Diffusione della radiazione EM: elettroni liberi e legati

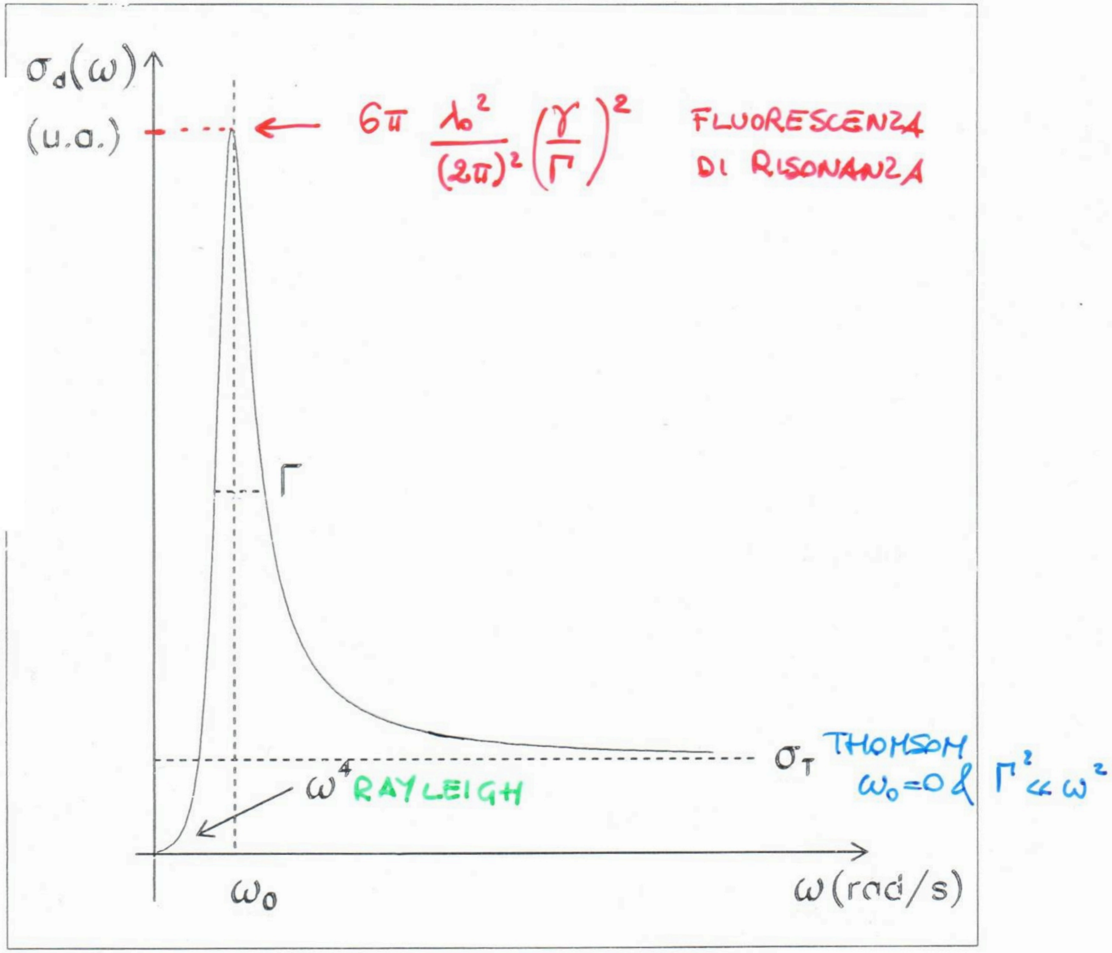
$r_0 = (1/4\pi\varepsilon_0)\,(e^2/mc^2) = 2.82\ 10^{-15}$ m raggio classico dell'elettrone

