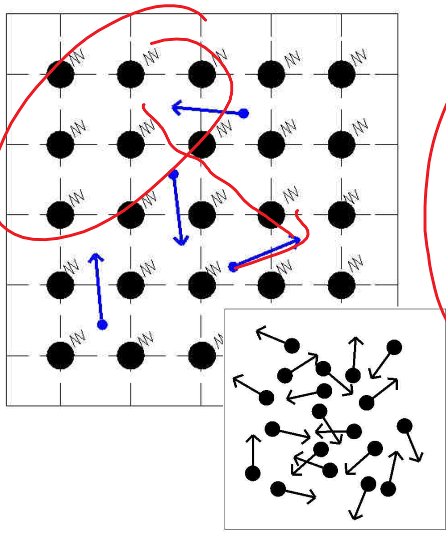
00 - Üvegek hőtechnikája

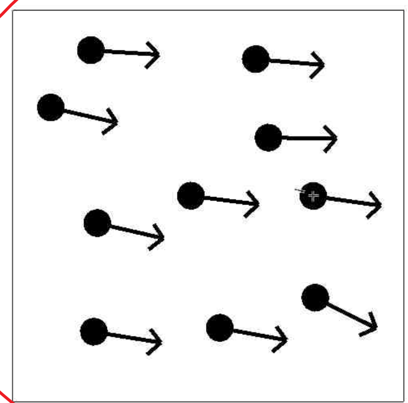
2016. október 13.
17:47

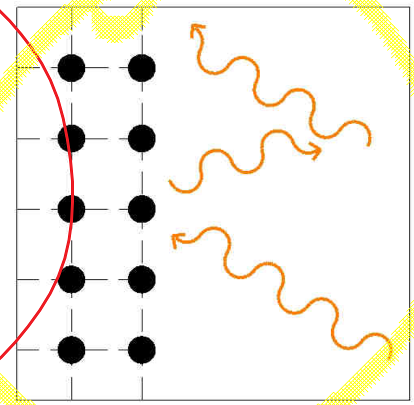
hővezetés

~~konvekció~~

sugárz.





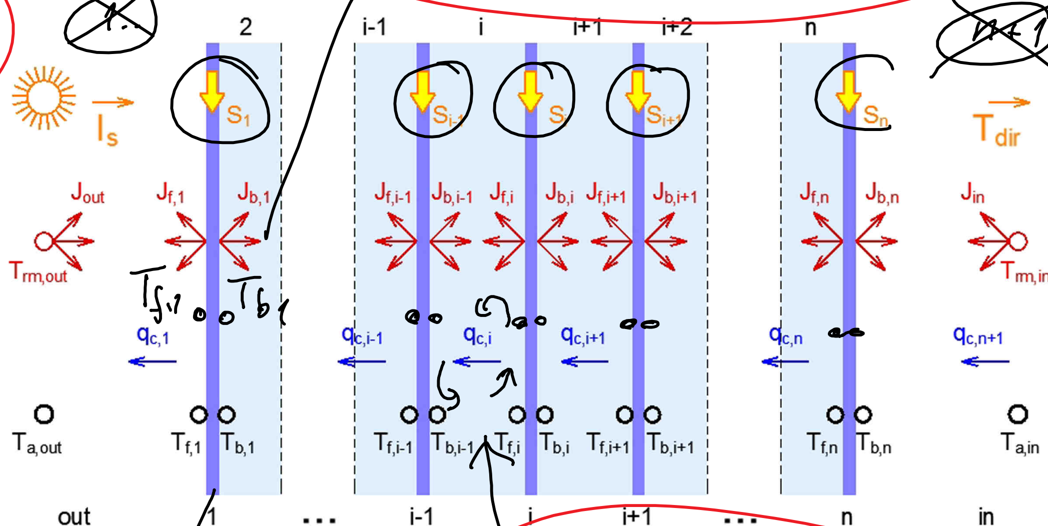


termikus diffúzió

hosszúhull. infrav. sug.

szoláris sug.

kinn.



kövez. az üvegben

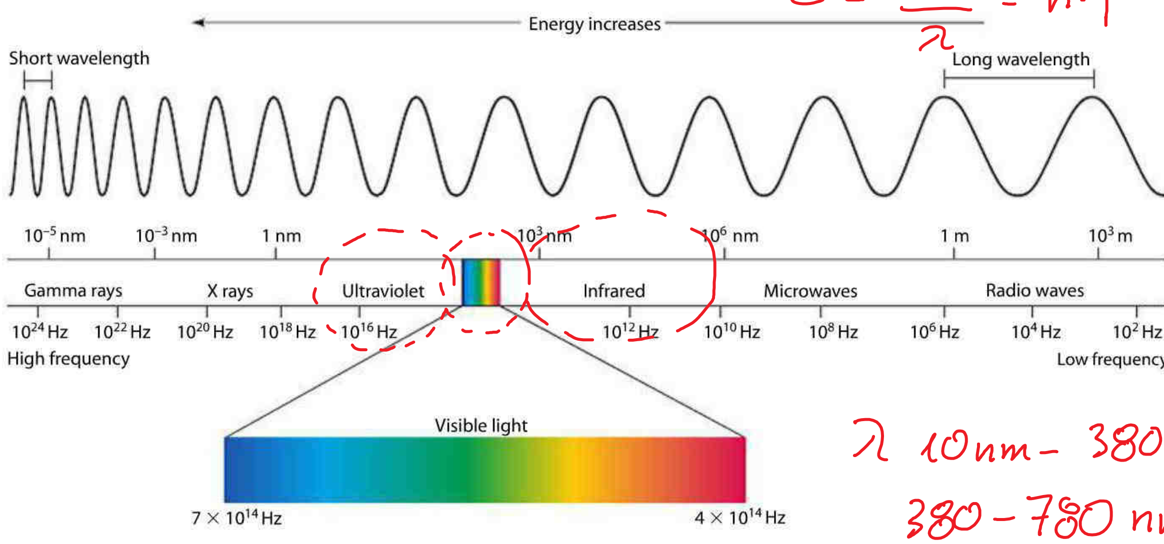
konvektív hőátad.

