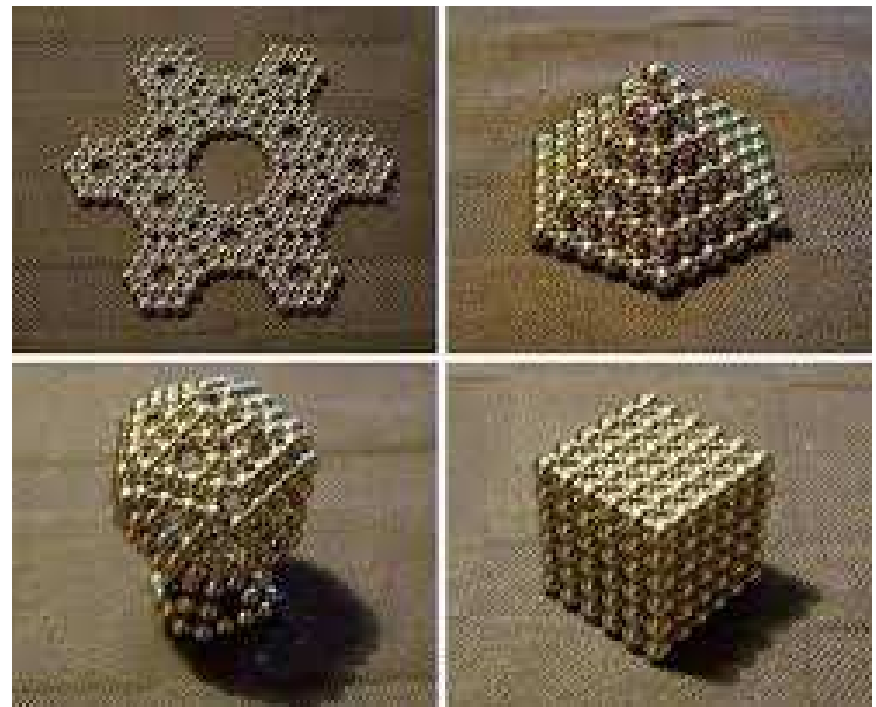


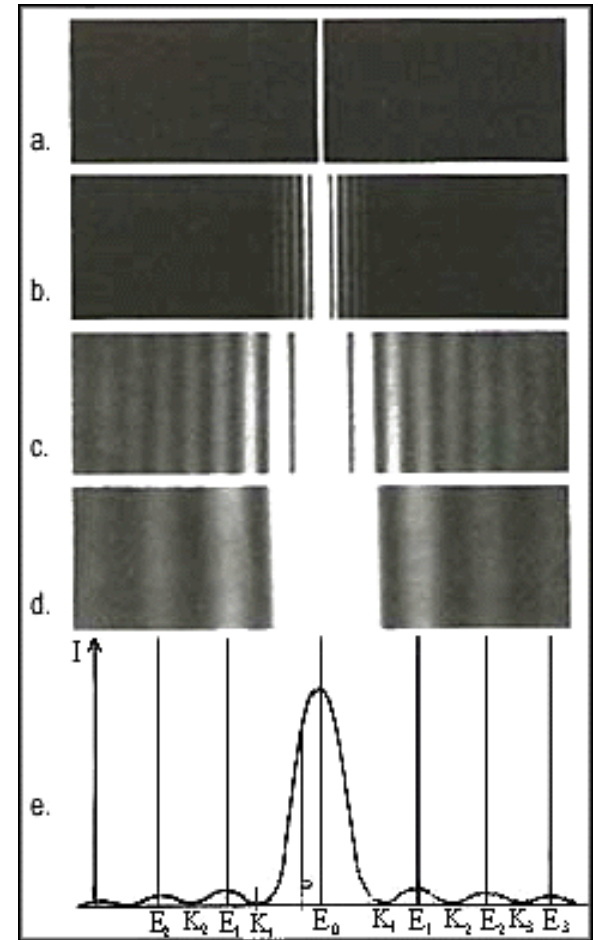
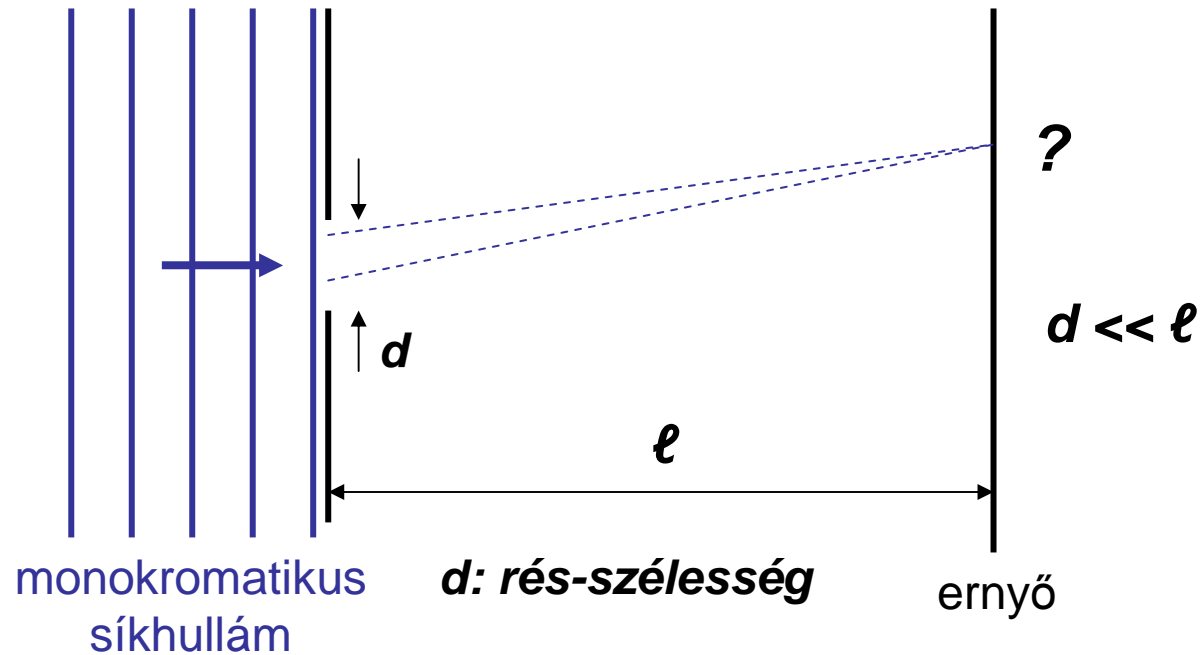
Fizika 112

19. Előadás



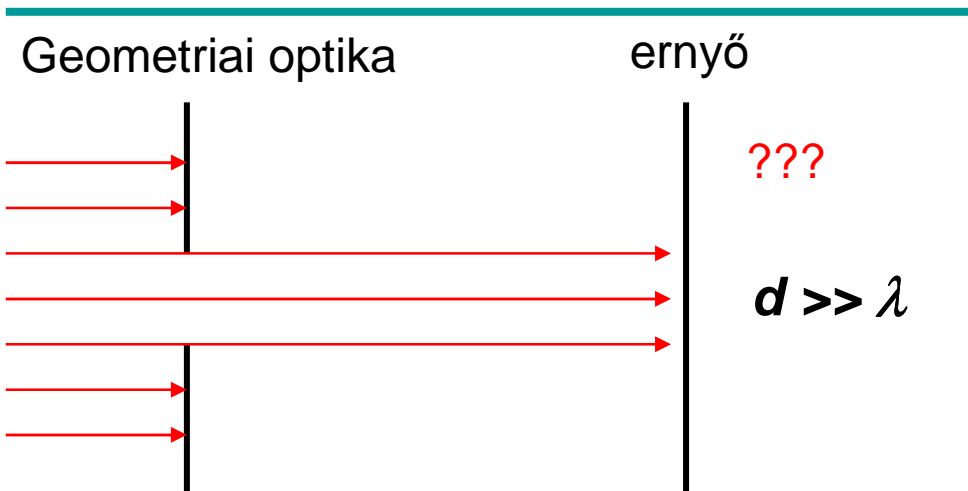
Diffrakció I.

alapkísérlet



Ernyőn látható elhajlási kép (egyre keskenyebb réssel)

A d (rés-szélesség) összemérhető λ -val



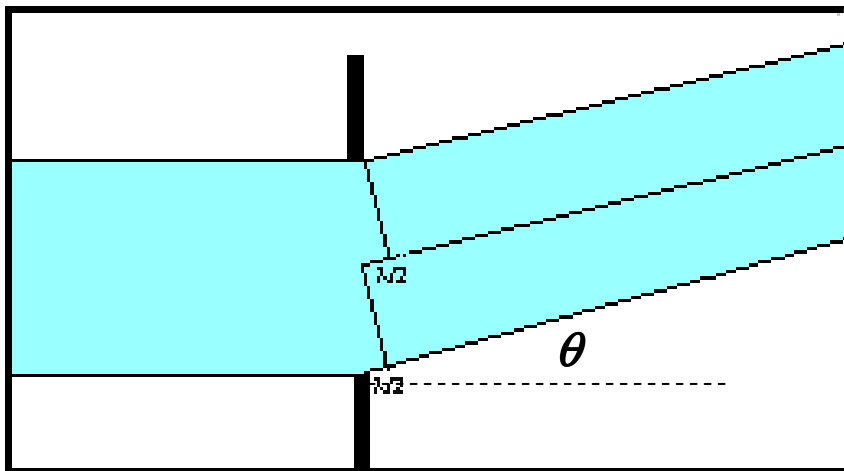
Diffrakció II.