$\sigma_T = 8\pi/3\ r_0^2 = 0.665\ 10^{-24}$ cm^2 sezione d'urto Thomson (10^{-24} cm^2 = 1barn)

$$\gamma = \frac{1}{4\pi\varepsilon_0}\,\frac{q^2\omega^2}{3mc^3}$$

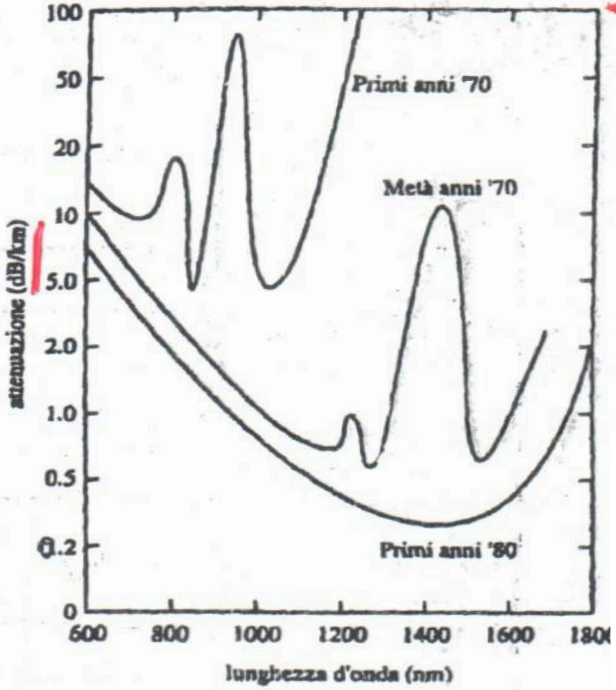
$$\sigma_d = \left(\frac{8}{3}\pi r_0^2\right)\frac{\omega^4}{(\omega_0^2-\omega^2)^2+\omega^2\Gamma^2} \qquad \Gamma = \gamma + \gamma'$$

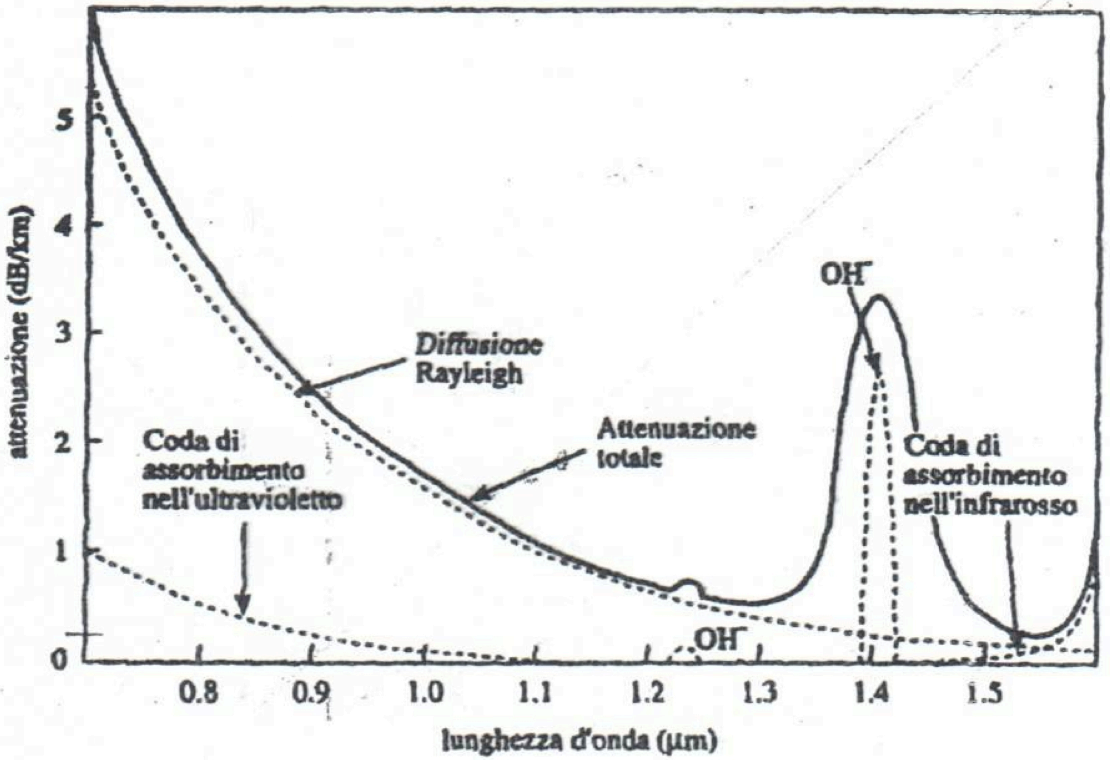
$$\sigma_{d\,ris} \simeq \frac{3}{2}\pi\,\frac{\lambda_0^2}{(2\pi)^2}\,\frac{\gamma^2}{(\omega_0-\omega)^2+(\Gamma/2)^2}$$

