Ders Planı

1. Işığın dalga özelliği.
2. Dielektrik dalga klavuzları ve optik lifler.
3. Yarıiletkenler fiziği ve ışık yayan diyotlar.
4. Lazerler.

Ara Sınav

5. Fotoalgıçlar.
6. Fotovoltaik aygıtlar.
7. Kutuplanma ve ışığın modülasyonu.

Önerilen Ders Kitapları:

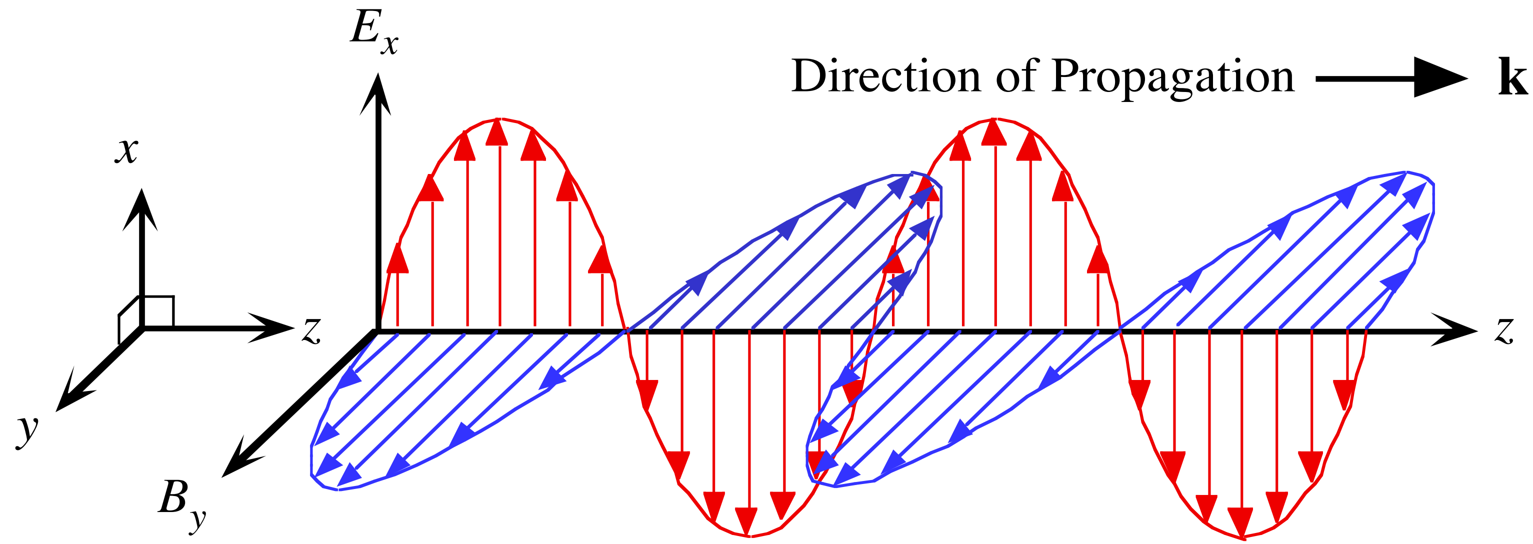
- Optoelectronics And Photonics: Principles And Practices, S.O. Kasap, Prentice Hall (2001).
- Optical Fiber Communications, J.M.Senior, | Prentice Hall |
- Optical Properties of Solids, M.Fox, Oxford University Press (2001).
- Semiconductor Devices: Physics and Technology, S.M.Sze, Wiley (1985).
- Introduction to Optics, Frank. L. Pedrotti, | Addison Wesley|

1. WAVE NATURE OF LIGHT

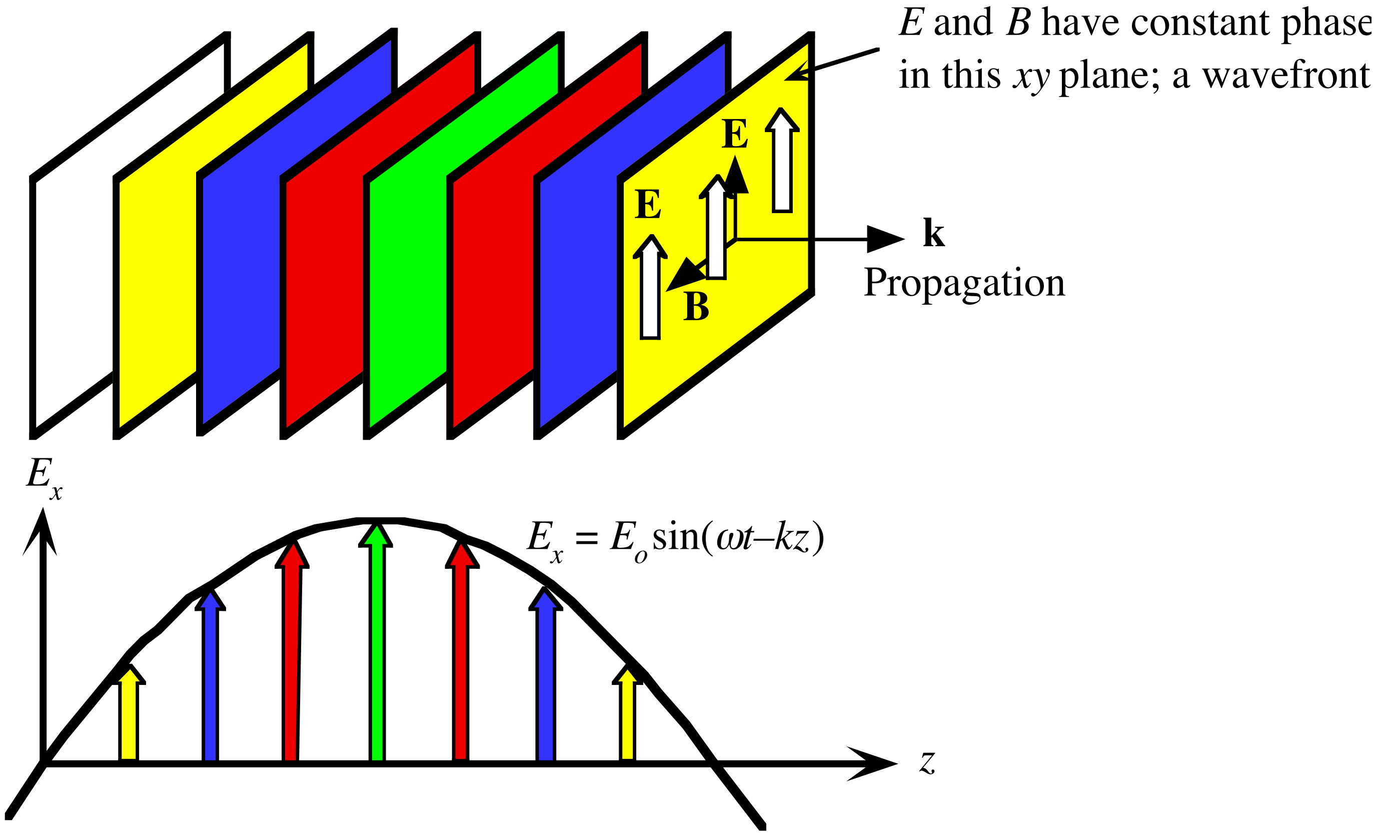
1.1 Light Waves in a Homogeneous Medium
- A. Plane Electromagnetic Wave
- B. Maxwell's Wave Equation and Diverging Waves

1.2 Refractive Index
1.3 Group Velocity and Group Index
1.4 Magnetic Field, Irradiance and Poynting Vector
1.5 Snell's Law and Total Internal Reflection (TIR)
1.6 Fresnel's Equations
- A. Amplitude Reflection and Transmission Coefficients
- B. Intensity, Reflectance and Transmittance