01 - Elektromágneses sugárzás

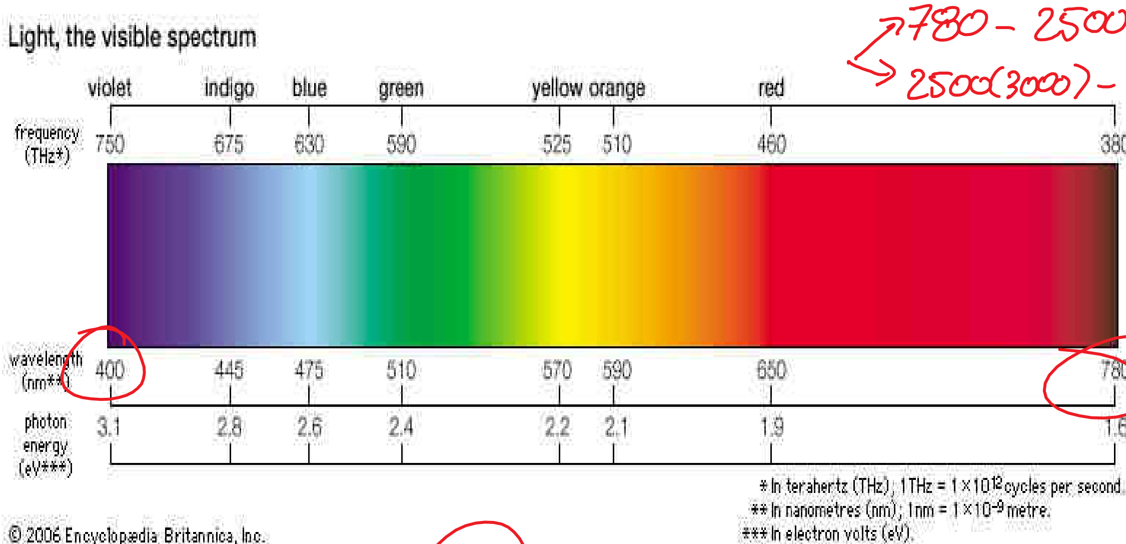
2016. október 13.
17:21

$c = f \cdot \lambda$ $c = 2{,}99e^{8}$ [m/s]

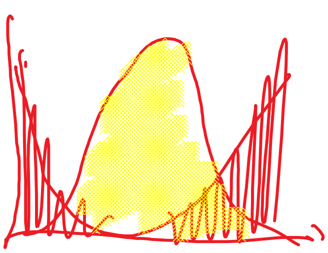
$E = \frac{h \cdot c}{\lambda} = h \cdot f$ $h = 6{,}626e^{-31}$ [Js]



λ 10nm – 380(400) nm UV
380 – 780 nm látható
780 – 2500(3000) nm rövidh.
2500(3000) – 50000 nm hosszúh.
iv.



ISO 10527:2007 (CIE S 014-1/E:2006)
CIE standard colorimetric observers



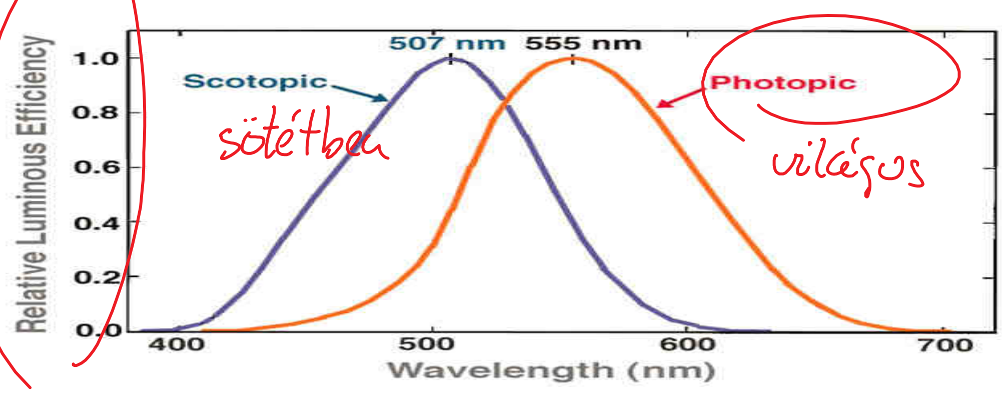


Figure 10. The scotopic and the photopic curves of relative spectral luminous efficiency as specified by the CIE (normalised values).

abszolút fekete test → tökéletes elnyelő
→ minden hullámhosszon sug. (T)

abszolút fekete test < minden hullámhosszon sug. (T)

Planck törvény

c - fénysebesség. $2{,}99e^8 \left[\frac{m}{s}\right]$

T - hőmérséklet [K]

h - planck áll.

k_B - Boltzmann áll.

