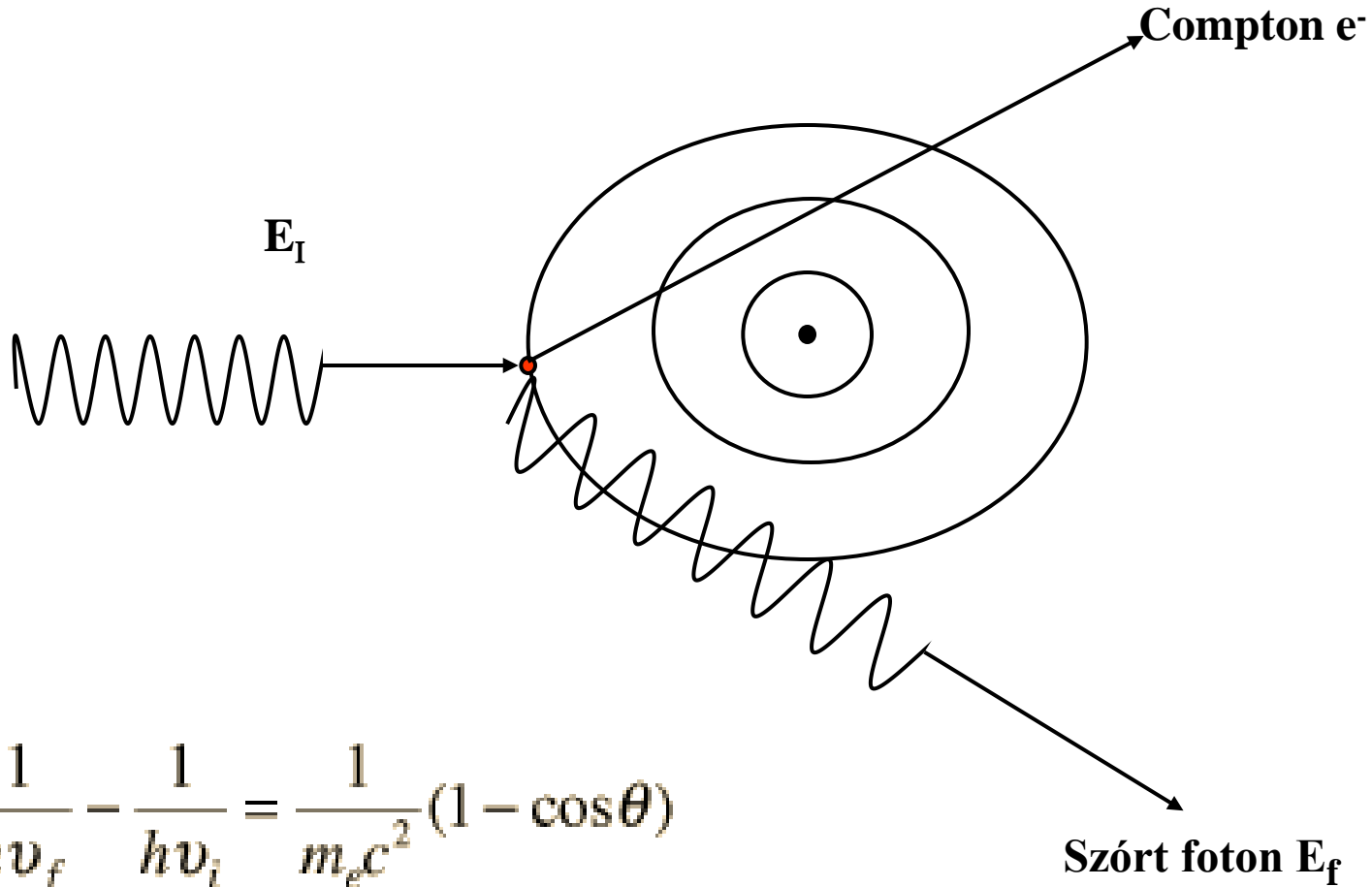


The differential energy spectrum of Auger electrons in stainless steel



Compton szórás

$$100 \text{ keV} < E_\gamma < 1.02 \text{ MeV}$$