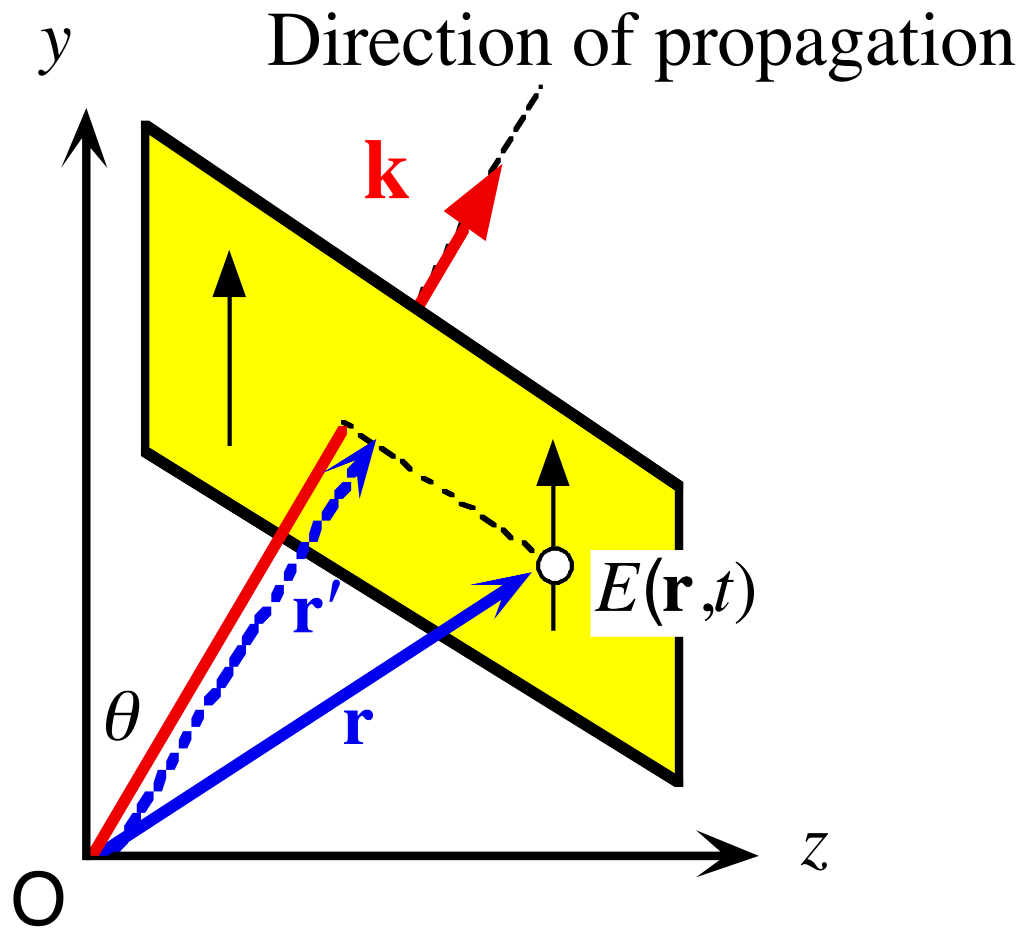
1.7 Multiple Interference and Optical Resonators
1.8 Goos-Hänchen Shift and Optical Tunneling
1.9 Temporal and Spatial Coherence
1.10 Diffraction Principles
- A. Fraunhofer Diffraction
- B. Diffraction grating



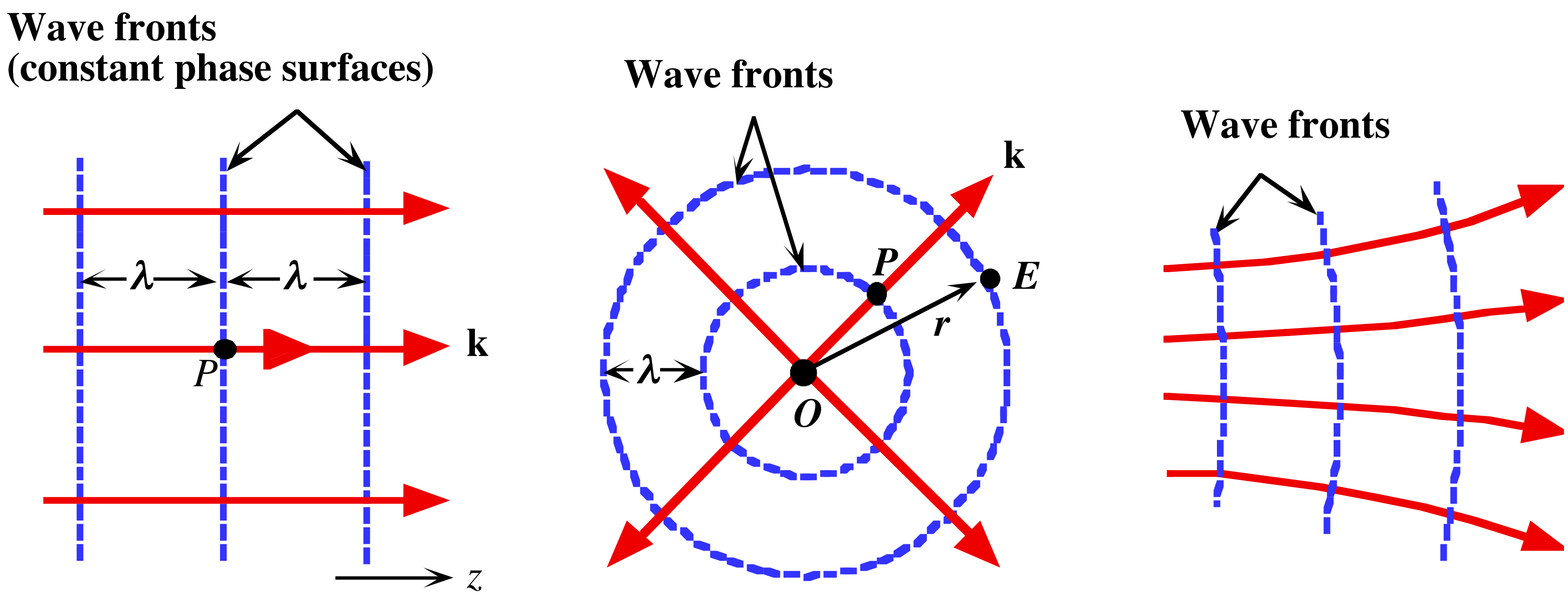
An electromagnetic wave is a travelling wave which has time varying electric and magnetic fields which are perpendicular to each other and the direction of propagation, *z*.



A plane EM wave travelling along z, has the same E_x (or B_y) at any point in a given xy plane. All electric field vectors in a given xy plane are therefore in phase. The xy planes are of infinite extent in the x and y directions.



A travelling plane EM wave along a direction **k**



A perfect plane wave

(a)

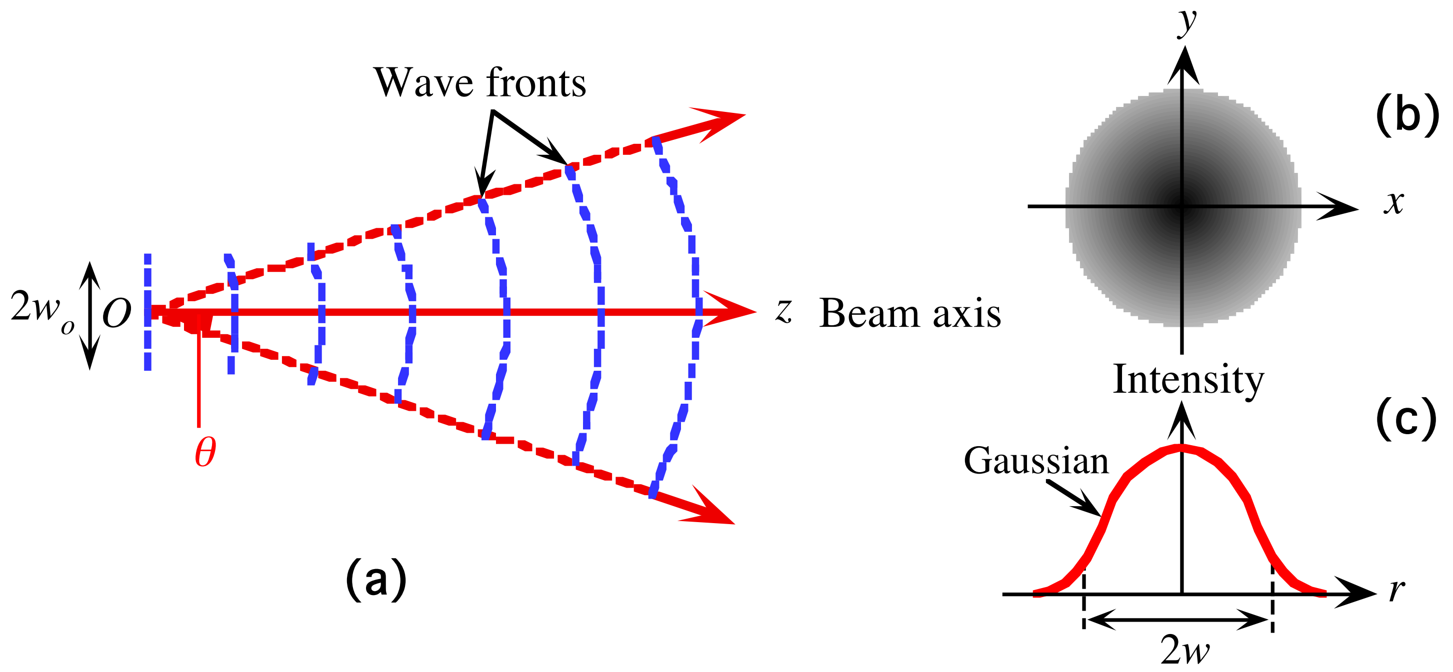
A perfect spherical wave

(b)