$1.38e^{-23}$ [J/k]

λ - hullámhossz [m]

$$\left[\frac{W}{m^3}\right] \quad I_{b,\lambda} = \frac{\pi \cdot 2 \cdot h \cdot c^2}{\lambda^5 \left(e^{h \cdot c/(\lambda k_B \cdot T)} - 1\right)}$$

fekete test spektrális sug. képessége
egységnyi felületen egys. idő alatt kib. energia egys. hullámhossz tart.

Stefan-Boltzmann törvény

σ - Stefan Boltzmann áll.

$5{,}669 \cdot 10^{-8}$ [W/m²K⁴]

$$I_b = \int_0^\infty I_{b,\lambda} \, d\lambda = \sigma \cdot T^4 =$$

$$= [W/m^2]$$

T [K]

Wien féle eltolódási törvény

$$\lambda_{max} \cdot T = 2898 \, [\mu m K]$$

szürke test

$$\frac{I_g(\lambda)}{I} = \varepsilon(\lambda) < 1$$

$$\varepsilon = \int_{\lambda_1}^{\lambda_2} \varepsilon(\lambda) d\lambda$$

$$\frac{I_g(\lambda)}{I_b(\lambda)} = \varepsilon(\lambda) < 1 \qquad \varepsilon = \frac{\int_{\lambda_1} \varepsilon(\lambda)\, d\lambda}{\int d\lambda}$$

elméleti max

$$\Rightarrow \boxed{I_g = \varepsilon \cdot I_b = \varepsilon \cdot \sigma \cdot T^4}$$

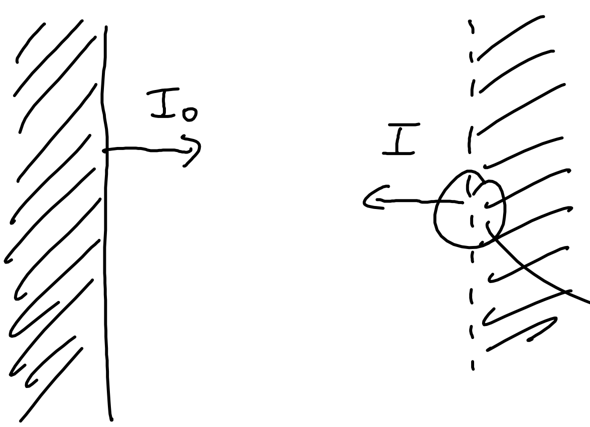
hosszúhullámú emissziós tényező

$$\varepsilon \cong 0.9 \ldots 0.99$$

$$\varepsilon_{low\text{-}e} = 0.1 \quad \ldots \quad 0.035 \ldots$$

$$\varepsilon_{float\ üveg} = 0.837$$

$$\varepsilon_{fémes} = 0.1 - 0.2$$



szürke

$\varepsilon = 1$ T_0 ε T

elnyelési tényező

$$q_r = \underbrace{\alpha \cdot I_0}_{bejövő} - \underbrace{I}_{kimenő}$$

egyensúly van

$$q_r = \emptyset \qquad T_0 = T$$

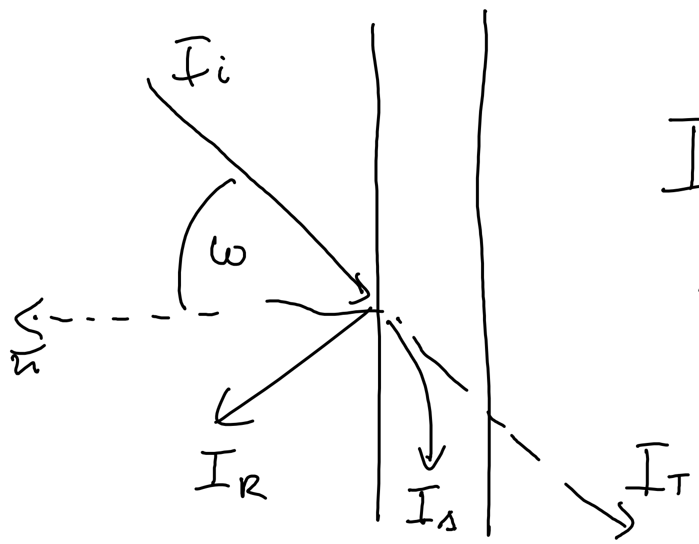
$$q_r = \emptyset \qquad IO = 1$$

$$\to \alpha \cdot I_0 - I = 0$$

Kirchhoff törvénye

$$\alpha \cdot \underbrace{\sigma \cdot T_0^4} - \varepsilon \cdot \sigma T_0^4 = \emptyset$$

$$\to \boxed{\alpha = \varepsilon}$$



$$I_i = I_T + I_R + I_A \qquad / I_i$$

$$1 = \frac{I_T}{I_i} + \frac{I_R}{I_i} + \frac{I_A}{I_i}$$

$$T + R + A = 1$$

transzmissziós t. — reflexiós t. — abszorbciós t.