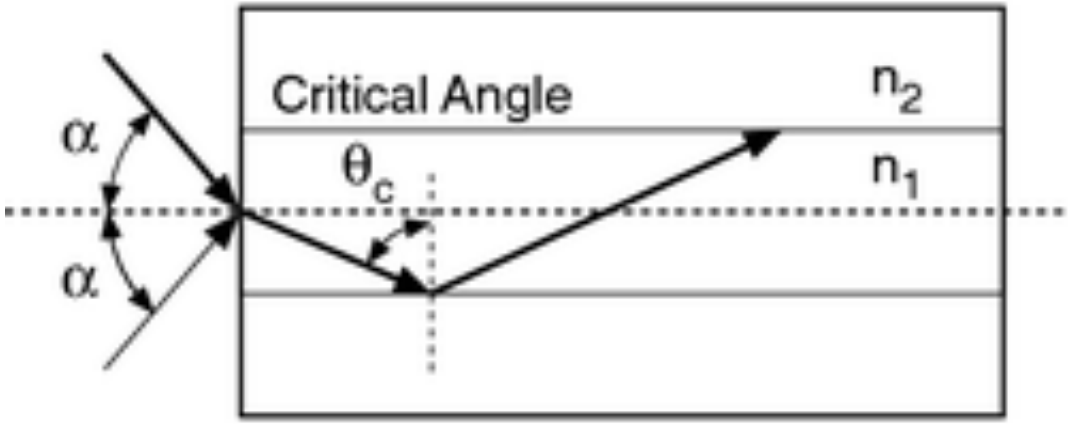


Fibre Ottiche

$$100 = 10 \log \frac{P_{OUT}}{P_{IN}}$$



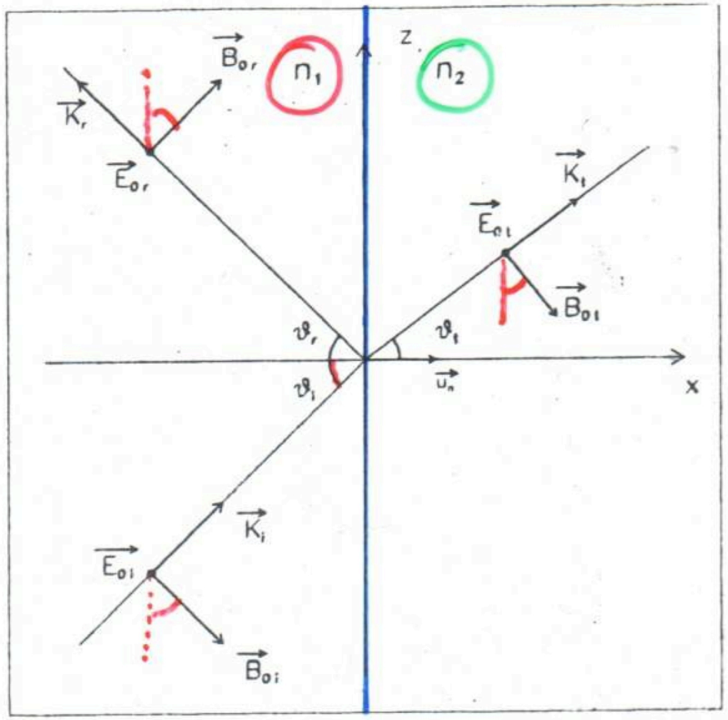




NA = sin α = sqrt ($n_1^2 - n_2^2$) = sqrt ($n_{core}^2 - n_{clad}^2$)
Full Acceptance Angle = 2α

n_{core} (For SMF-28 fiber: n_{core} ~1.47 @ 1310nm)
n_{clad} (For SMF-28 fiber: n_{clad} ~1.46 @ 1310nm)