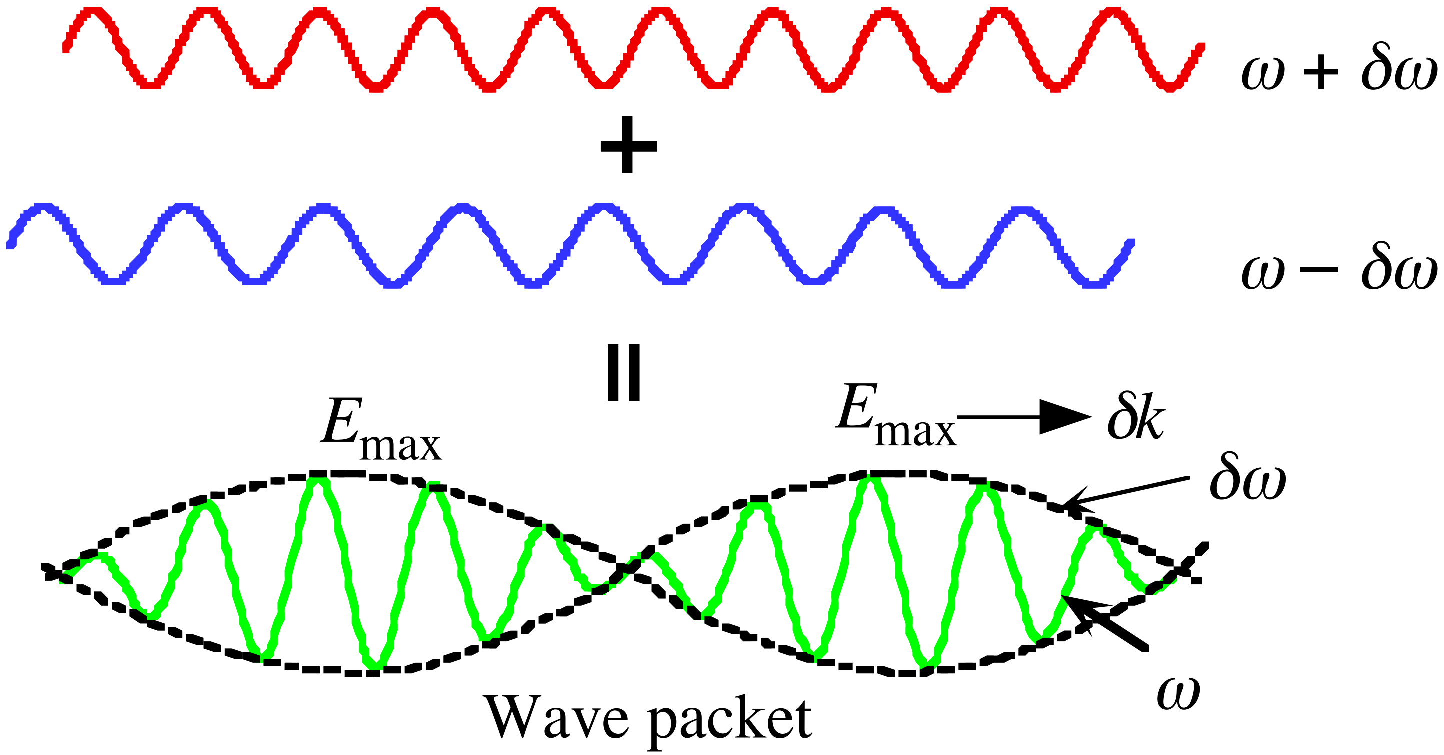
A divergent beam

(c)

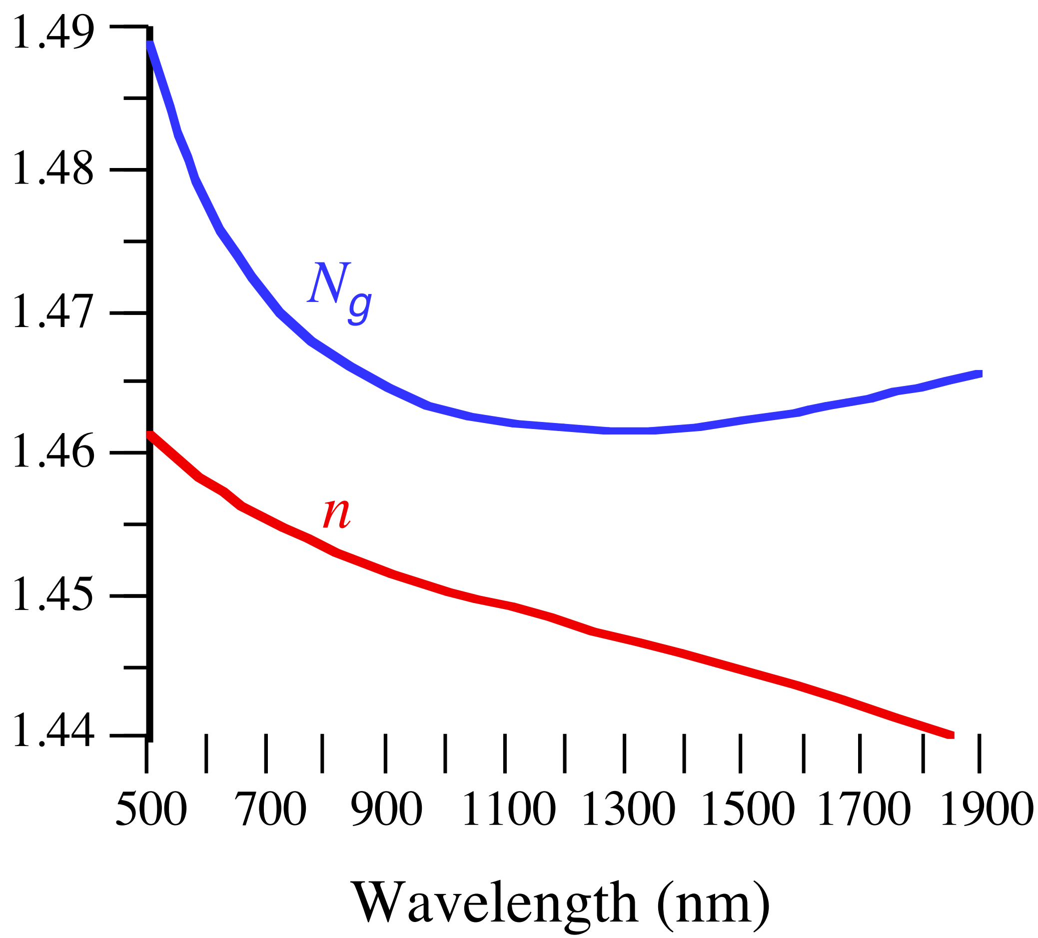
Examples of possible EM waves



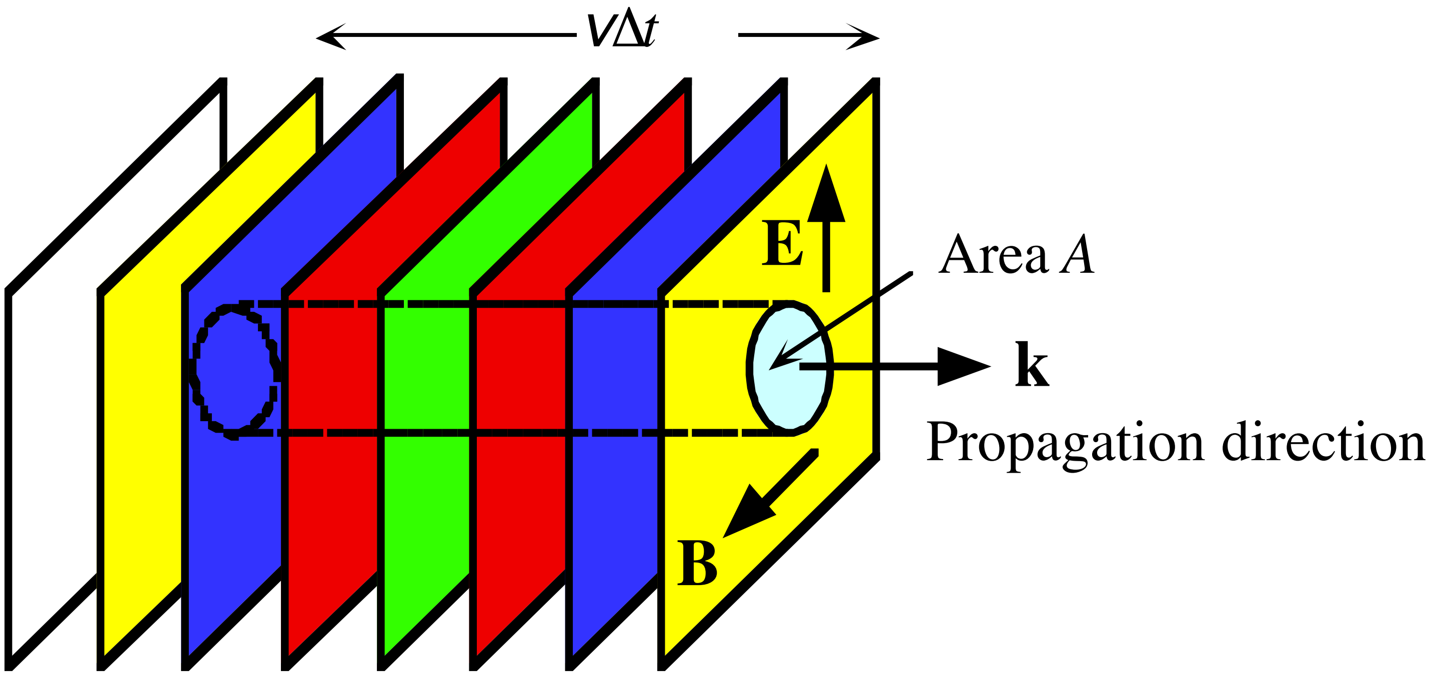
(a) Wavefronts of a Gaussian light beam. (b) Light intensity across beam cross section. (c) Light irradiance (intensity) vs. radial distance r from beam axis (z).