Interferencia: koherens hullámok szuperpozíciója



Alapkísérlet magyarázata:

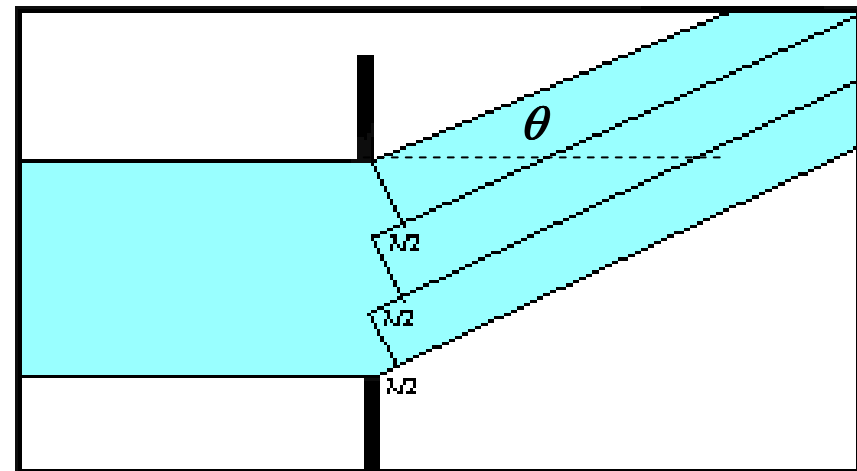
Fresnel zónák



Kioltás
(intensity min. → sötét folt az ernyőn)

$$d \sin \theta = \lambda$$

Ált.: $d \sin \theta = n \lambda \quad n = 1, 2, 3, \dots$

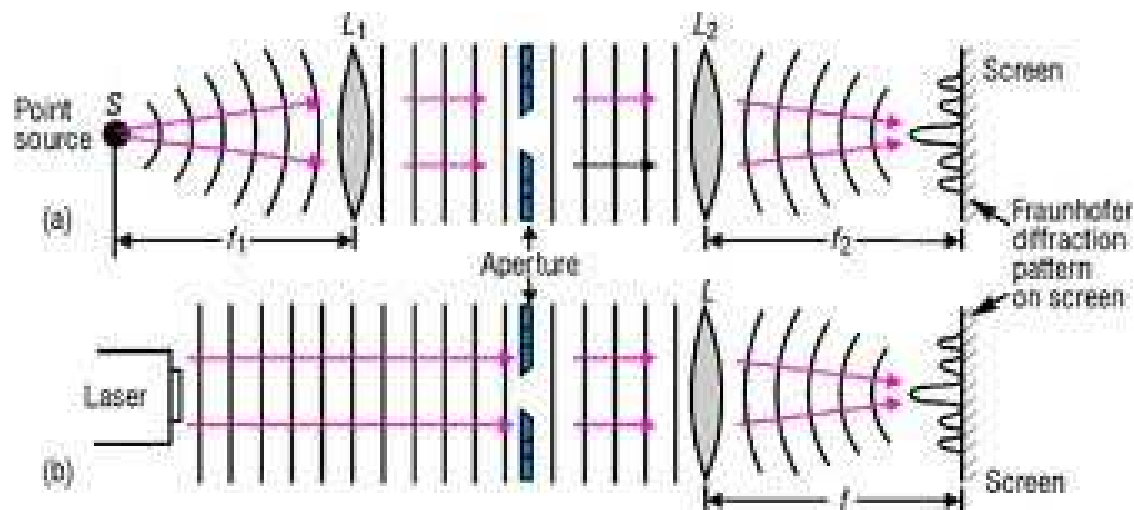
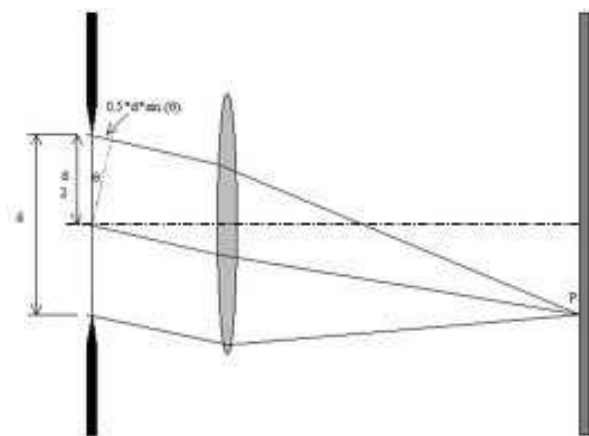


intensity max. → világos folt az ernyőn)

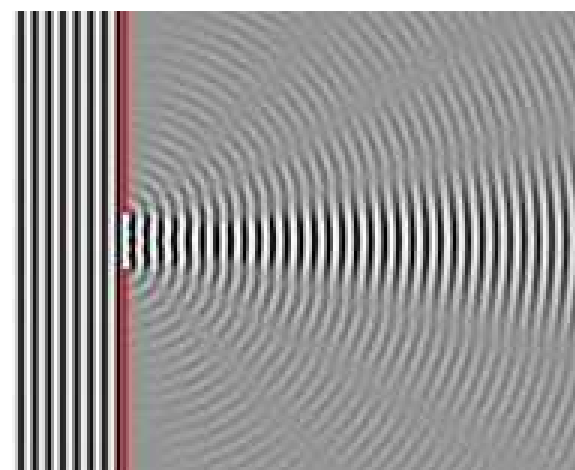
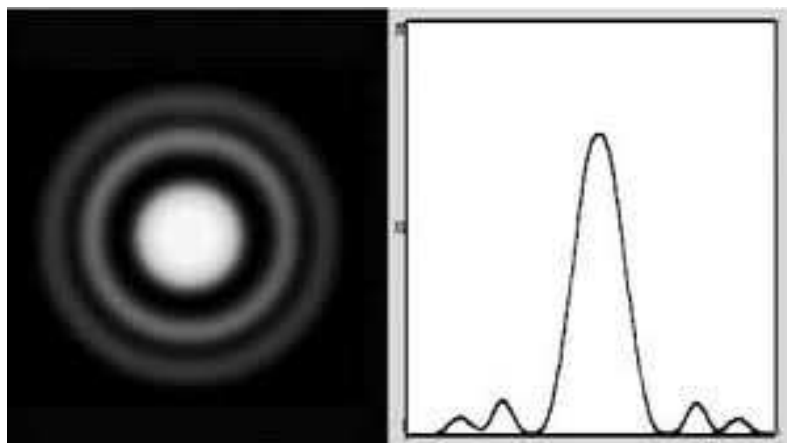
$$d \sin \theta = (2n+1)\lambda/2 \quad n = 1, 2, 3, \dots$$

Diffrakció III.

Fraunhofer-diffrakció

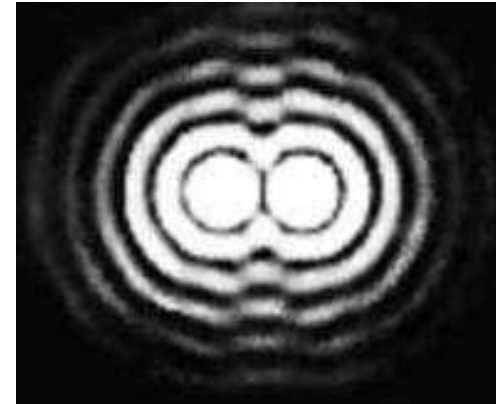
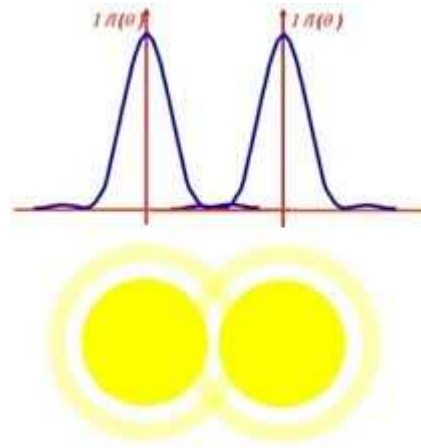
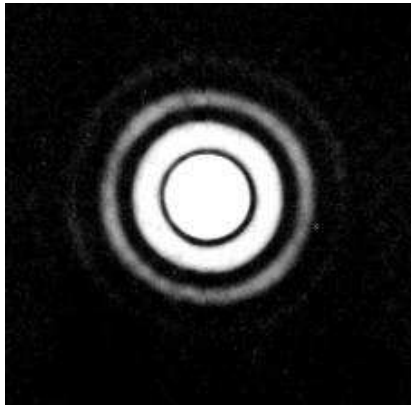


Kör alakú nyílás:

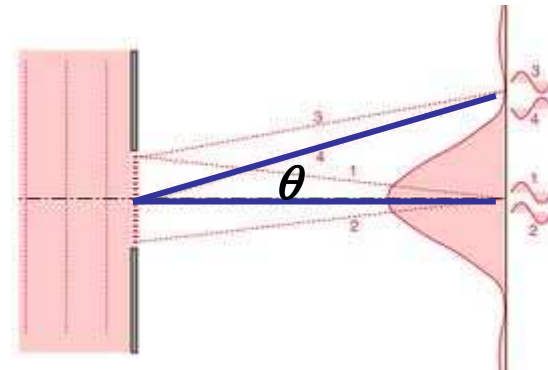
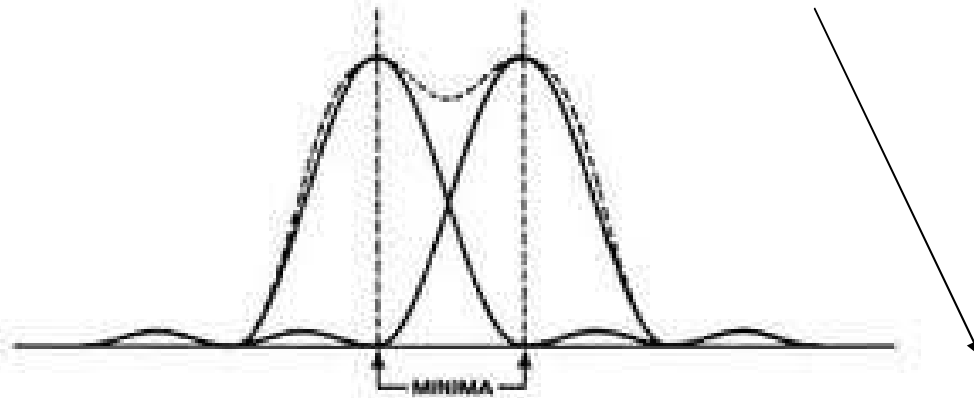


Diffrakció IV.