$$\frac{1}{h\nu_f} - \frac{1}{h\nu_i} = \frac{1}{m_e c^2} (1 - \cos\theta)$$

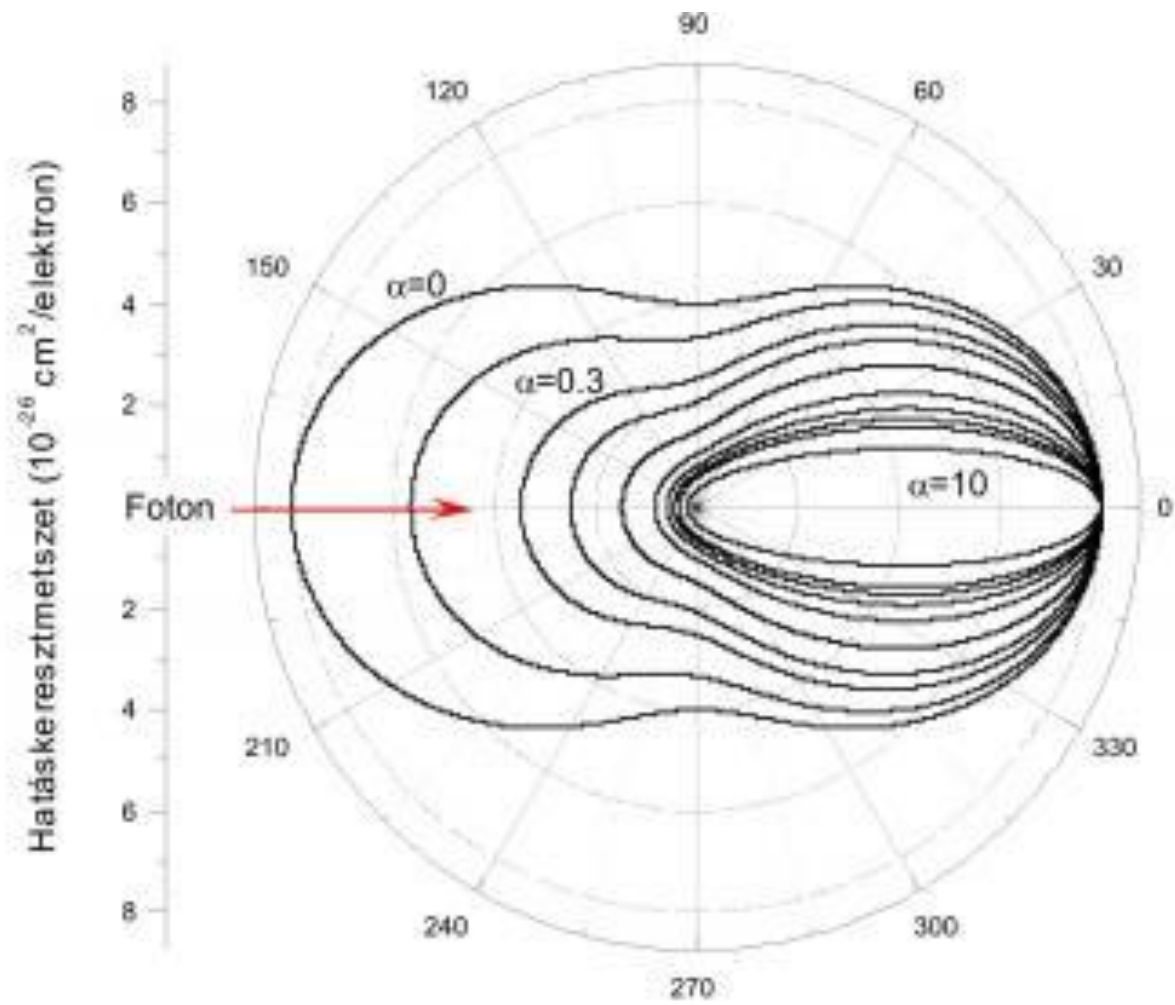
Klein-Nishina

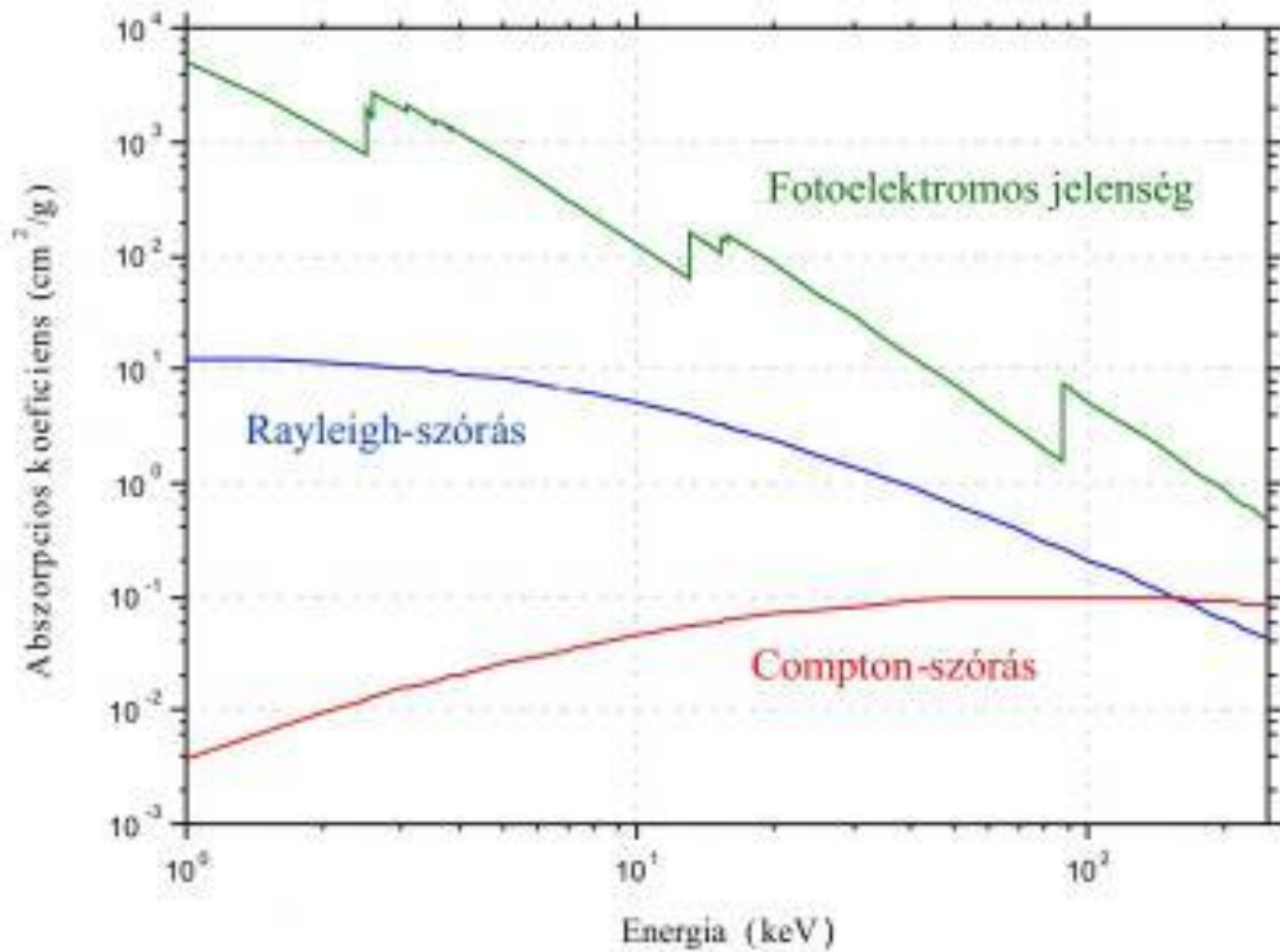
$$\frac{d\sigma_{KN}}{d\Omega} = \frac{d\sigma_T}{d\Omega} F_{KN} = \frac{r_0^2}{2} (1 + \cos^2\vartheta)$$

$$F_{KN} = \frac{r_0^2}{2} \frac{1}{\{1+\alpha(1-\cos\vartheta)\}^2} \left(1 + \cos^2\vartheta + \frac{\alpha^2(1-\cos\vartheta)^2}{1+\alpha(1-\cos\vartheta)} \right)$$