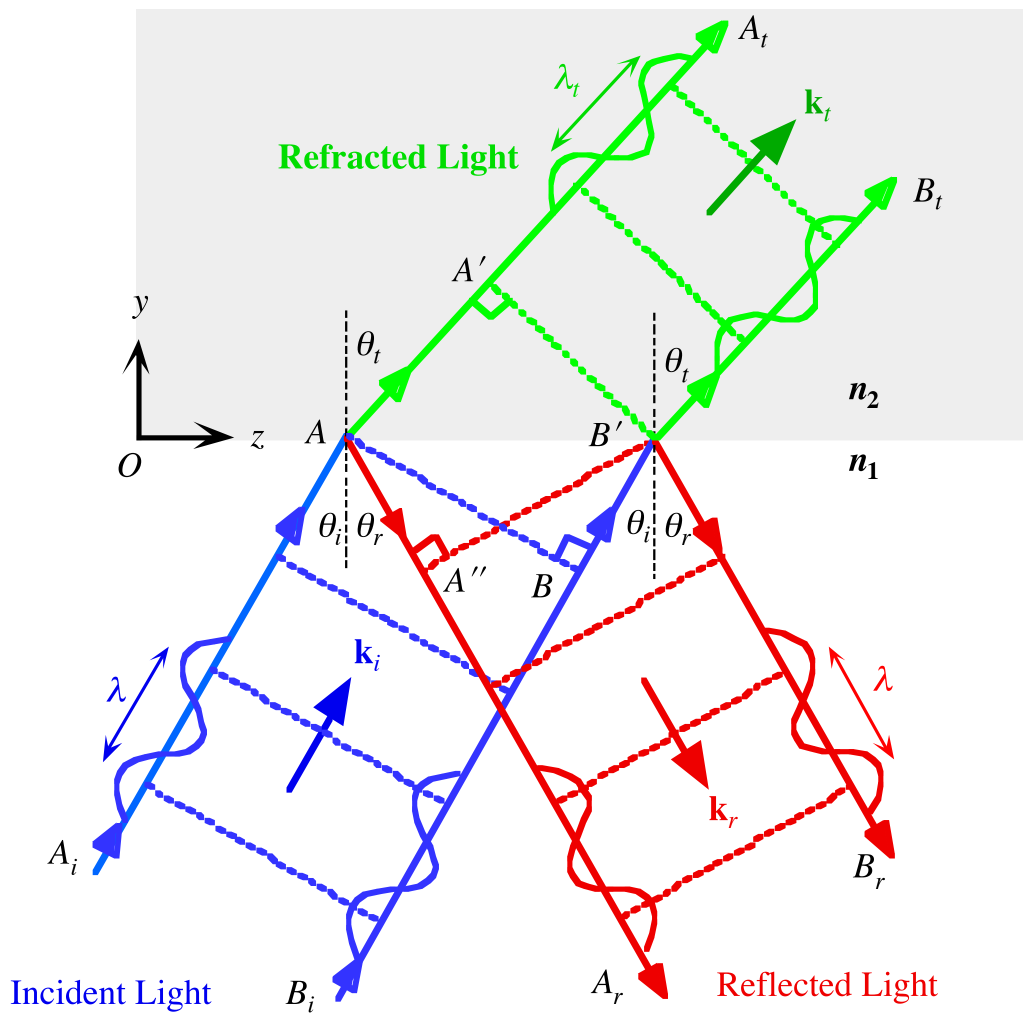
Two slightly different wavelength waves travelling in the same direction result in a wave packet that has an amplitude variation which travels at the group velocity.



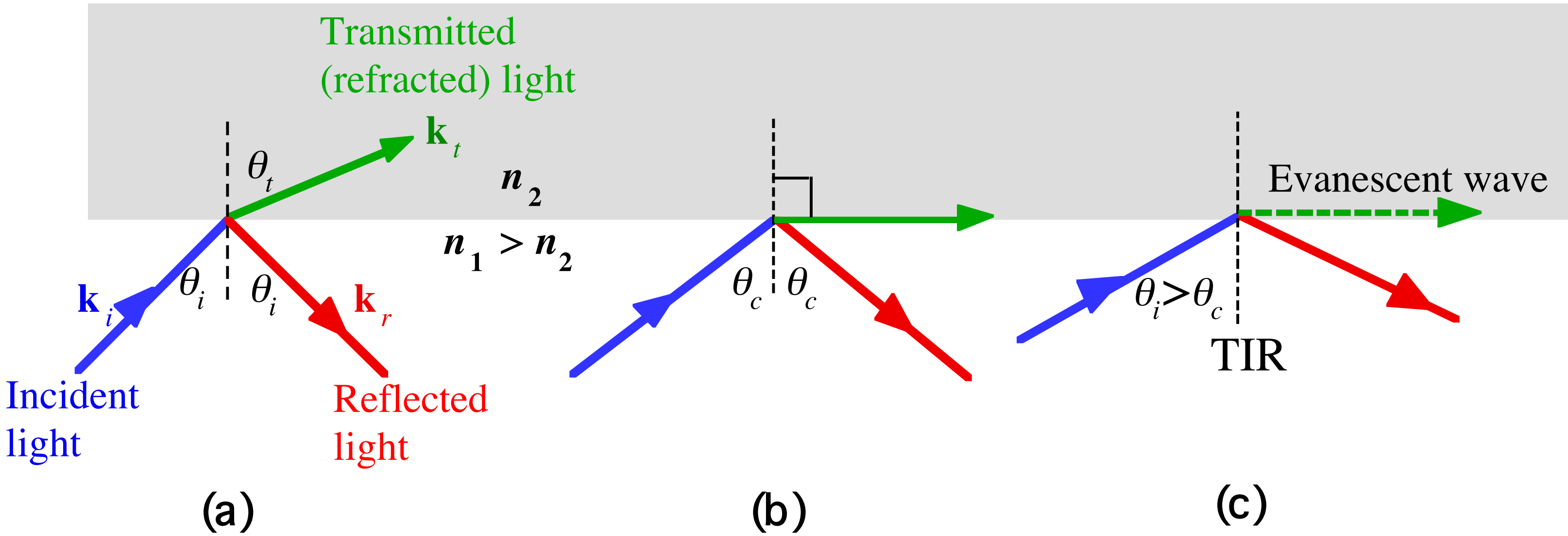
Refractive index n and the group index N_g of pure SiO_2 (silica) glass as a function of wavelength.



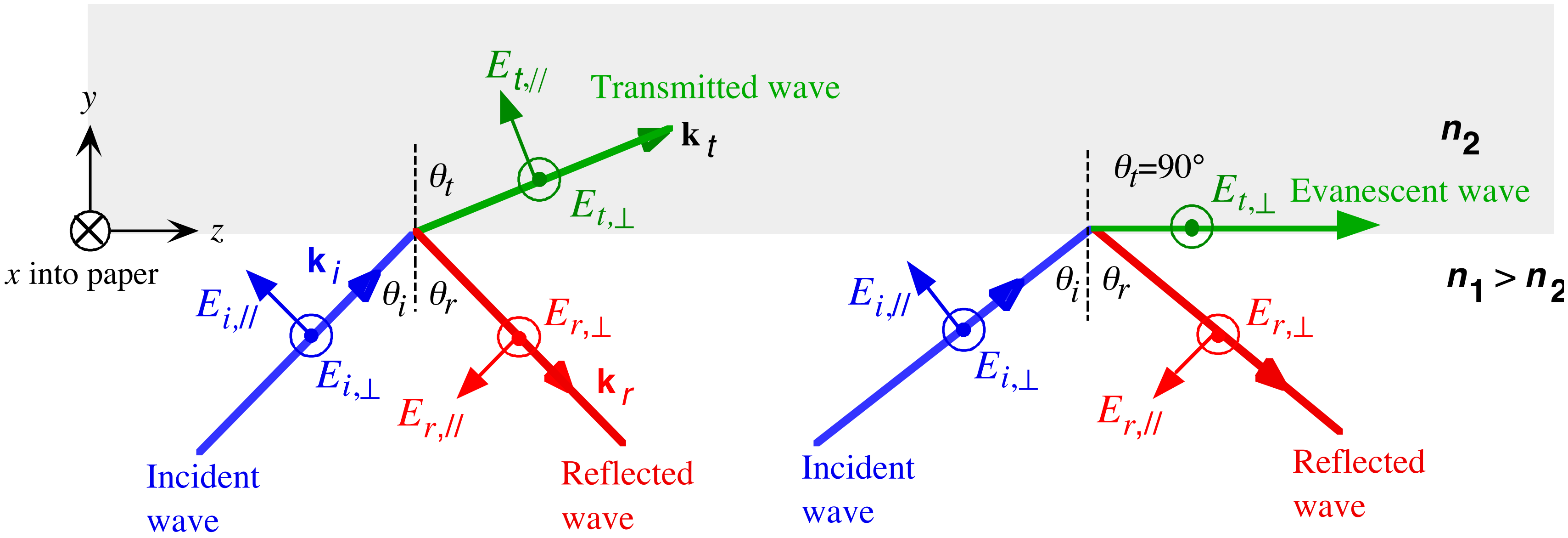
A plane EM wave travelling along **k** crosses an area A at right angles to the direction of propagation. In time Δt, the energy in the cylindrical volume $Av\Delta t$ (shown dashed) flows through A .