$$T(\omega, \lambda) + R(\omega, \lambda) + A(\omega, \lambda) = 1$$

$\emptyset$

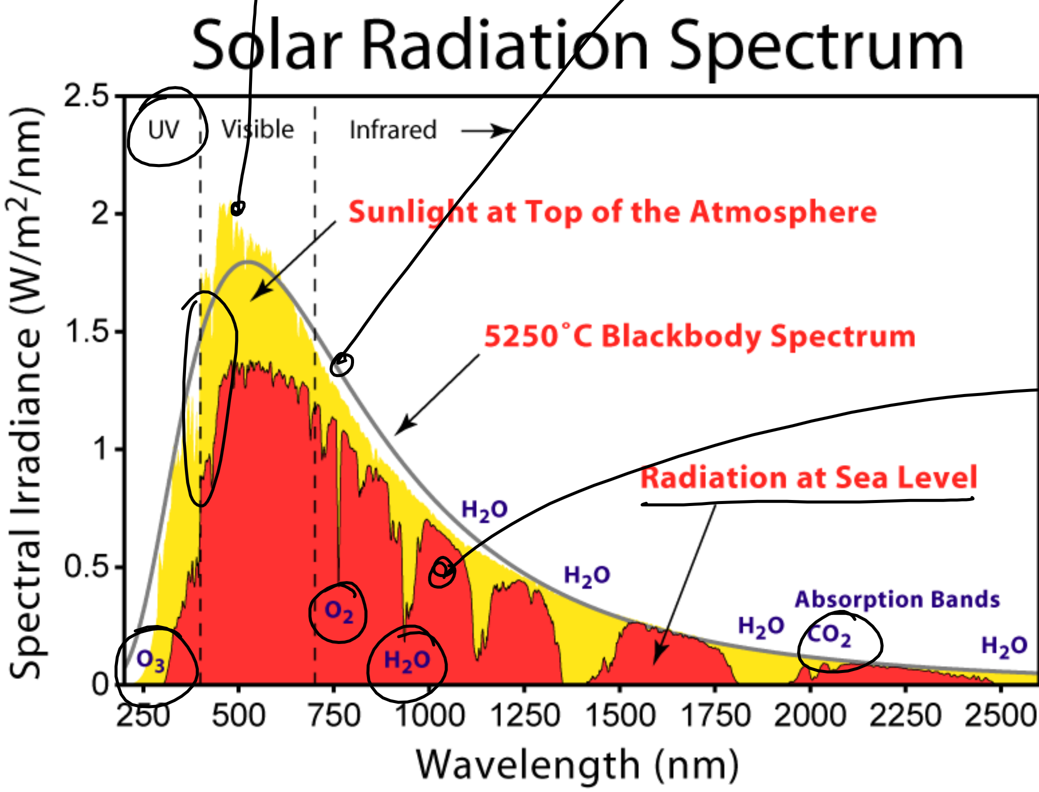
02 - a Nap spektruma

2016. október 13.