$$\alpha = \frac{h\nu}{mc^2} \quad \frac{d\sigma_T}{d\Omega}$$

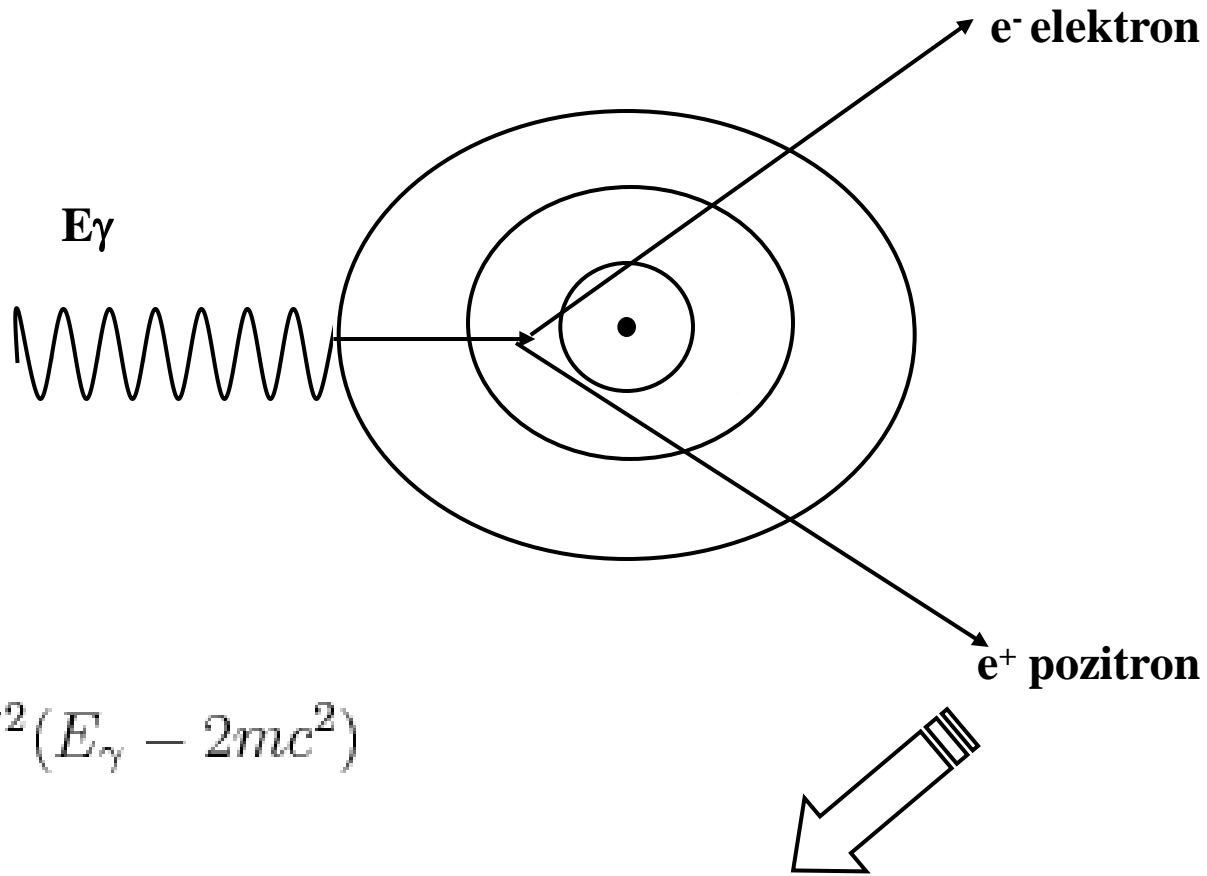
F_{KN} a Klein-Nishina forma faktor





Ólom

Párképzés $E_\gamma > 1.02 \text{ MeV}$