A light wave travelling in a medium with a greater refractive index ($n_1 > n_2$) suffers reflection and refraction at the boundary.



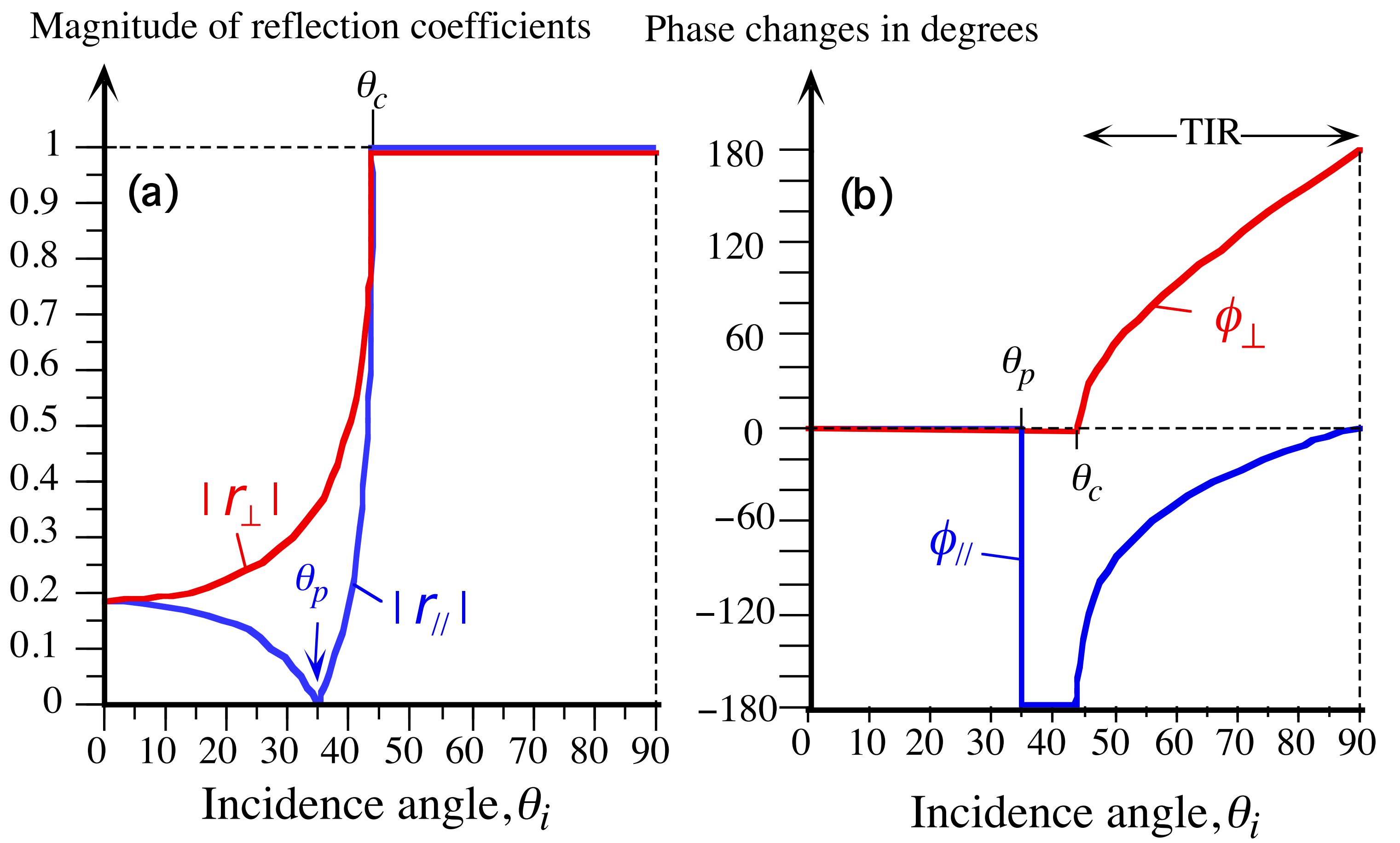
Light wave travelling in a more dense medium strikes a less dense medium. Depending on the incidence angle with respect to θ_c, which is determined by the ratio of the refractive indices, the wave may be transmitted (refracted) or reflected. (a) $\theta_i < \theta_c$ (b) $\theta_i = \theta_c$ (c) $\theta_i > \theta_c$ and total internal reflection (TIR).



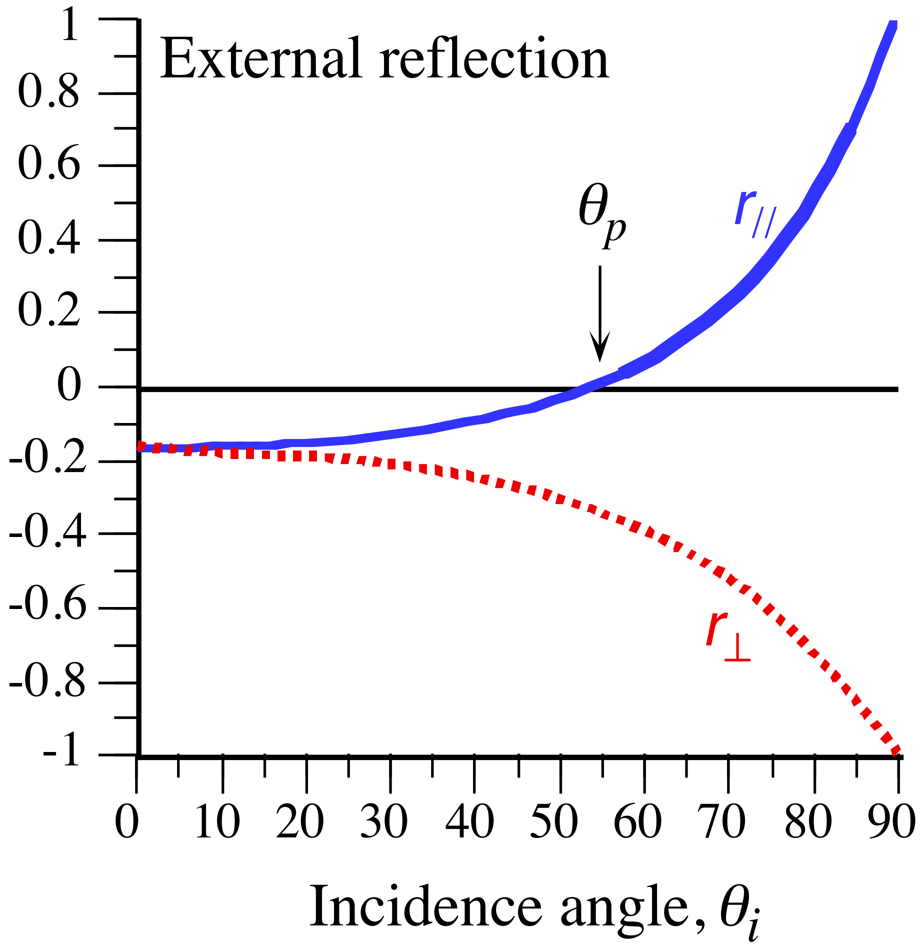
(a) $\theta_i < \theta_c$ then some of the wave is transmitted into the less dense medium. Some of the wave is reflected.

(b) $\theta_i > \theta_c$ then the incident wave suffers total internal reflection. However, there is an evanescent wave at the surface of the medium.

Light wave travelling in a more dense medium strikes a less dense medium. The plane of incidence is the plane of the paper and is perpendicular to the flat interface between the two media. The electric field is normal to the direction of propagation . It can be resolved into perpendicular (⊥) and parallel (//) components



Internal reflection: (a) Magnitude of the reflection coefficients $r_{//}$ and $r_{\perp}$ vs. angle of incidence θ_i for $n_1 = 1.44$ and $n_2 = 1.00$. The critical angle is 44°. (b) The corresponding phase changes $\phi_{//}$ and $\phi_{\perp}$ vs. incidence angle



The reflection coefficients $r_{//}$ and $r_{\perp}$ vs. angle of incidence θ_i for $n_1 = 1.00$ and $n_2 = 1.44$.