19:21

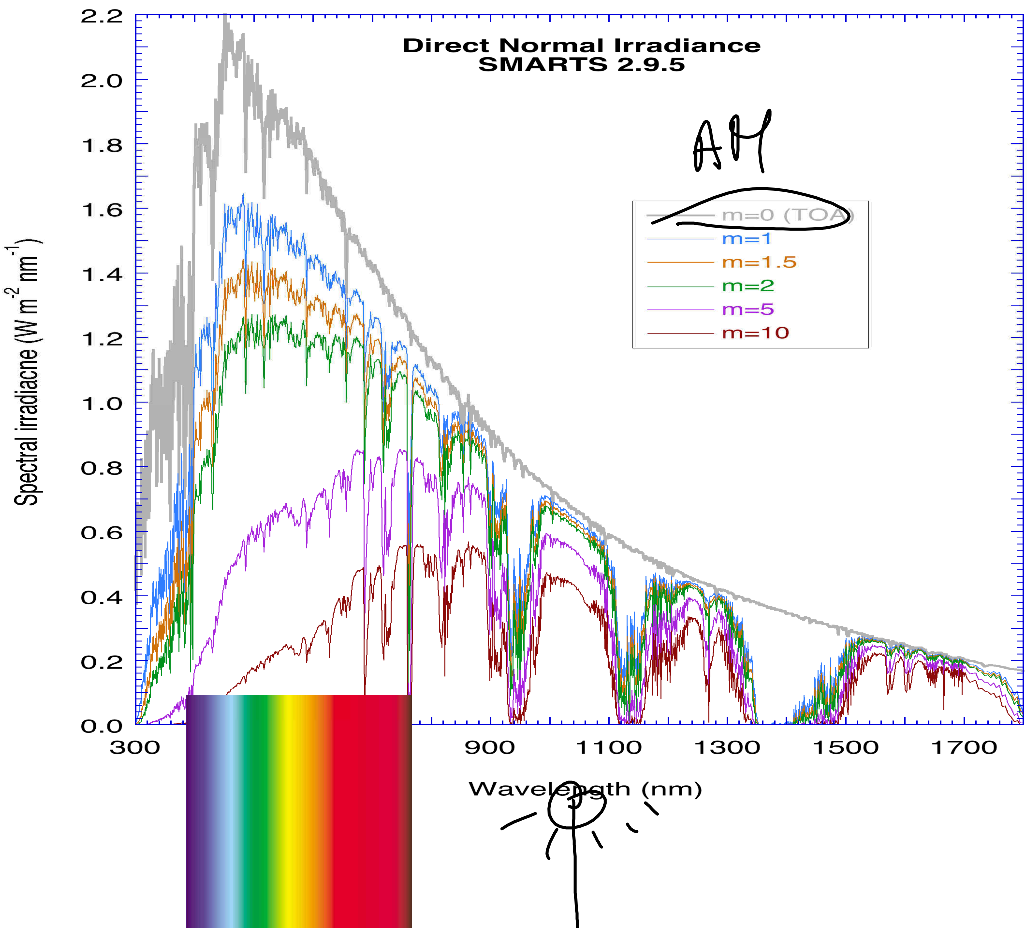
valós spektrum

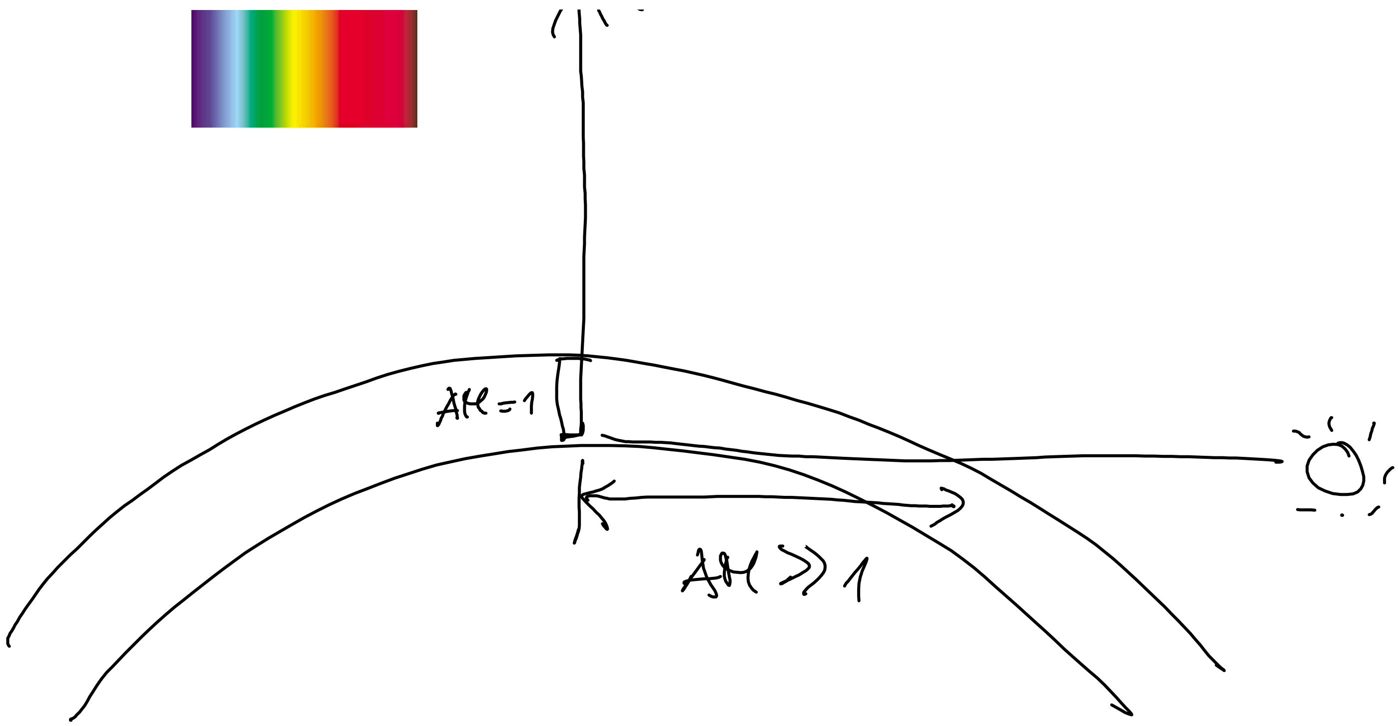
elméleti abszolút fekete test

~6000 [K]