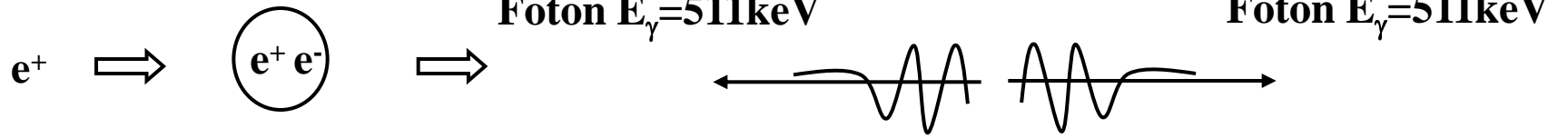


$$\sigma_p \sim NZ^2(E_\gamma - 2mc^2)$$

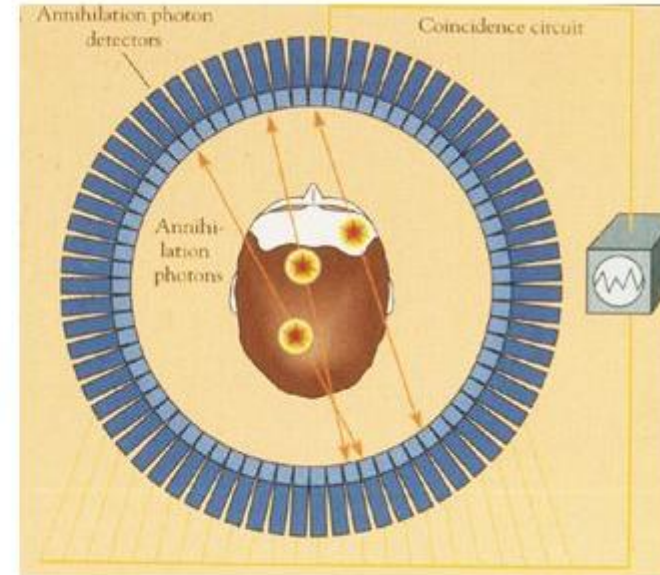
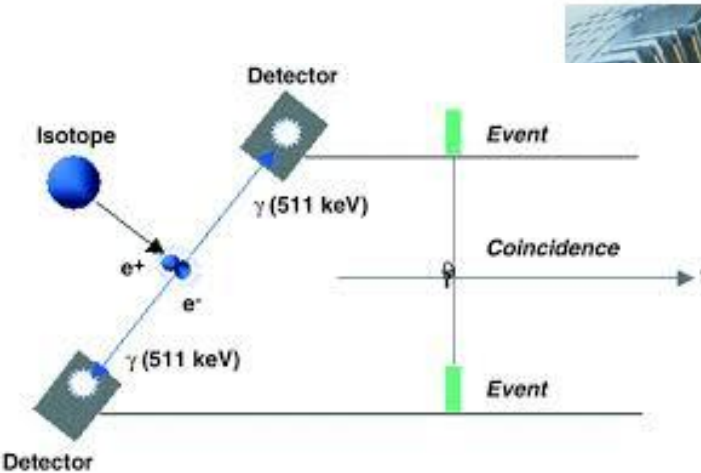
ANNIHILÁCIÓ