Felbontás: Rayleigh feltétel



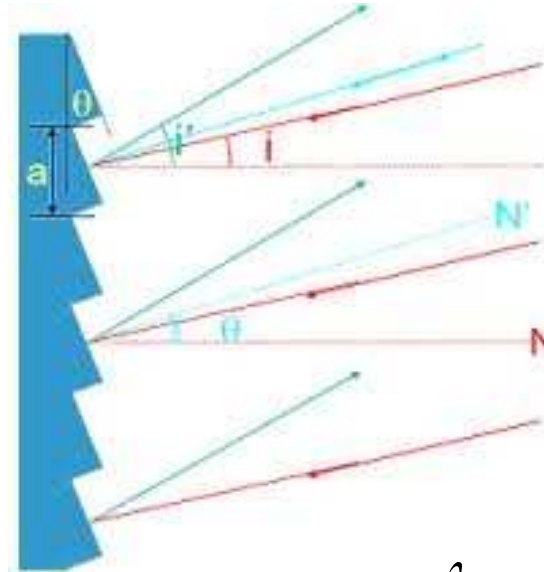
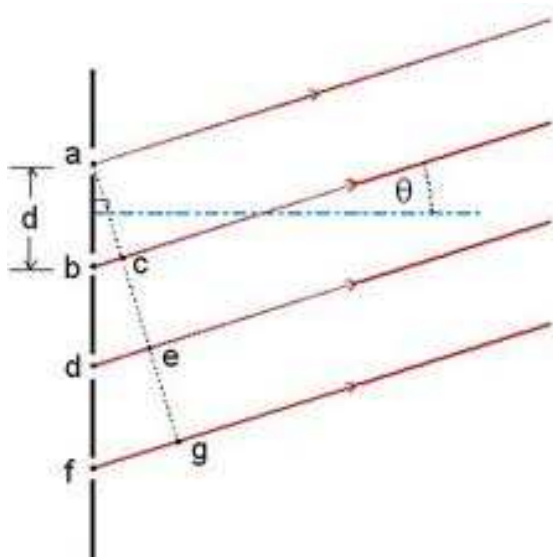
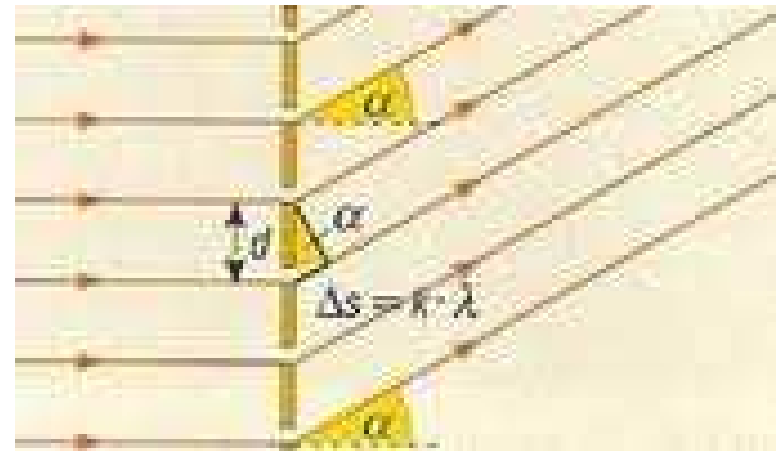
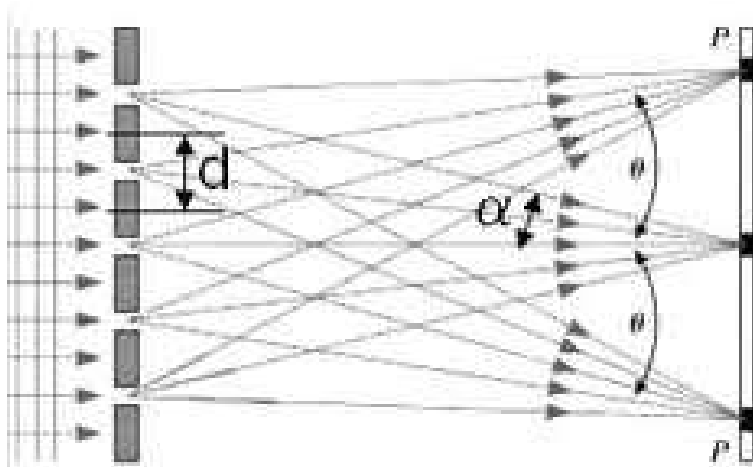
Rayleigh feltétel: $\sin \theta = 1.220 \frac{\lambda}{D}$



Távcső felbontása!

Diffrakció V.

Optikai rács



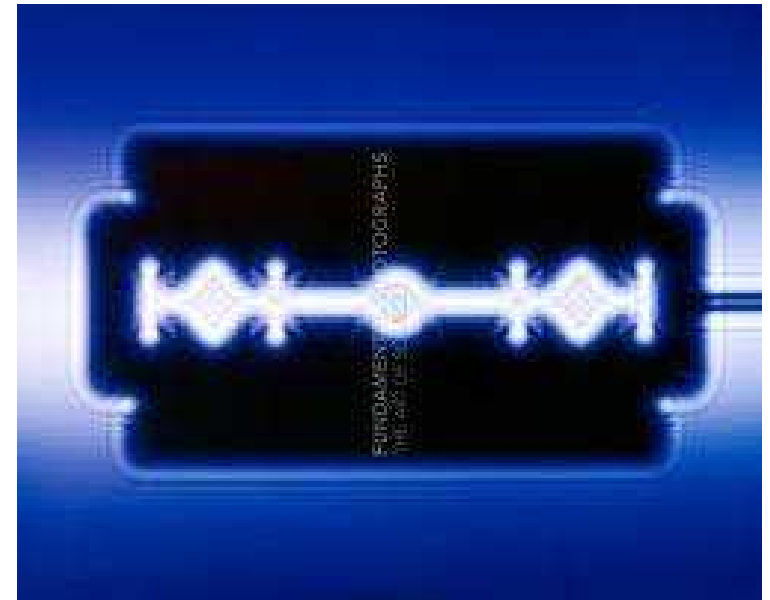
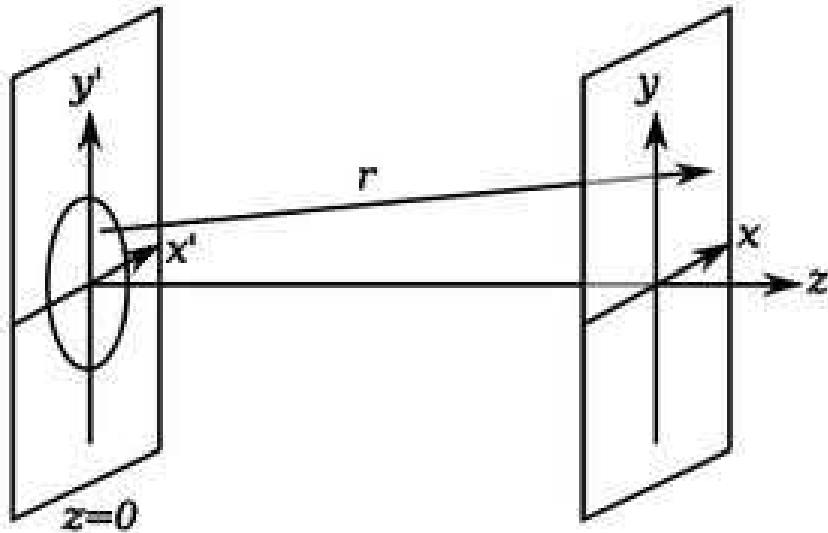
Erősítés: $d \sin \theta = n \lambda$

Rács felbontása: $R = \frac{\lambda}{\Delta \lambda} = Nm$

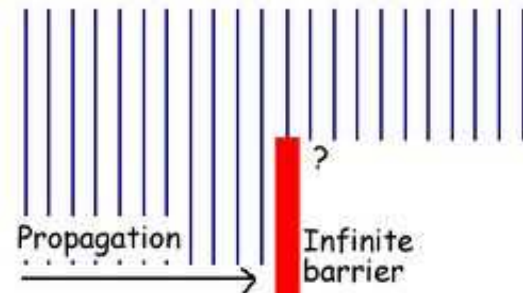
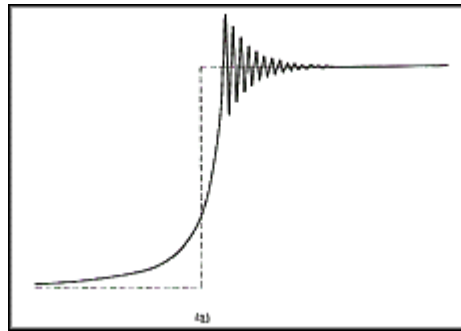
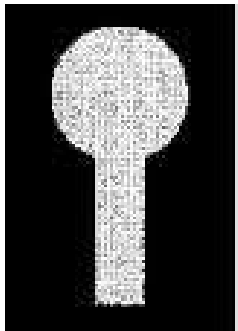
Diffrakció VI.