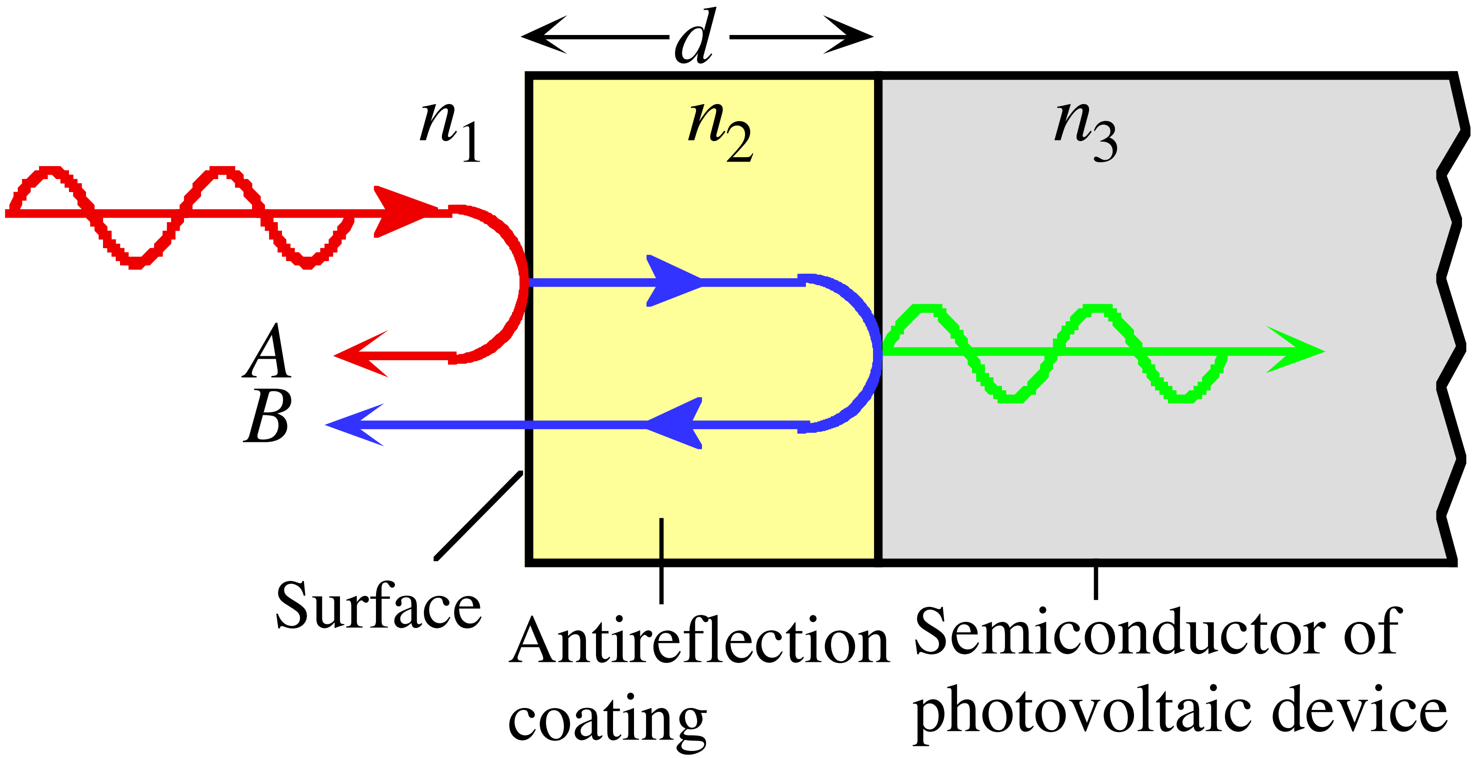
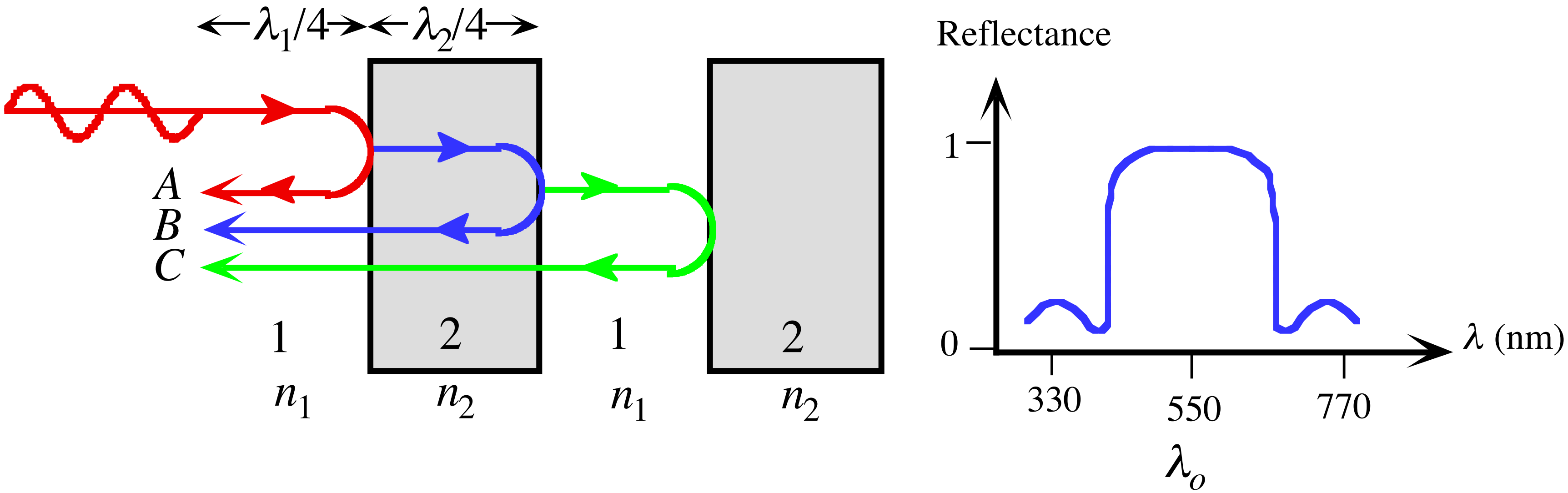
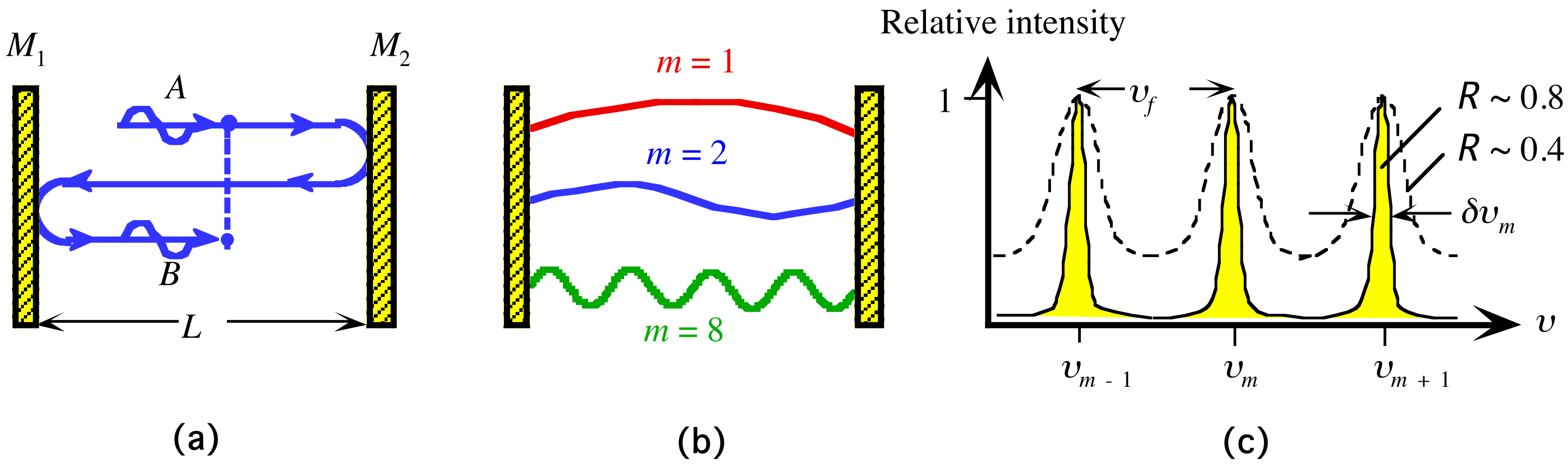