Formule di Fresnel

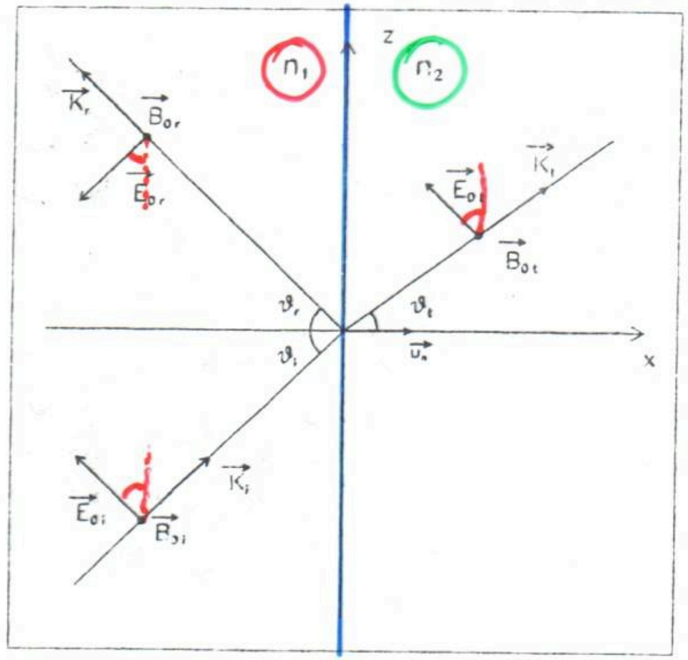


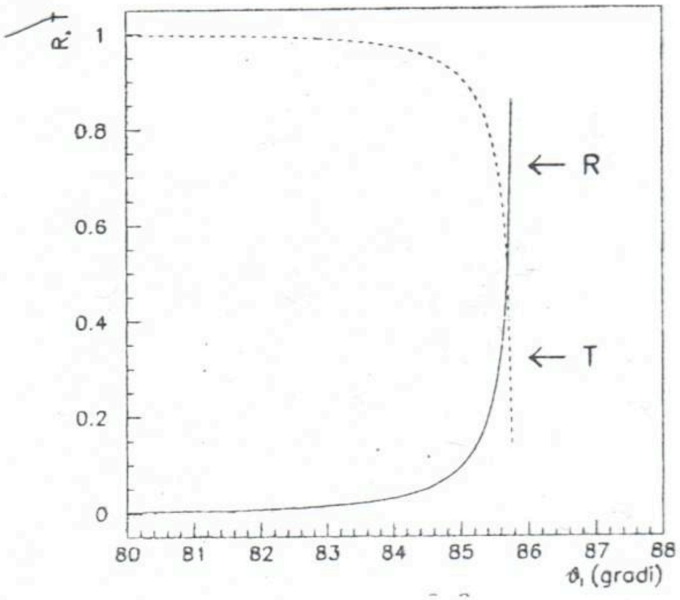
$r_\perp$

$t_\perp$

$r_{||}$

$t_{||}$



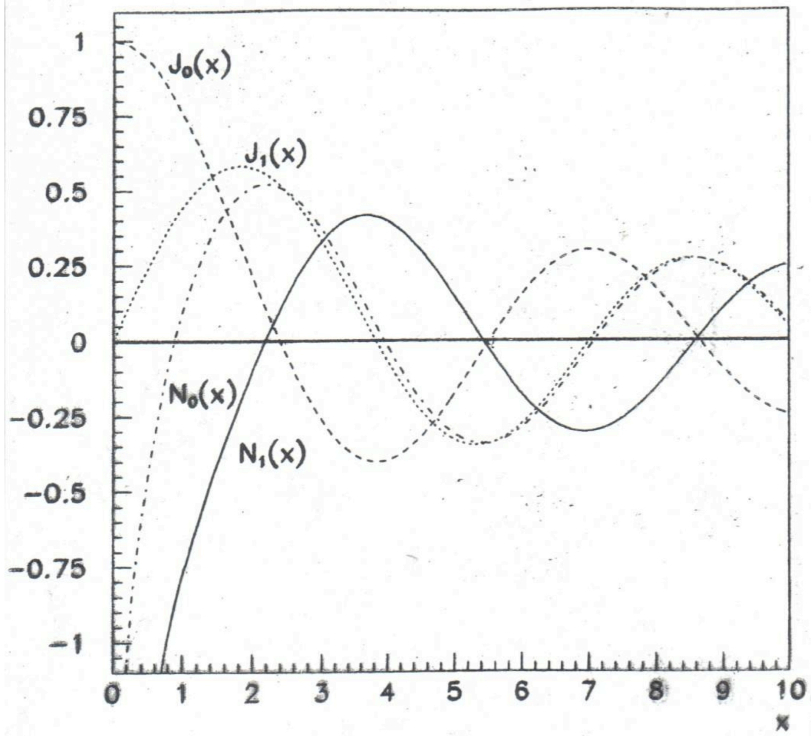


$E_{0i\perp}$

$n_1 = 1.461$ nocciolo
$n_2 = 1.457$ mantello

$\theta_L = 85.759$ gradi
N.A. = 10.25 gradi

Funzioni di Bessel modificate

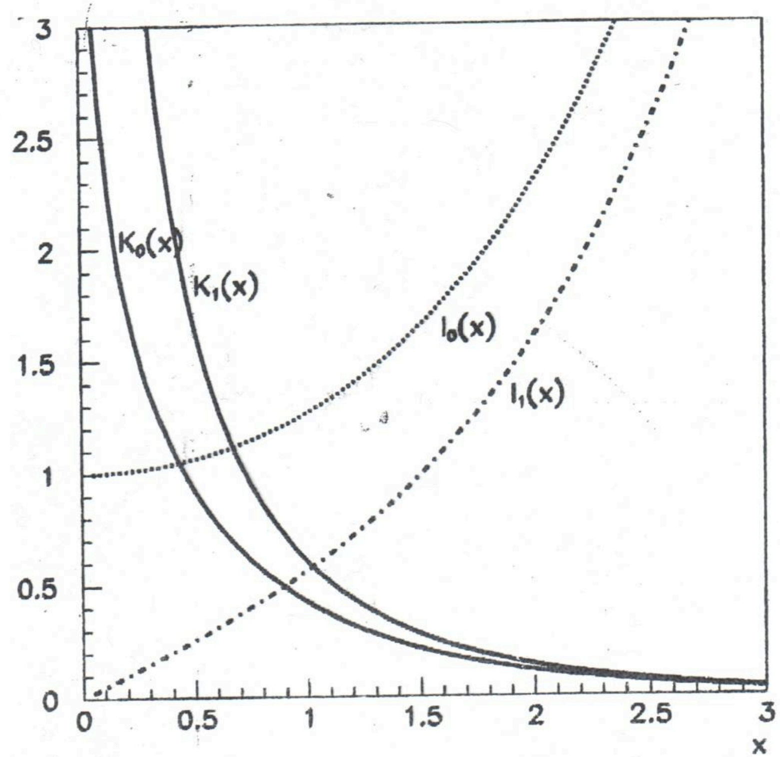


BESSEL

NEUMANN

X : REALE

m : INTERO



BESSEL

NEUMANN

X : | IMMAGINARIO |

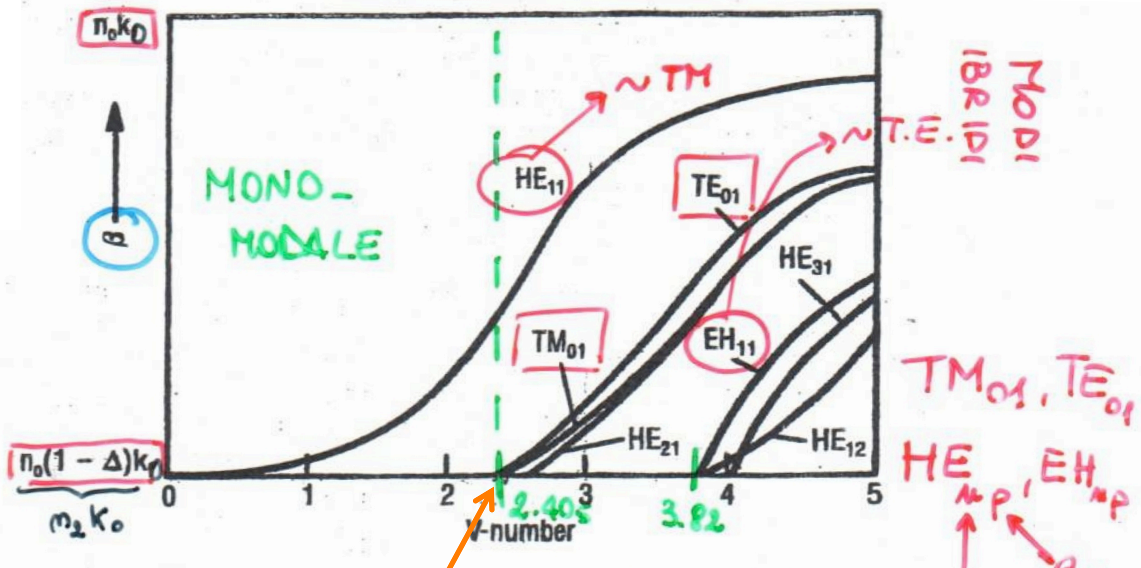
m : INTERO

→ MODI

FIBRA OTTICA

A SEZIONE CIRCOLARE

$$\Delta = \frac{n_1 - n_2}{n_1} \sim 0$$



BESSEL β_t