Fresnel-diffrakció

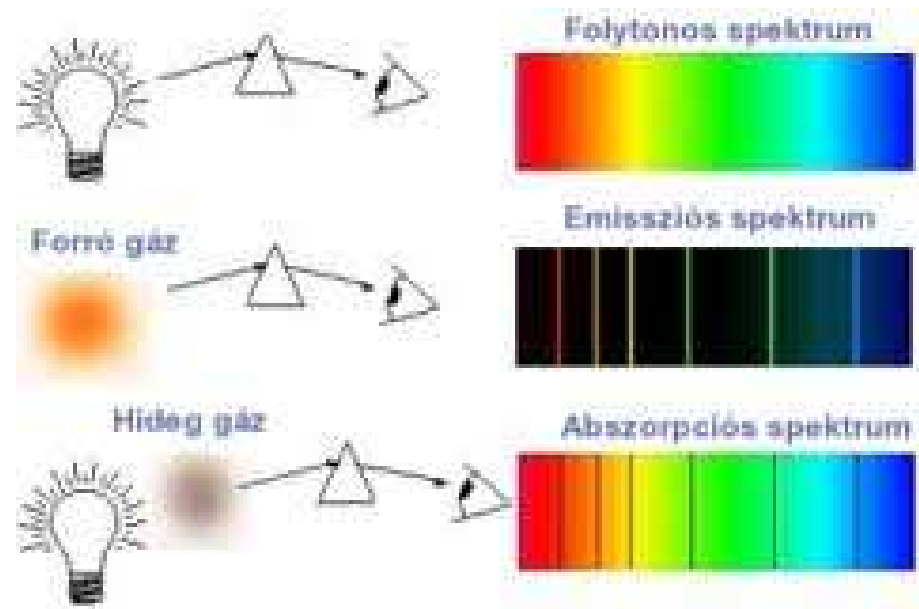
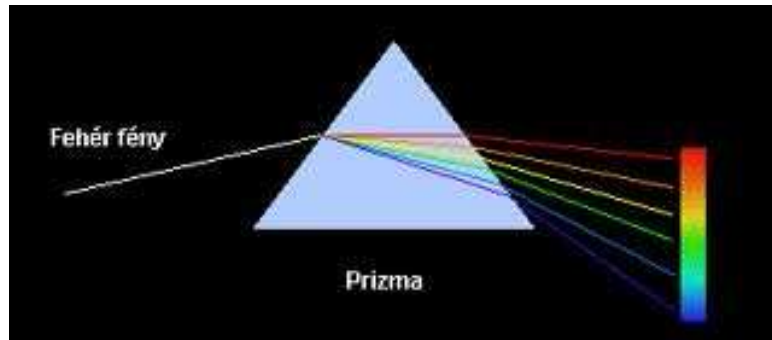
(véges távolság)



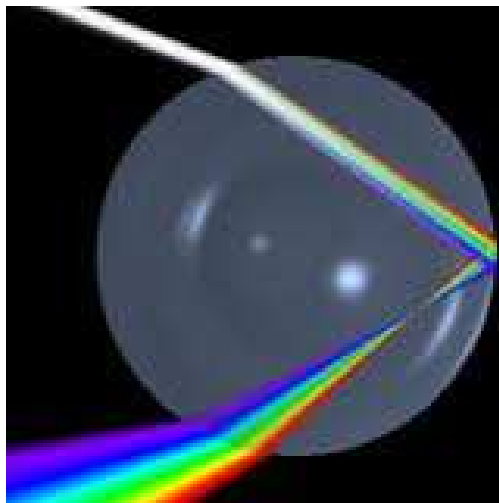
$$E(x, y, z) = \frac{z}{i\lambda} \iint_{-\infty}^{+\infty} E(x', y', 0) \frac{e^{ikr}}{r^2} dx' dy'$$



$$n = n(\lambda) \quad I.$$

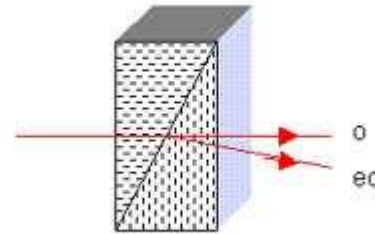
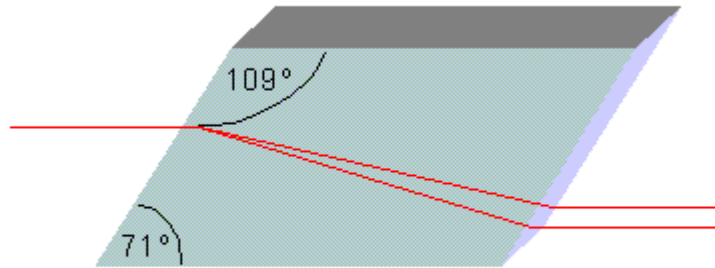
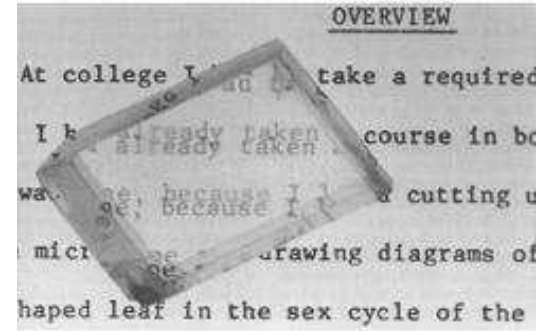


Szivárvány:



$n = n(\lambda)$ II.

Kettőstörés: $n_o \neq n_e$



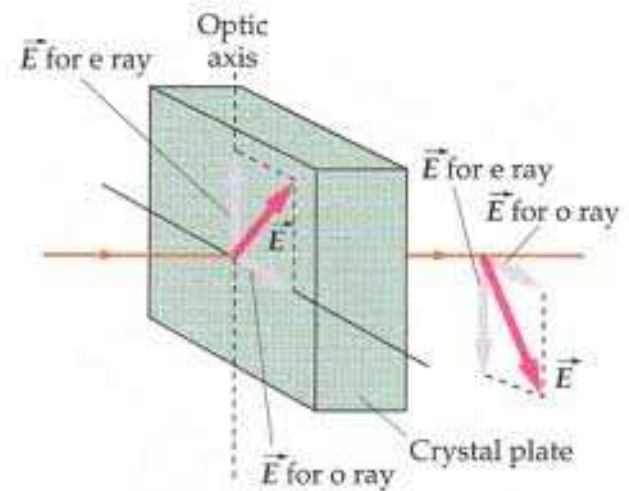
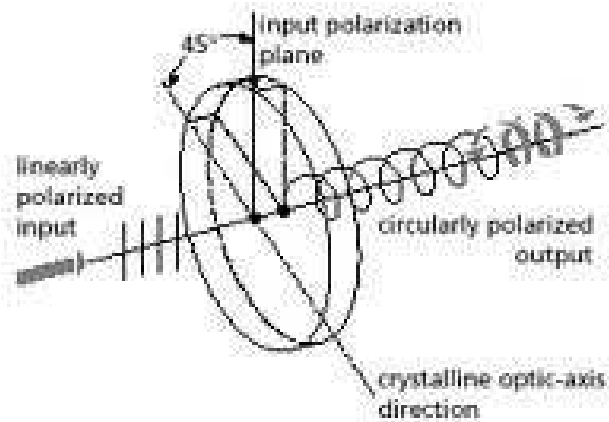
ordinárius

extraordinárius

Lambda-negyedes lemez

$n_{jobbra} \neq n_{balra}$

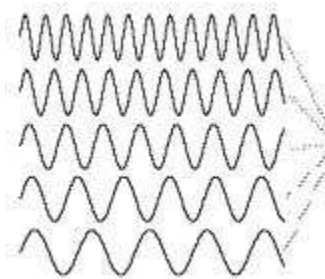
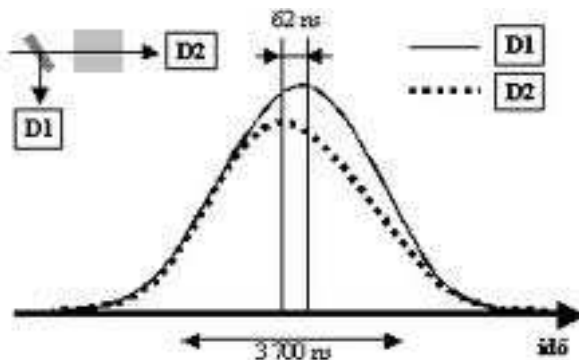
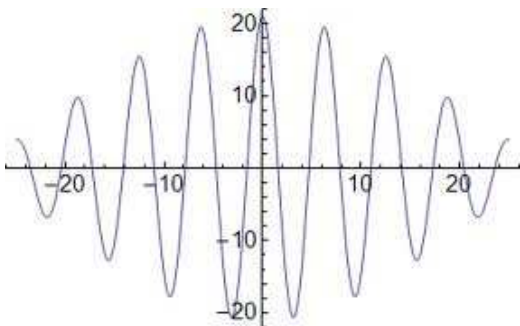
Lambda-feles lemez



$n = n(\lambda)$ III.

Fázissebesség: $v_f = \frac{d\omega}{dk}$

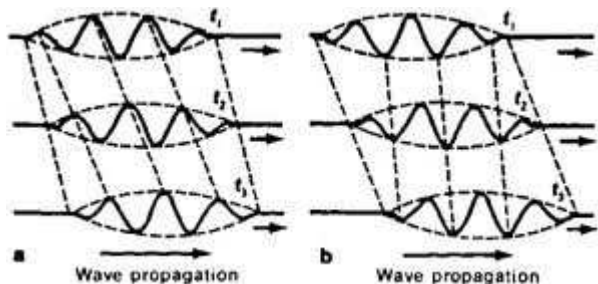
Csoport-sebesség, fázissebesség



Adding several waves of different wavelength together will produce an interference pattern which begins to localize the wave.

But that process spreads the wave number k values and makes it more uncertain. This is an inherent and inescapable increase in the uncertainty Δk when Δx is decreased.