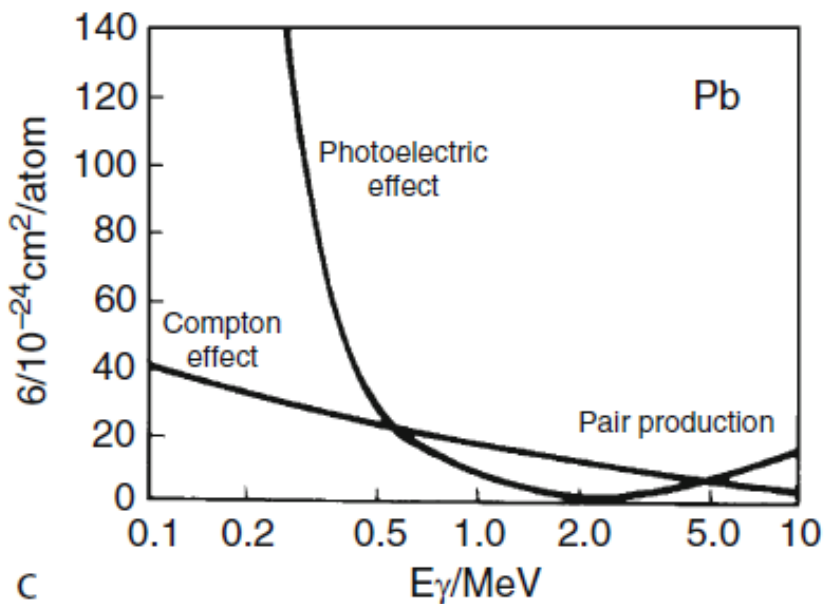
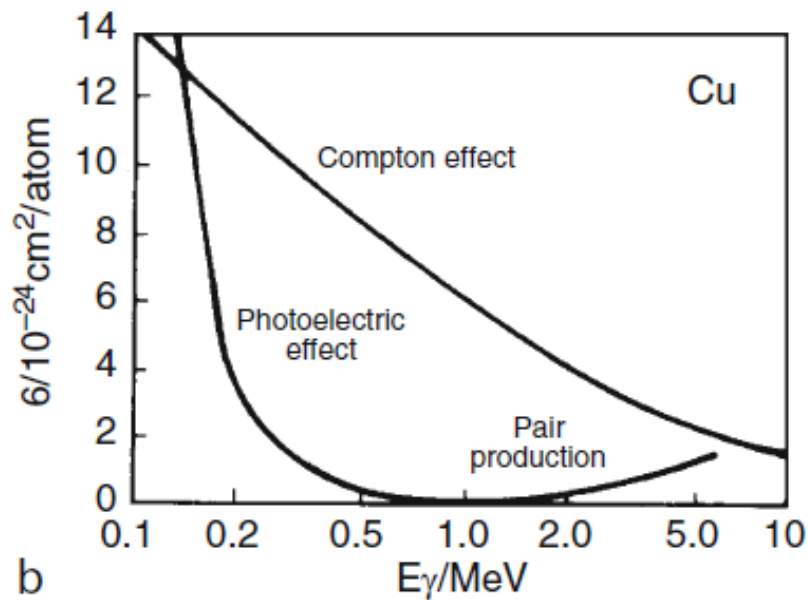
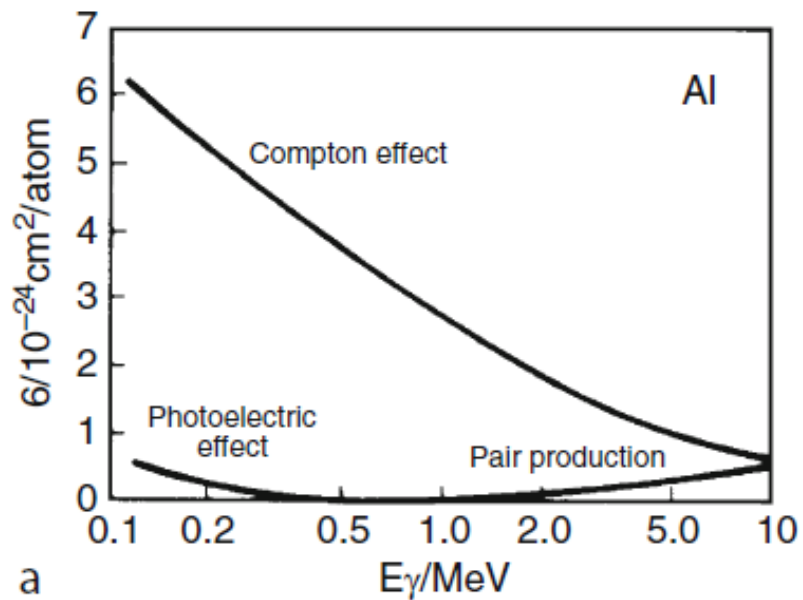
ANNIHILÁCIÓ

Pozitron Pozitrónium

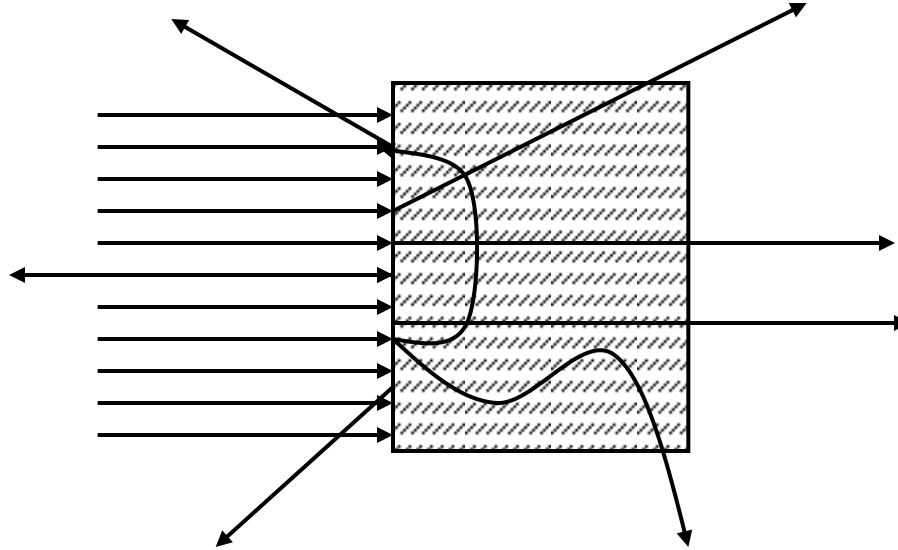


Pozitron Emissziós Tomográfia





Gamma-sugárzás elnyelődése



$$I = I_0 \cdot e^{-\mu \cdot x'}$$

ahol:

μ' - lineáris abszorpciós együttható

x - vastagság