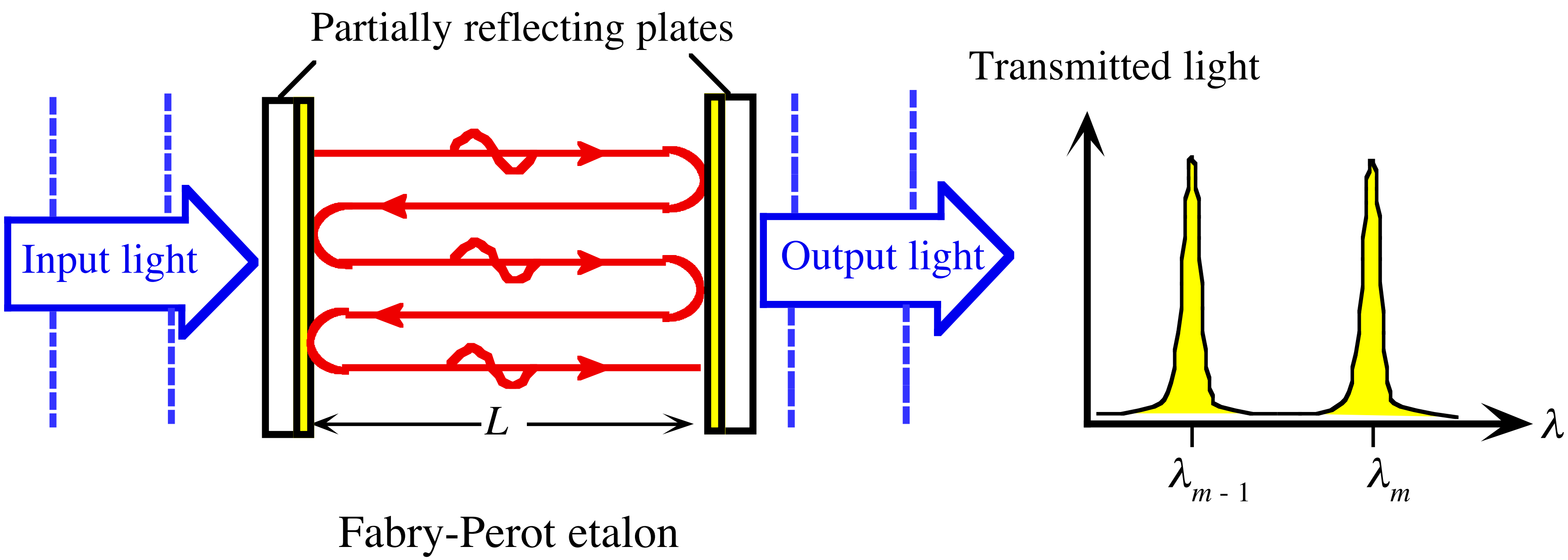
Illustration of how an antireflection coating reduces the reflected light intensity



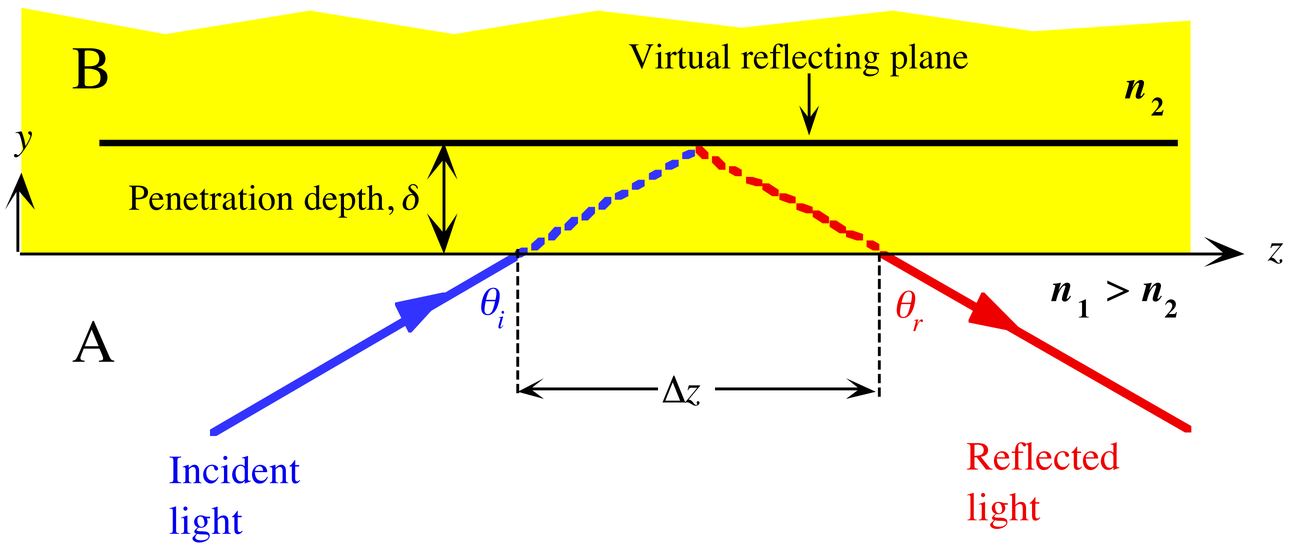
Schematic illustration of the principle of the dielectric mirror with many low and high refractive index layers and its reflectance.



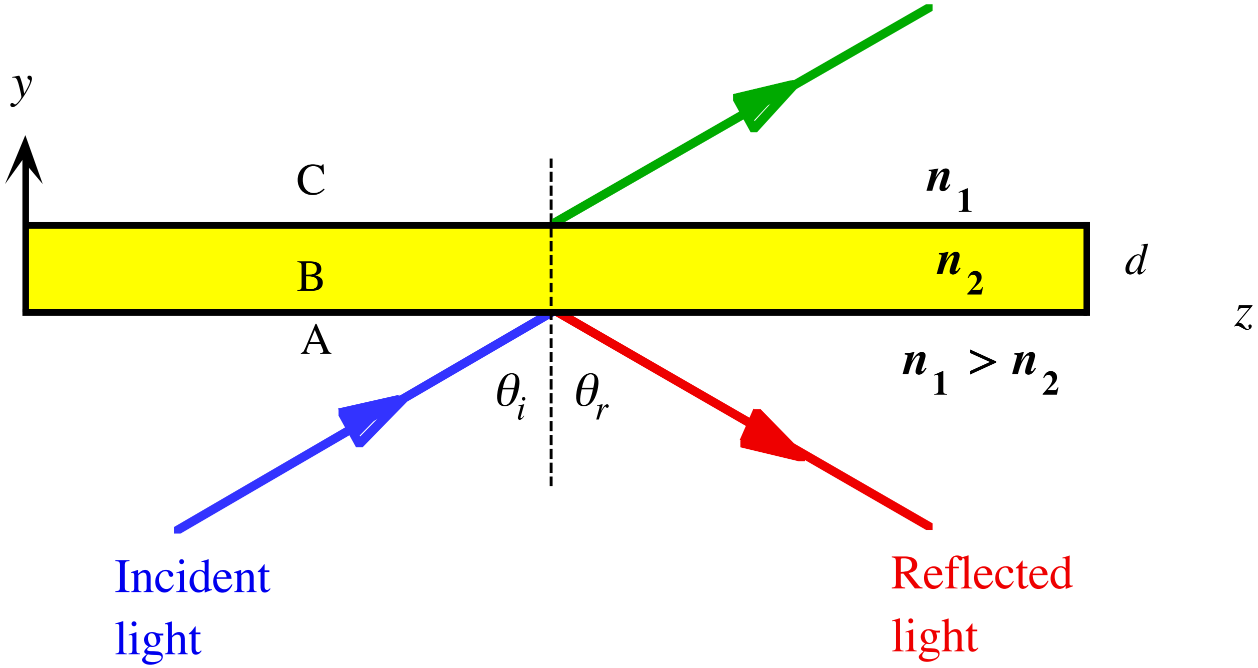
Schematic illustration of the Fabry-Perot optical cavity and its properties. (a) Reflected waves interfere. (b) Only standing EM waves, *modes,* of certain wavelengths are allowed in the cavity. (c) Intensity vs. frequency for various modes. R is mirror reflectance and lower R means higher loss from the cavity.



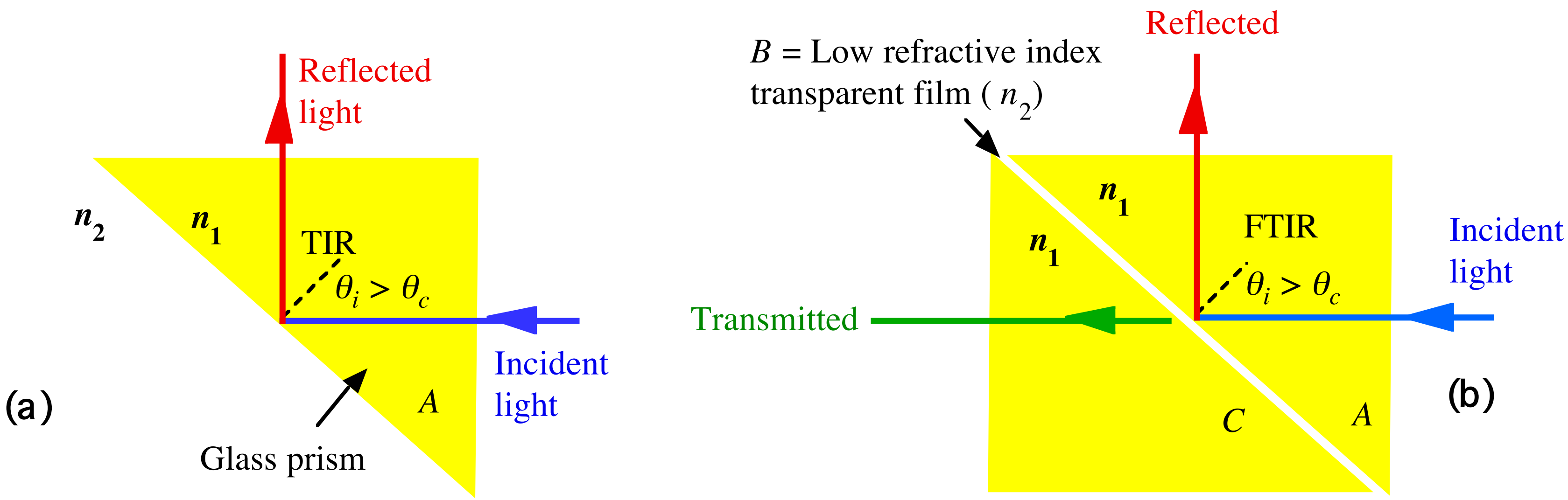
Transmitted light through a Fabry-Perot optical cavity.