$\Delta k \Delta x \approx 1$



$$\Psi(x,t) = A e^{i(\omega_0 t - k_0 x)} \int_0^{\infty} g(k) e^{i(\Delta\omega t - \Delta k x)} dk$$

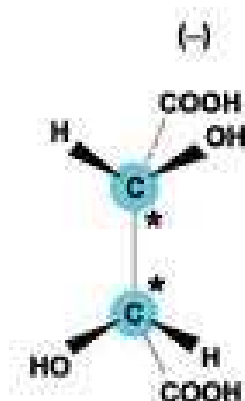
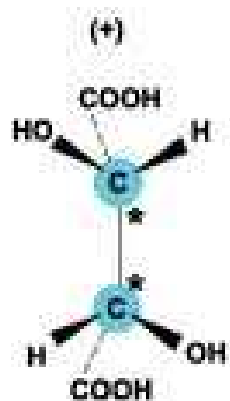
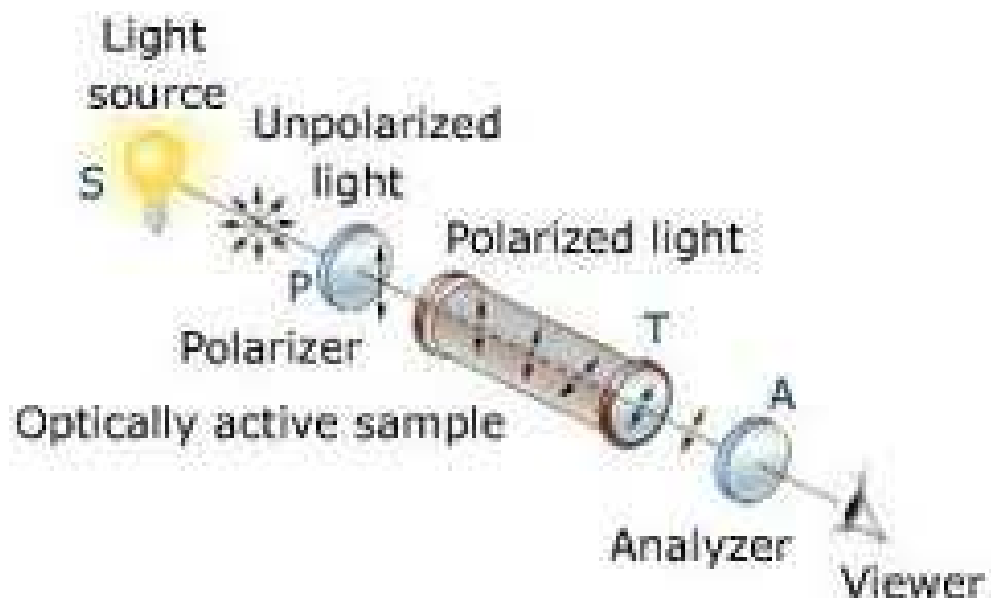
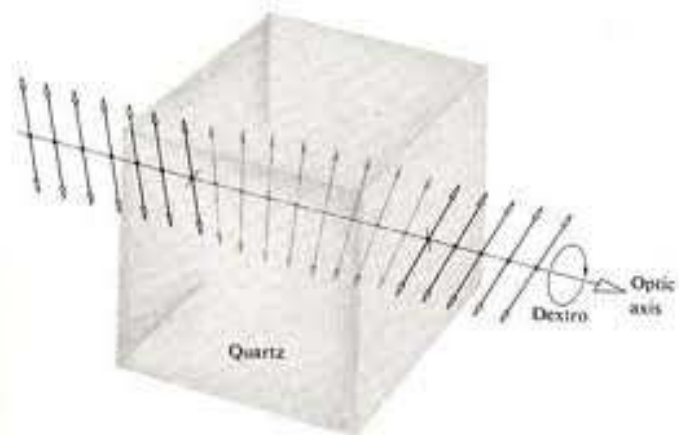


$$\Psi(x,t) = A \int_0^{\infty} g(k) e^{i(\omega t - kx)} dk = A e^{i(\omega_0 t - k_0 x)} \int_0^{\infty} g(k) e^{i((\omega - \omega_0)t - (k - k_0)x)} dk$$

$$\Delta\omega t_1 - \Delta k x_1 = \Delta\omega t_2 - \Delta k x_2 \implies \Delta k (x_1 - x_2) = \Delta\omega (t_2 - t_1)$$

$$v_{cs} = \frac{\Delta x}{\Delta t} = \frac{\Delta\omega}{\Delta k} \implies v_{cs} = \frac{dx}{dt} \implies v_g = \left(\frac{\partial k}{\partial \omega} \right)^{-1} = c \left(\frac{\partial}{\partial \omega} (\omega n(\omega)) \right)^{-1} = \frac{c}{n(\omega) + \omega \frac{\partial n}{\partial \omega}} = \frac{c}{n_g(\omega)}$$

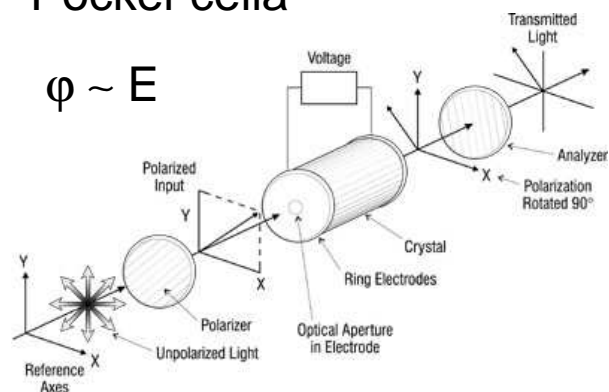
Optikai aktivitás



Modulátorok

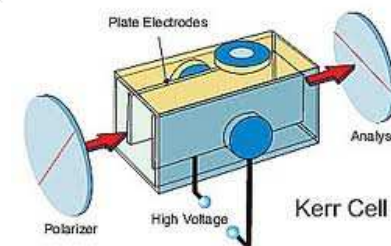
Pockel-cella

$$\phi \sim E$$

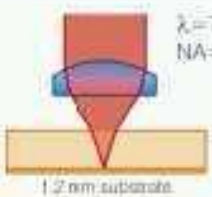
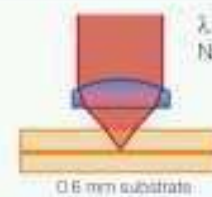
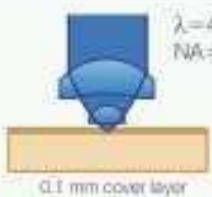

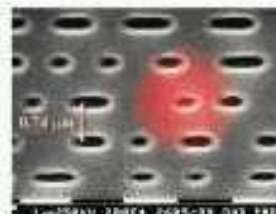



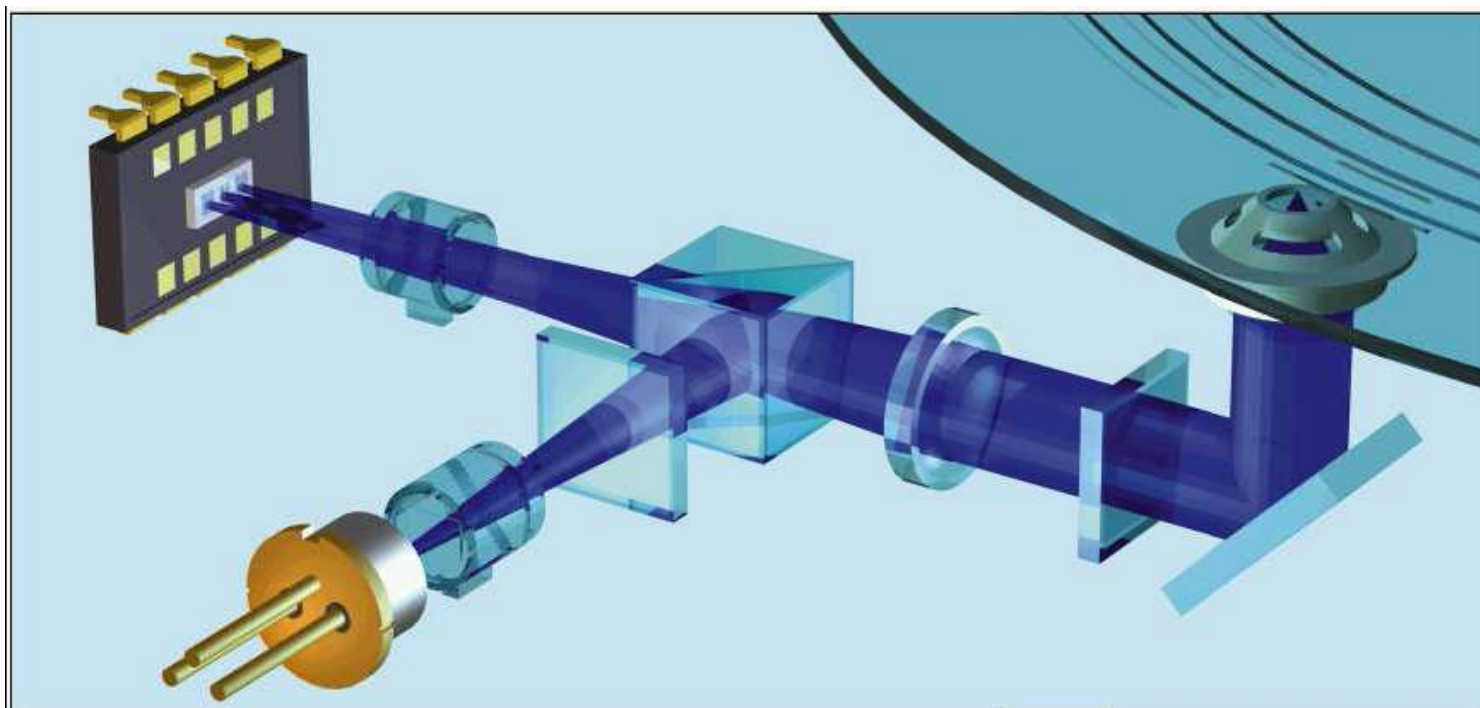
Kerr-cella

$$\phi \sim E^2$$



CD olvasófej

CD	DVD	DVR
 <p>$\lambda = 780 \text{ nm}$ $NA = 0.45$</p> <p>1.2 mm substrate</p>	 <p>$\lambda = 650 \text{ nm}$ $NA = 0.6$</p> <p>0.6 mm substrate</p>	 <p>$\lambda = 400 \text{ nm}$ $NA = 0.85$</p> <p>0.1 mm cover layer</p>
 <p>1.2 μm</p>	 <p>0.74 μm</p>	 <p>0.4 μm</p>