~1.5 AM

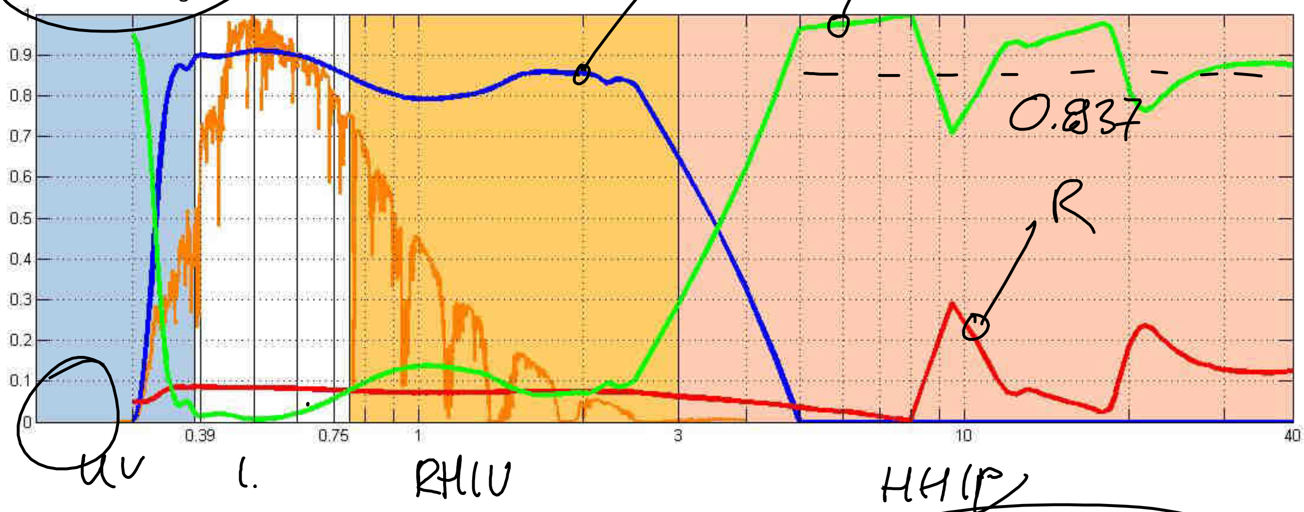



AM = 1
AM >> 1

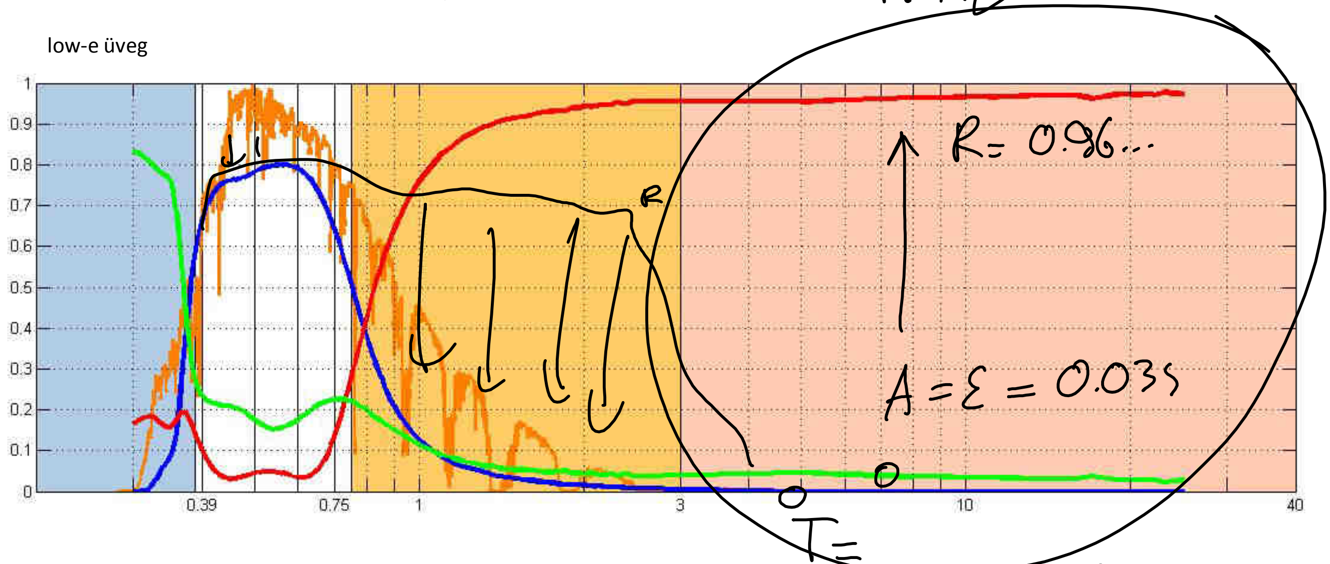
03 - Építési üvegek spektrális tulajdonságai