Figure 0.13. Low order modes of an optical fiber. Plot of the propagation constant in a fiber (β) as a function of V-number of a fiber. Each V-number represents a different fiber configuration or a different wavelength of light in a given fiber configuration. [after D.B. Keck in Fundamentals of Optical Fiber Communication, 2nd Edition, M. K. Barnoski, ed. see references, Copyright © Academic Press, 1981]

$$V = k_0 \, r_1 \, NA$$
$$= 2\pi/c \, \nu \, r_1 \, NA$$

Cutoff Wavelength

$\lambda_c = 2\pi \cdot a/V_c \cdot \text{sqrt}\,(n_{core}^2 - n_{clad}^2)$

a	is the fiber core radius
n_{core}	is the index of refraction of the core
n_{clad}	is the index of refraction of the cladding
λ_c	is the cutoff wavelength
V_c	is the cutoff V number, equals 2.405

The cutoff wavelength is the minimum wavelength in which a particular fiber still acts as a single mode fiber. Above the cutoff wavelength, the fiber will only allow the LP_{01} mode to propagate through the fiber (fiber is a single mode fiber at this wavelength). Below the cutoff wavelength, higher order modes, i.e. LP_{11}, LP_{21}, LP_{02}, etc will be able to propagate (fiber becomes a multimode fiber at this wavelength).

$n, p \rightarrow \beta$: MODI DEGENERI

COMBINAZIONE LINEARE $\rightarrow$

$\rightarrow$ MODI POLARIZZATI LINEARMENTE:

LP_{qp}

1 TM, TE

m+1 EH

m-1 HE

q: ZERI/NODI AZIMUTALI $\vec{E}$

p: NODI RADIALI $\vec{E}$

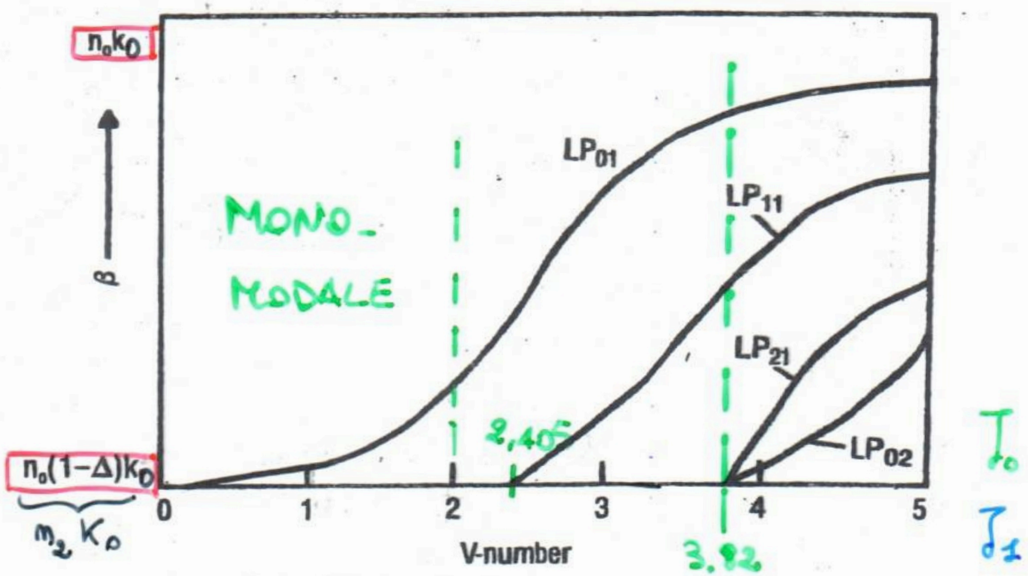
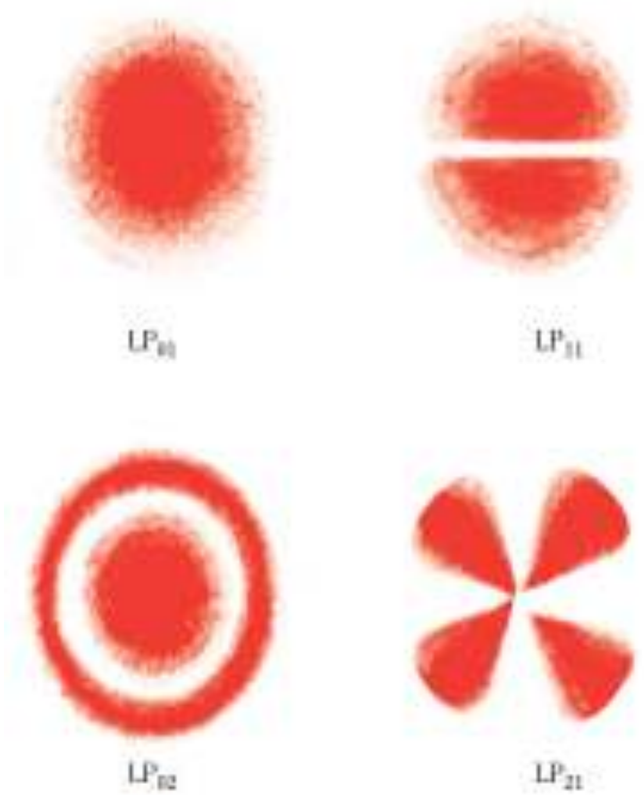


Figure 0.15. Low order linearly polarized modes of an optical fiber. Compare with Figure 0.13.