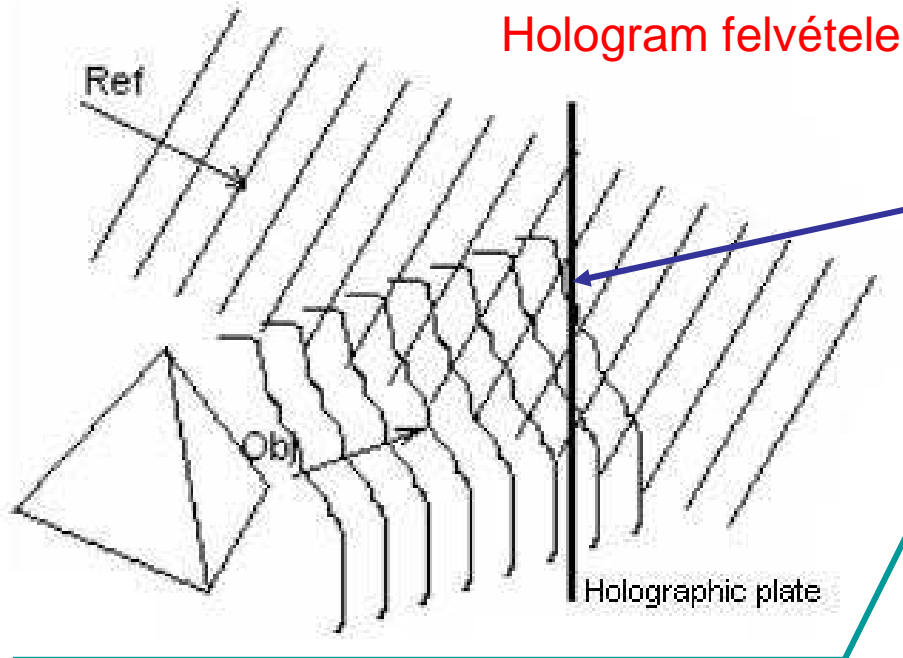
Holográfia I.

Hagyományos holográfia (amplitúdó hologram)

Expozíció (megvilágítás)

$$I = I_o + I_r + E_o E_r^* + E_r E_o^*$$

+ előhívás (fotokémiai folyamat)



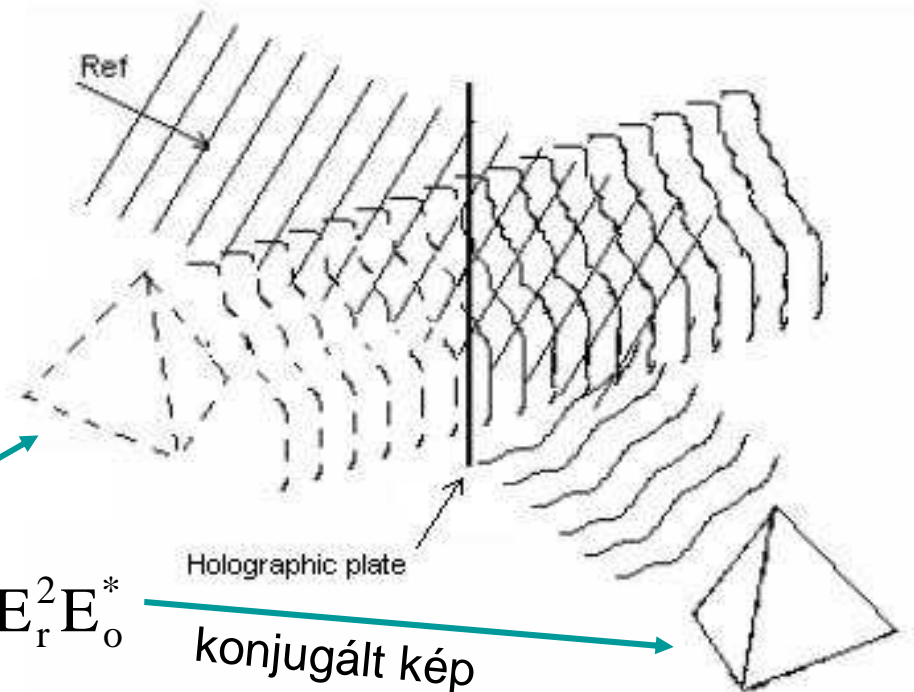
Rekonstrukció (3D-kép visszaállítása)

A hologram transzmissziója:

$$h(x, y) = h_o + t \cdot I(x, y)$$

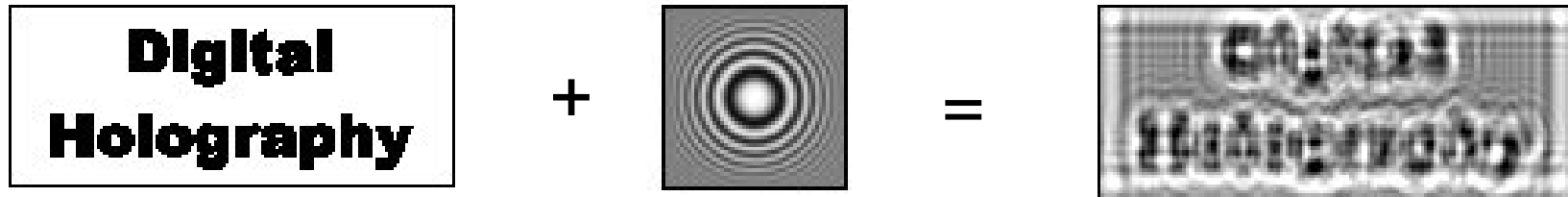
Rekonstrukció:

$$E_r h = h_o E_r + E_r t (I_o + I_r) + E_o |E_r|^2 + E_r^2 E_o^*$$



Holográfia II.

Digitális holográfia



Hagyományos hologram-lemez felbontása: 5000 vonal/mm

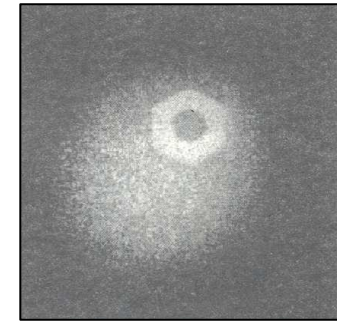
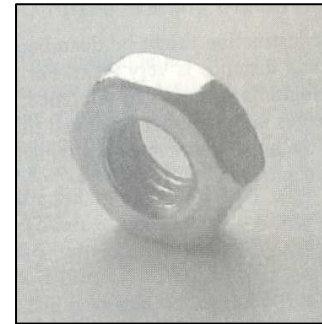
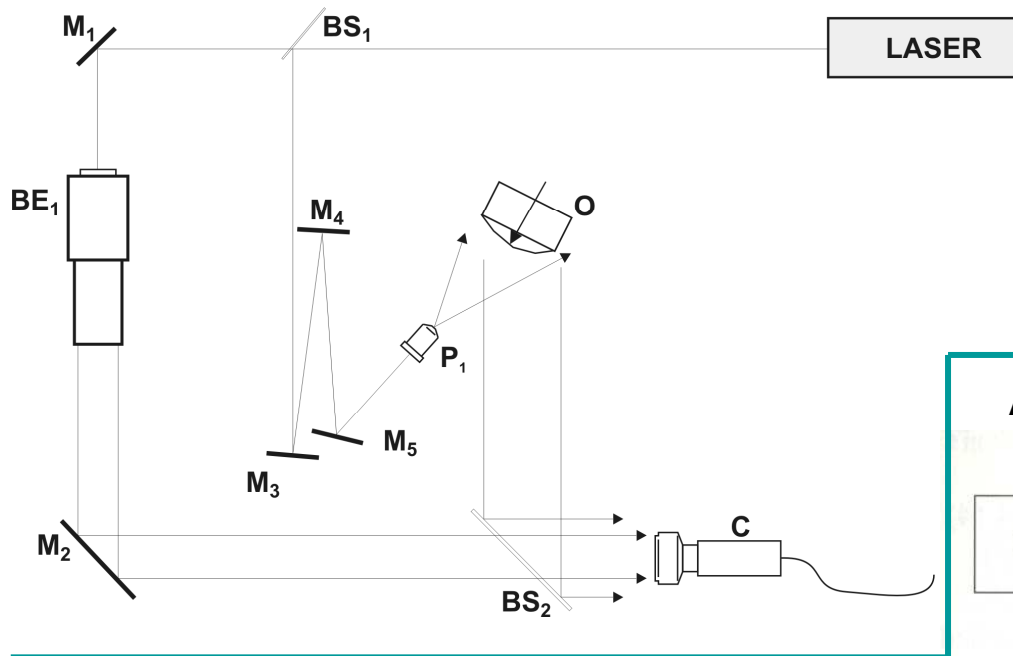
Camera	Chip type	Number of pixels	Pixel size [μm^2]	Frames per second	Dynamic range	Θ_{max} for $\lambda=633\text{nm}$
Roper Sci. MegaPlus 1.4i	FT	1017* 1035	6.8 * 6.8	6.9	8 bit	2.7°
Roper Sci. Megaplu 16.8i	FT	4096* 4096	9 * 9	0.47	8 bit	2.0°
Roper Sci. Megaplu ES 1.0	IT	1008* 1018	9 * 9	30	8 or 10 bit	2.0°
Roper Sci. Megaplu 4.0	IT	2048* 2048	7.4 * 7.4	30	8 or 12 bit	2.45°
Hamamatsu C8484-01	PSI	1344* 1024	6.45 * 6.45	8.3	12 bit	2.81°
Duncan DT1100	PS	1392* 1040	4.65 * 4.65	12	8 or 12 bit	3.9°

FT: full frame: interline transfer, PSI: progressive scan interline, PS: progressive scan