2016. október 13.
17:30

Normál síküveg

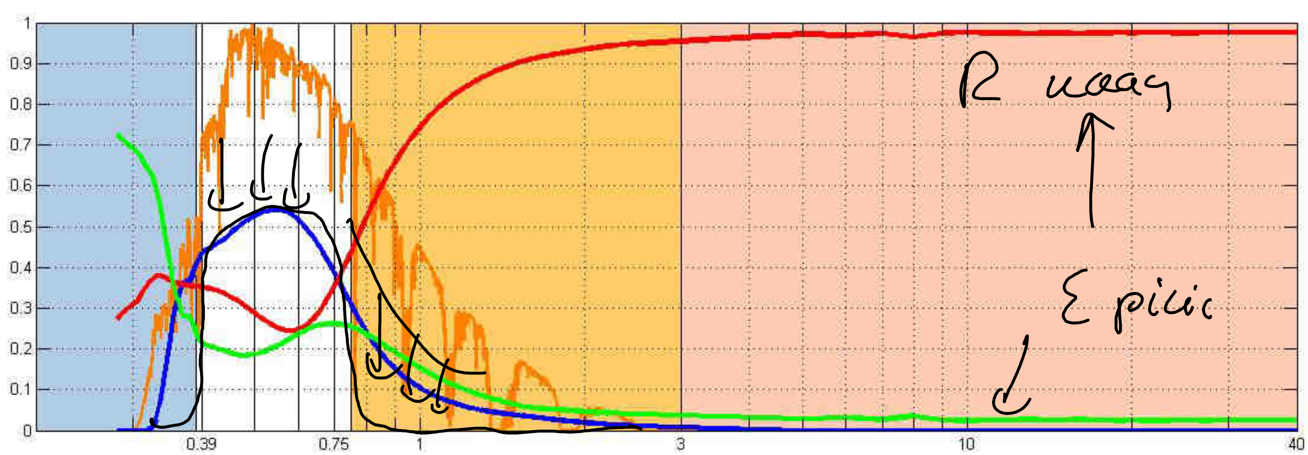


low-e üveg

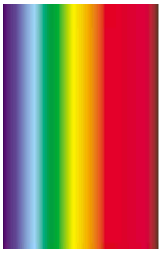


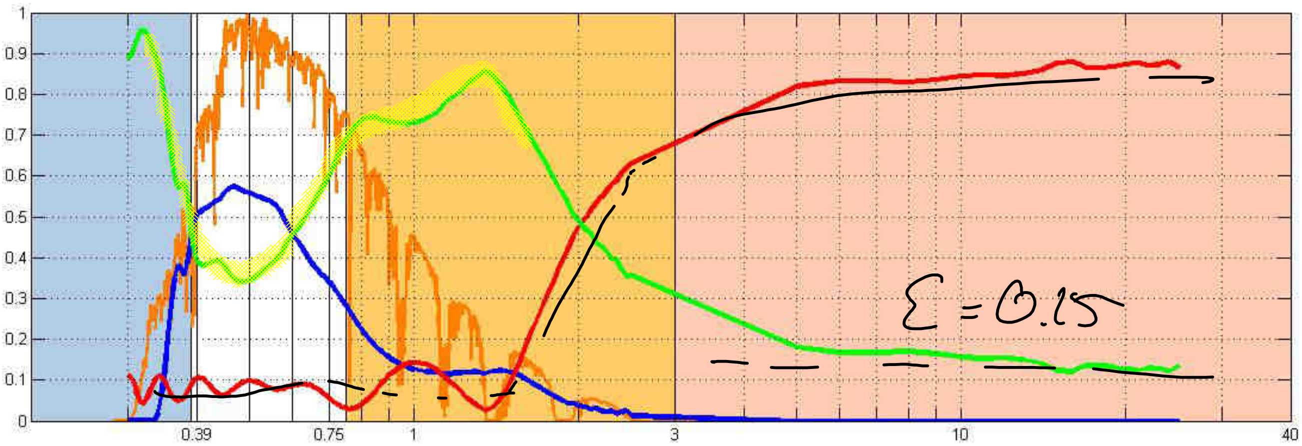
SS

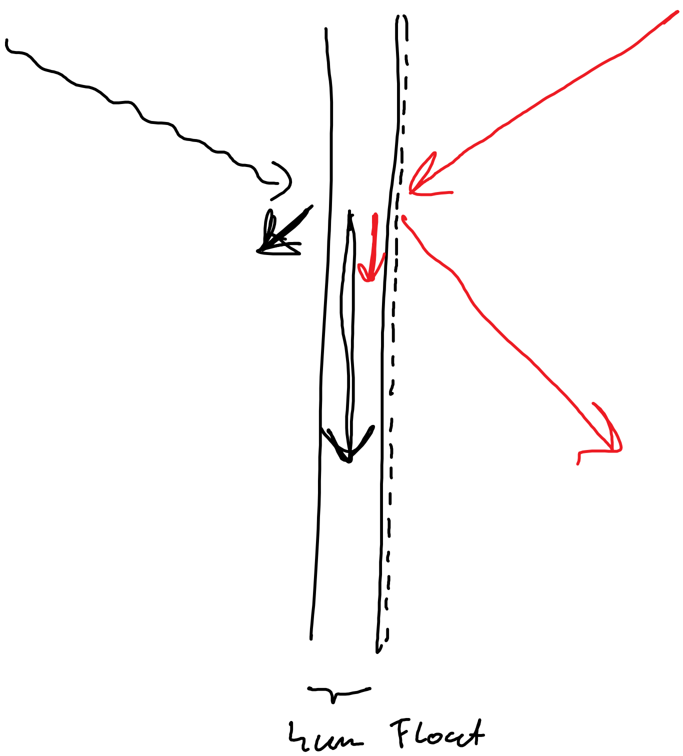
Pilkington suncool silver

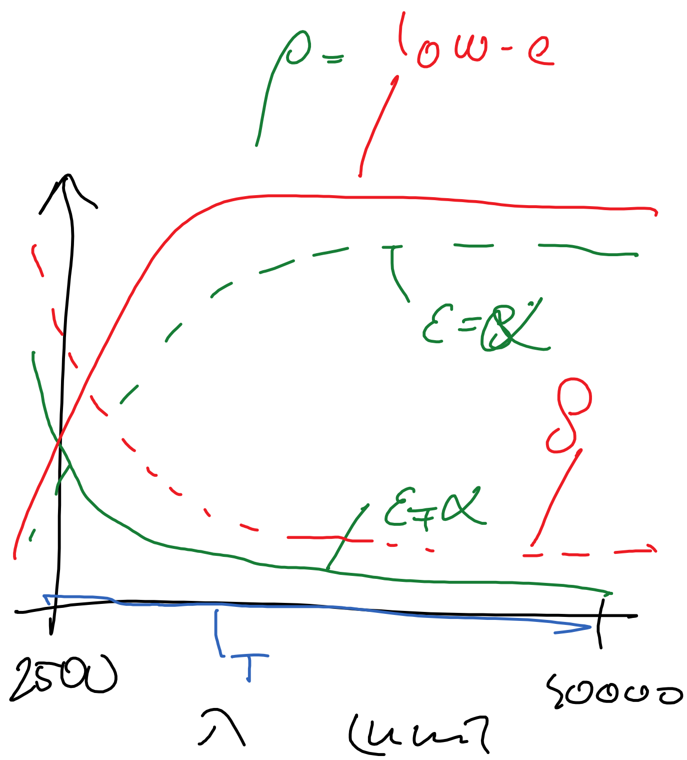


Abszorbciós hővédő üveg



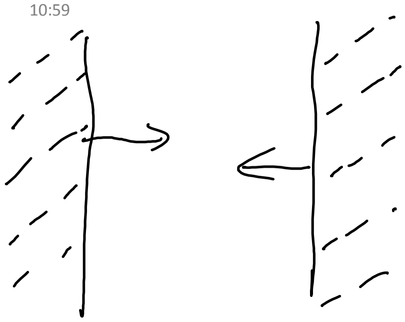






04 - IR

2016. október 14.
10:59



T_1 ε_1 T_2 ε_2

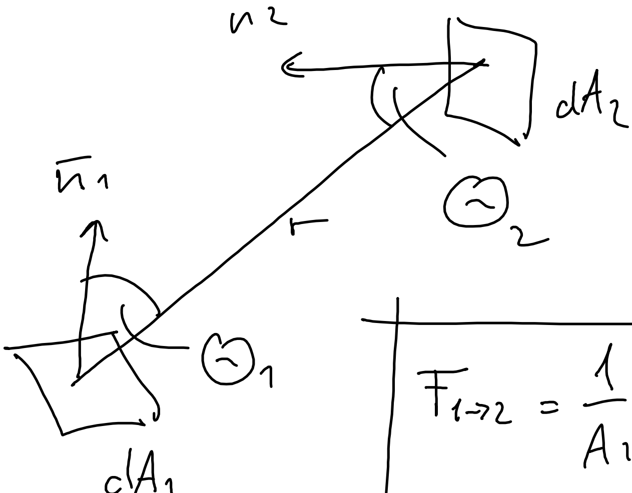
$$\dot{q} = ? =$$

$$= \varepsilon_{12}\,\sigma \cdot \left(T_1^4 - T_2^4\right)$$

redukált feketeségi fok

v. „kölcsönös emissziós tényező"

$$\varepsilon_{1-2} = \frac{1}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$



$$\boxed{F_{1\to 2} = \frac{1}{A_1}\int_{A_1}\int_{A_2} \frac{\cos\Theta_1 \cos\Theta_2}{\pi r^2}\, dA_2\, dA_1}$$

$$\boxed{q_{1\to 2} = \frac{\sigma\left(T_1^4 - T_2^4\right)}{\frac{1-\varepsilon_1}{A_1\varepsilon_1} + \frac{1}{A_1 F_{1\to 2}} + \frac{1-\varepsilon_2}{A_2\varepsilon_2}}}$$

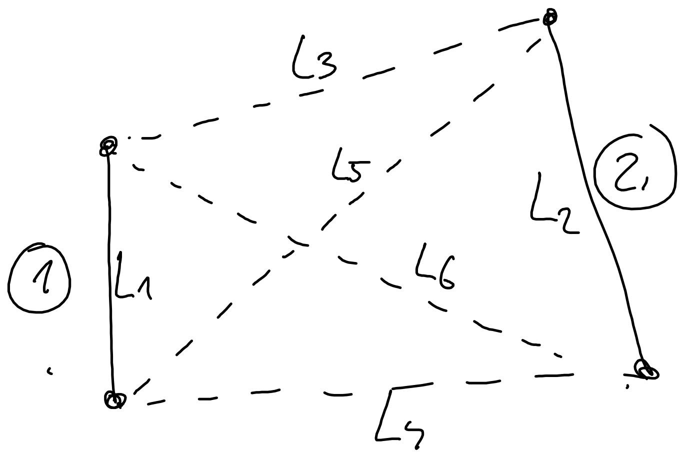