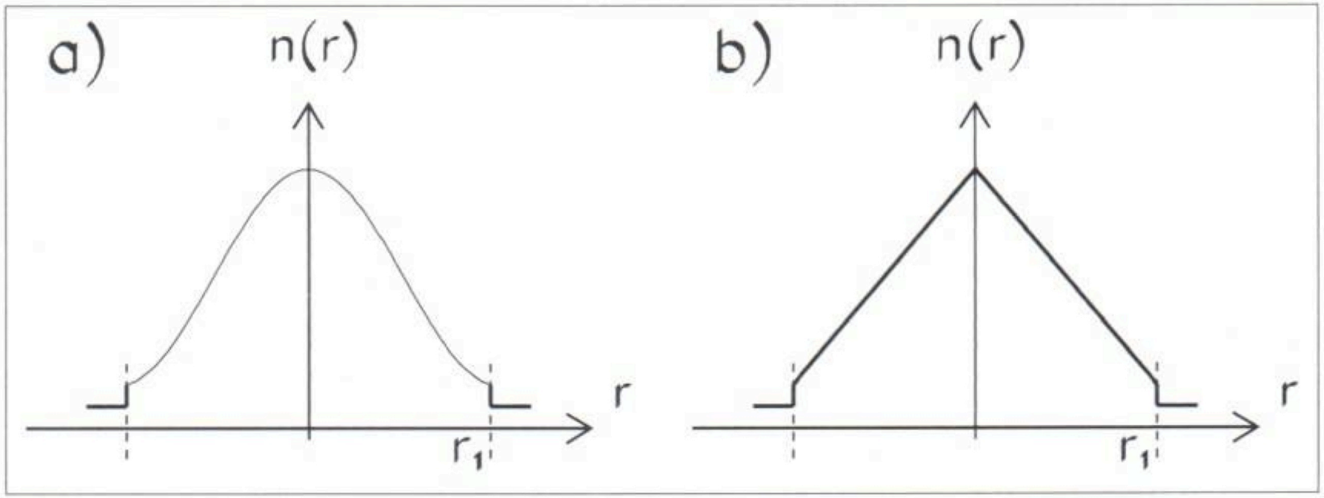
r_1 = 25 μm   NA = 0.20

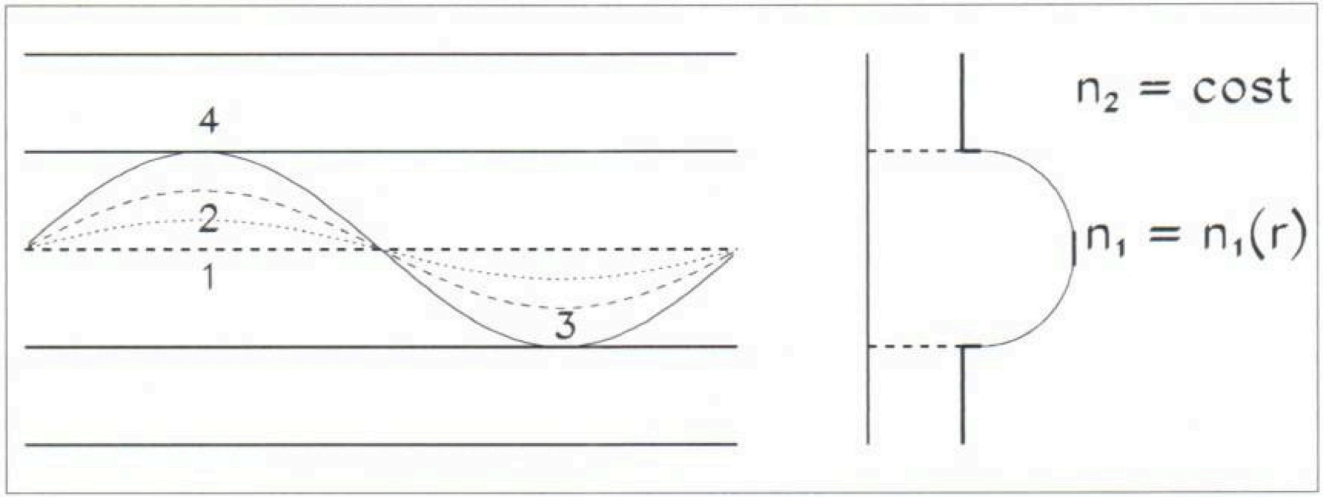
r_1 = 50 μm   NA = 0.30

λ = 633 nm   V=50, 150



Irradiance patterns for low order LP Modes


a)
n(r)
r
r1
b)
n(r)
r
r1


4
2
1
3
n2 = cost
n1 = n1(r)