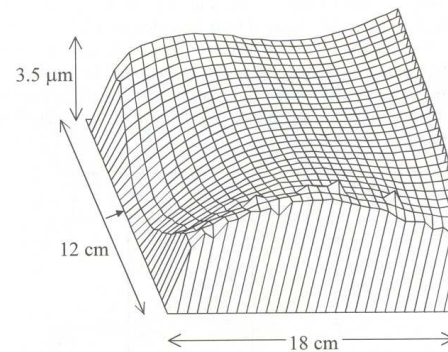
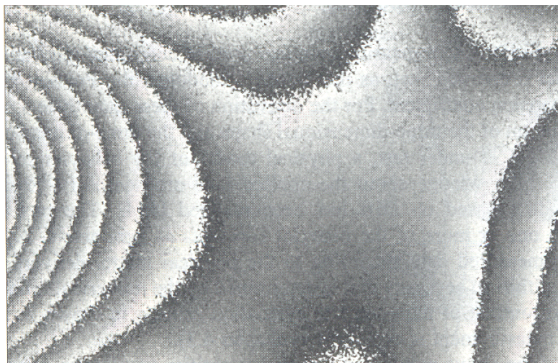
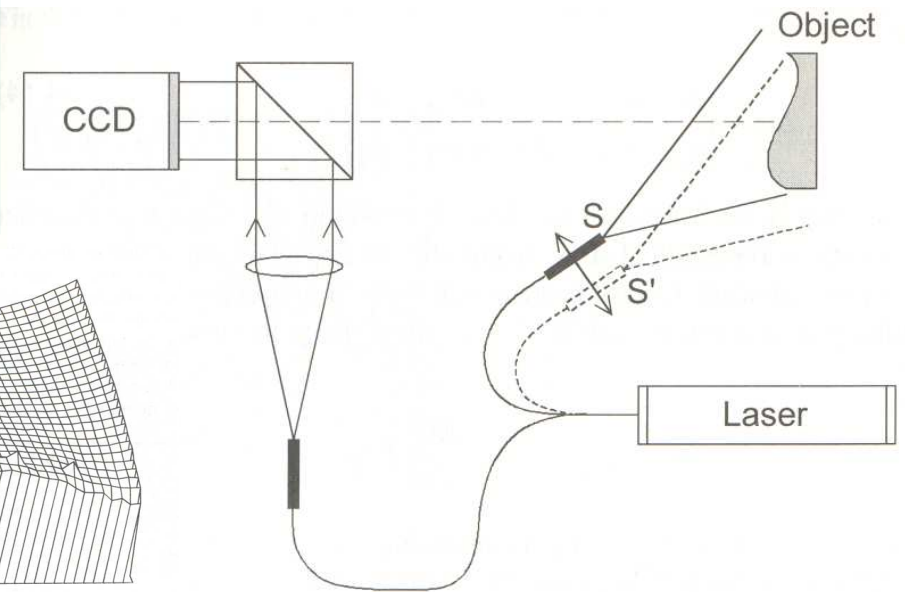
Holográfia III.

Digitális holográfia

"In-line" elrendezés

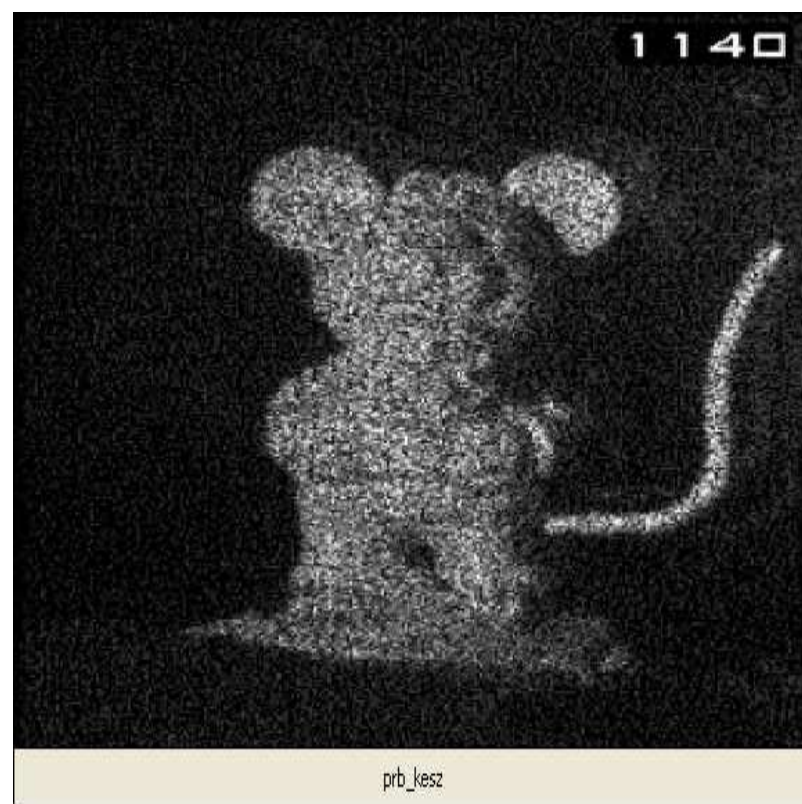
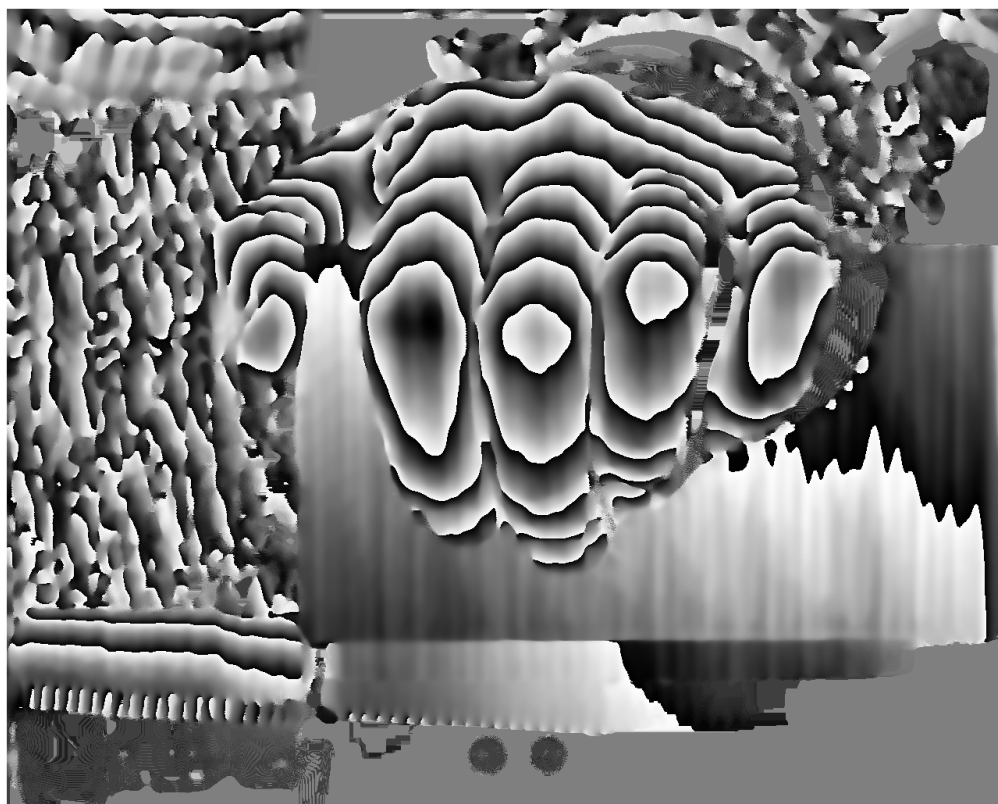


Alakmérés:

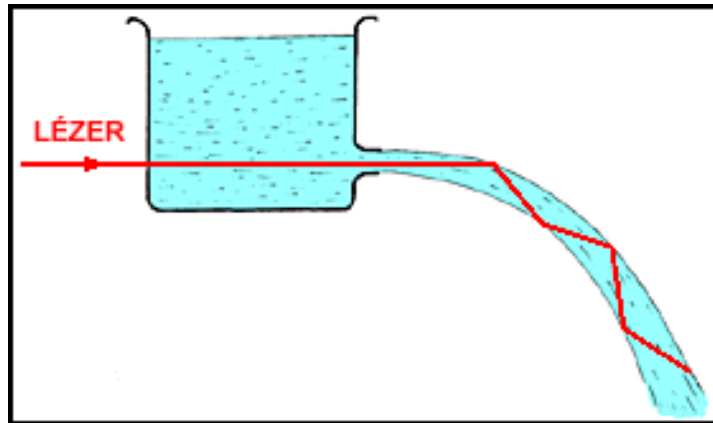


Holográfia IV.