$$F_{1\to 2} A_1 = F_{2\to 1} \cdot A_2$$

$$\sum_{i=1}^{n} F_{1\to i} = 1$$

$F_{1\to 2} =$ (crossed strings) $-$ (uncrossed strings)

$\sum_{i=1} F_{1\to i} = 1$

$$F_{1\to 2} = \frac{(\text{crossed strings}) - (\text{uncrossed strings})}{2\cdot L_1}$$



$$F_{1\to 2} = \frac{(L_5+L_6)-(L_3+L_4)}{2\cdot L_1}$$

(1) $T_{MRT}^4 = \varepsilon_1 F_1 T_1^4 + \varepsilon_2 F_2 T_2^4 + \dots \varepsilon_n F_n T_n^4$

(2) $T_{MRT}^4 \cong F_1 F_1^4 + F_2 T_2^4 + \dots T_n T_n^4$

(3) $$T_{MRT}^4 \cong \frac{T_1^4 A_1 + T_2^4 A_2 + \dots T_n^4 A_n}{\Sigma A}$$

(4) $$T_{MRT} \cong \frac{T_1 A_1 + T_2 A_2 + \dots T_n A_n}{\Sigma A}$$

ha ΔT kicsi

$$q_r = \varepsilon_{12}\sigma\left(T_g^4 - T_{MRT}^4\right)$$

felületen

$$(T_1^4 - T_2^4) = (T_1+T_2)(T_1^2+T_2^2)(T_1-T_2) =$$

$$\cong 4T^3 (T_1-T_2)$$

$$(T_1^4 - T_2^4) = (T_1+T_2)(T_1^2+T_2^2)(T_1-T_2) =$$

$$\cong 4 \cdot T_{nom}^3 (T_1 - T_2)$$

$$T_{nom} \cong \frac{T_1+T_2}{2}$$

$$q = \sigma \cdot \varepsilon (T_1^4 - T_2^4) = \underbrace{4 \varepsilon \sigma T_m^3}_{h_r} (T_1 - T_2)$$

$$h_r(T)(T_1 - T_2)$$