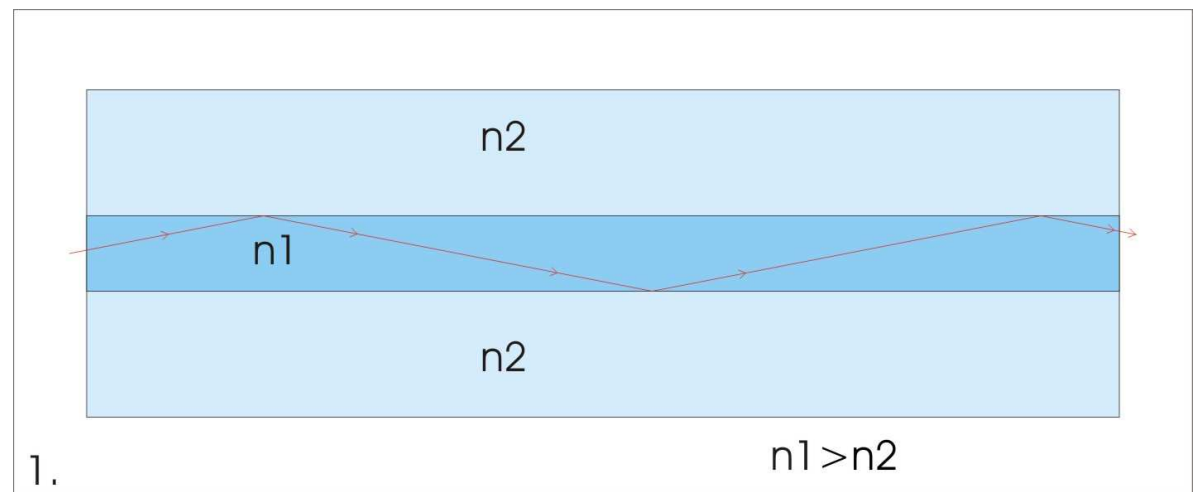
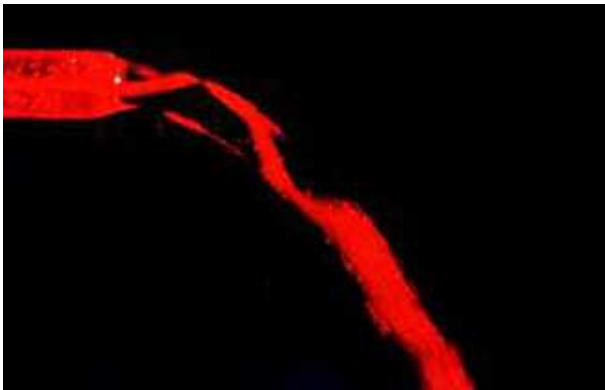
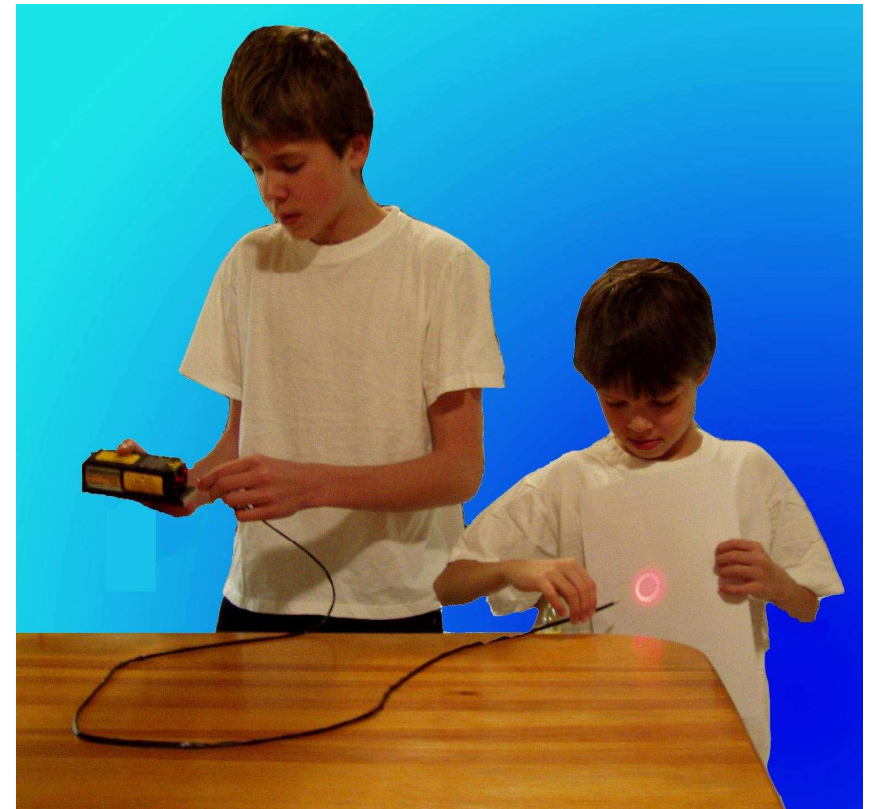
Digitális holográfia



Optikai adatátvitel I.



? teljes visszaverődés ?



Optikai adatátvitel II.

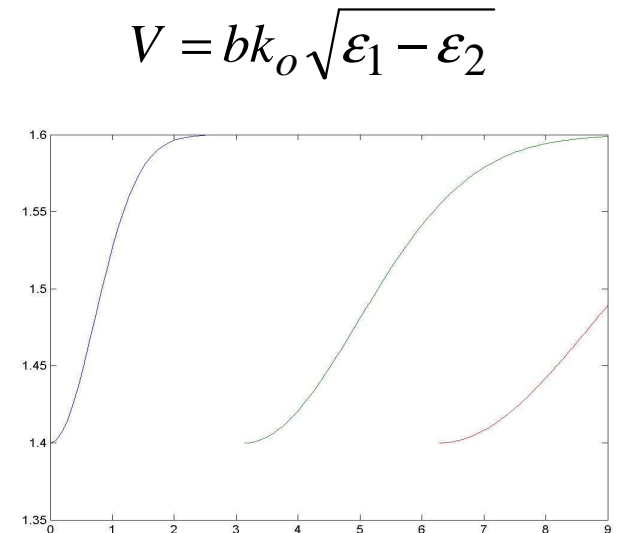
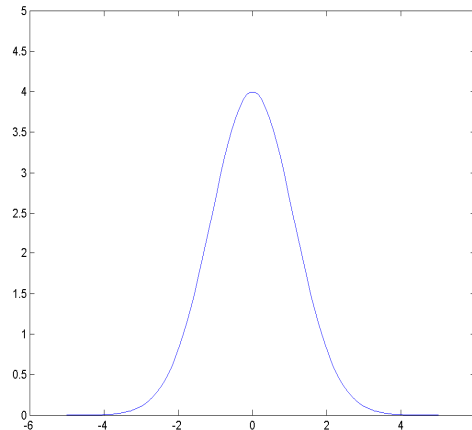
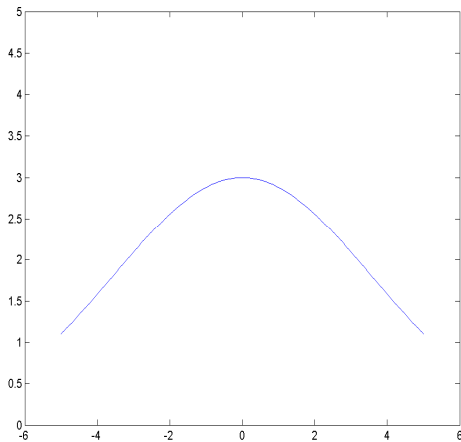
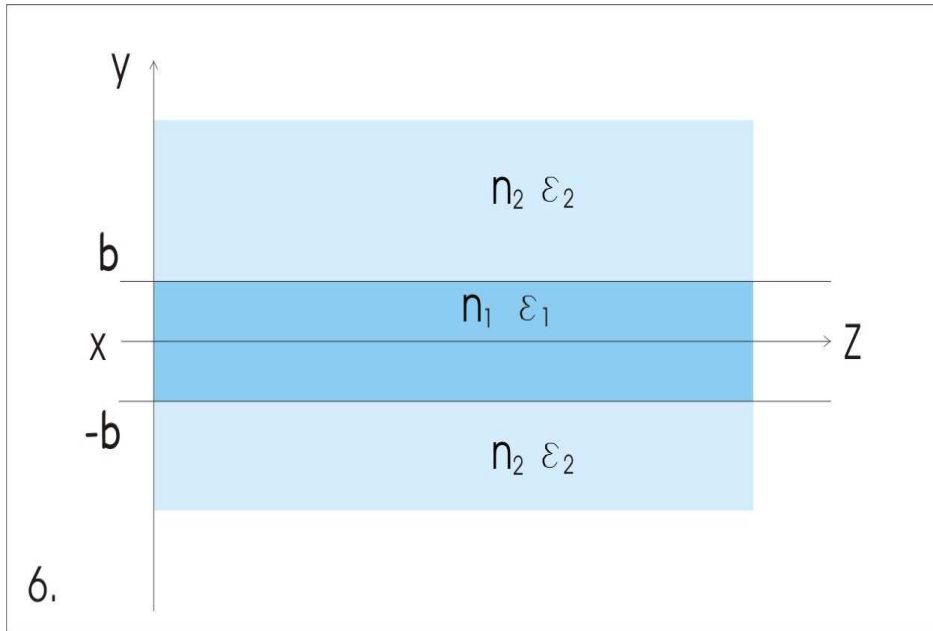
Feltételek:

x: ∞ :

z: terjedés iránya

$$\epsilon_1 > \epsilon_2$$

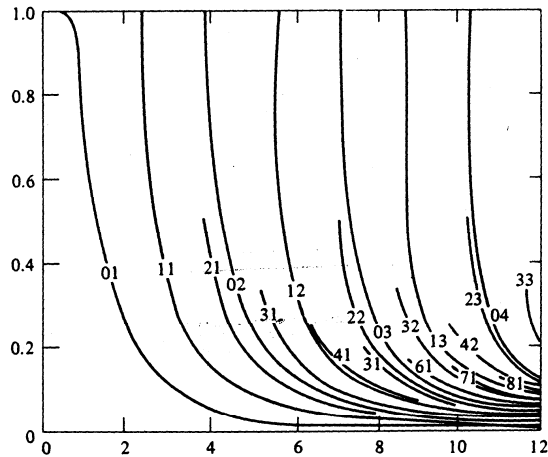
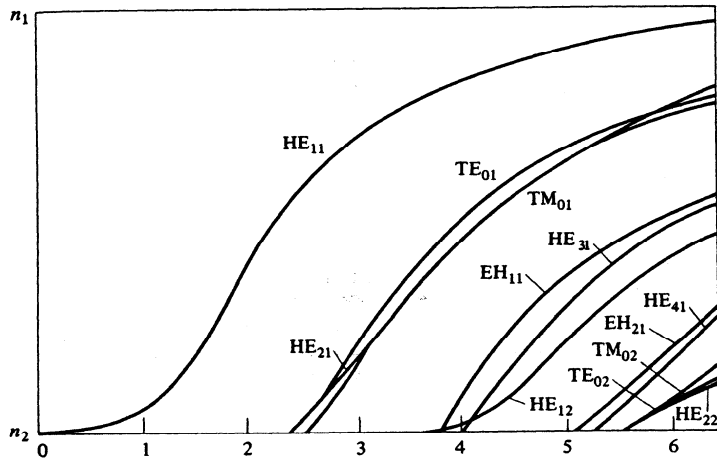
Időfüggés: $\exp[i(\omega t - \beta z)]$



$$V = bk_o \sqrt{\epsilon_1 - \epsilon_2}$$

Optikai adatátvitel III.

Módusdiszperzió



$$\text{telj.hányad} = \frac{\text{magan}}{\text{köpenyben}}$$