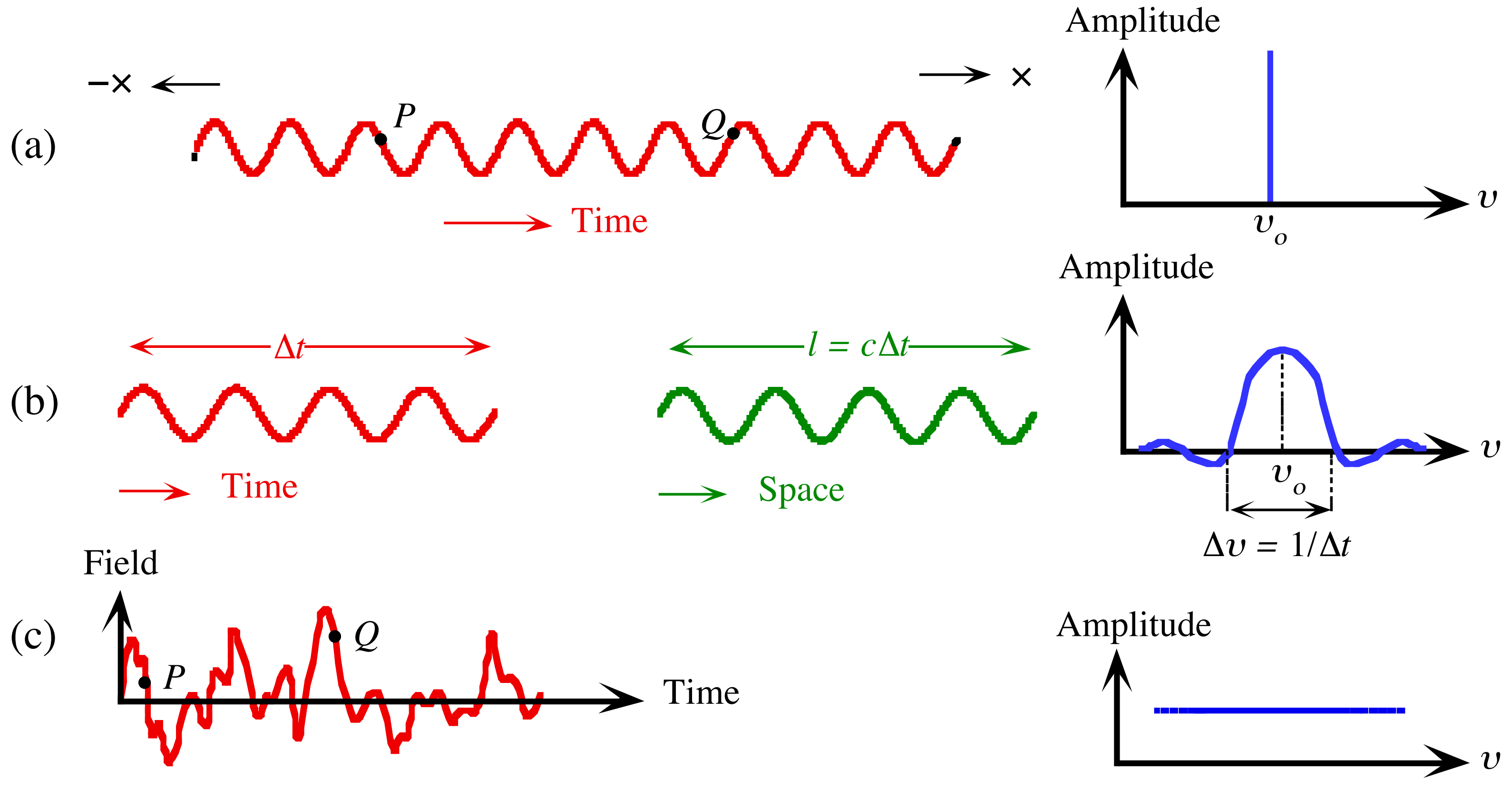
The reflected light beam in total internal reflection appears to have been laterally shifted by an amount Δz at the interface.



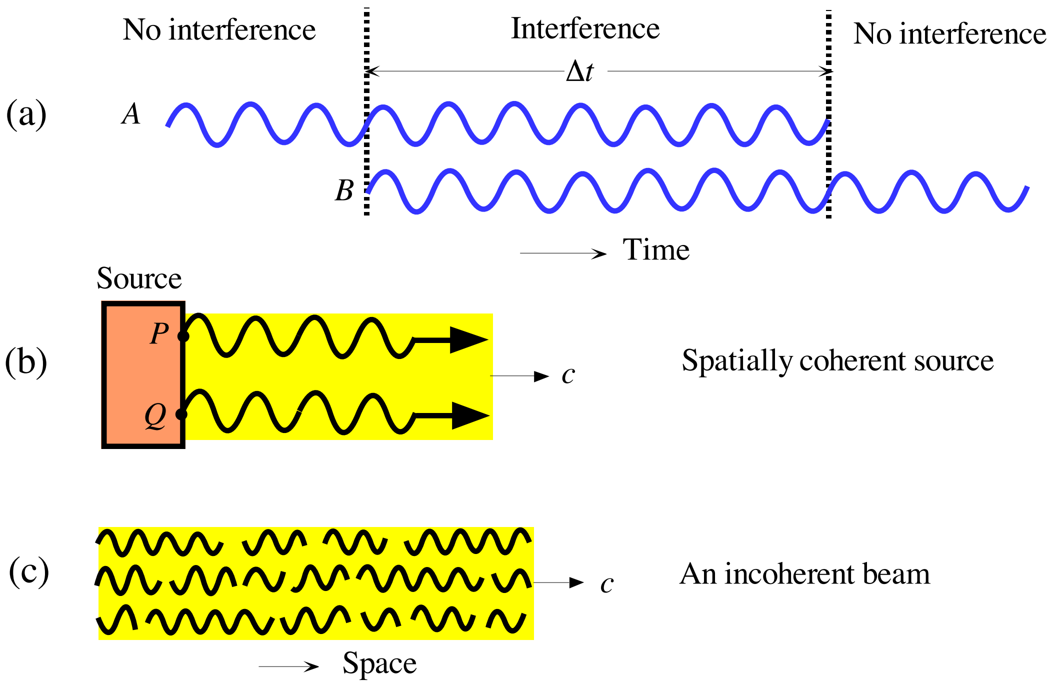
When medium B is thin (thickness d is small), the field penetrates to the BC interface and gives rise to an attenuated wave in medium C. The effect is the tunnelling of the incident beam in A through B to C.



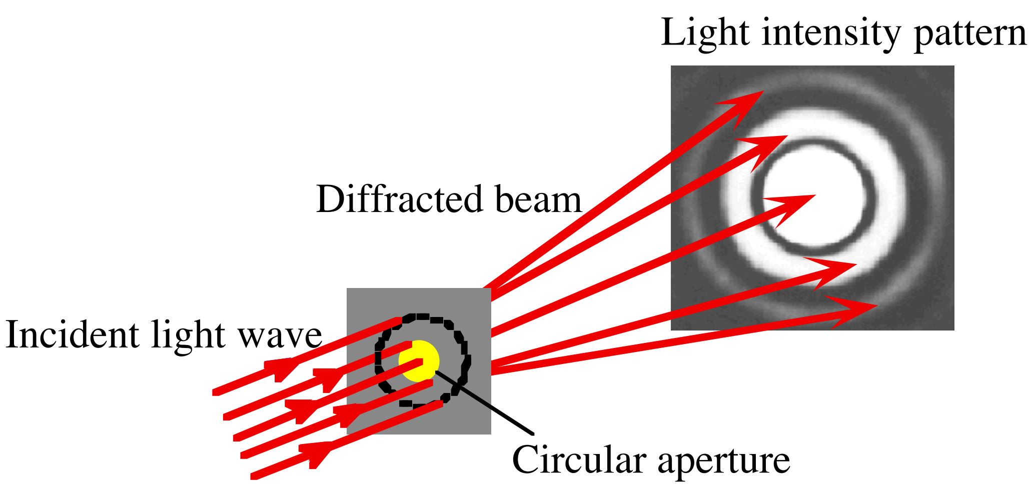
(a) A light incident at the long face of a glass prism suffers TIR; the prism deflects the light.
(b) Two prisms separated by a thin low refractive index film forming a beam-splitter cube. The incident beam is split into two beams by FTIR.



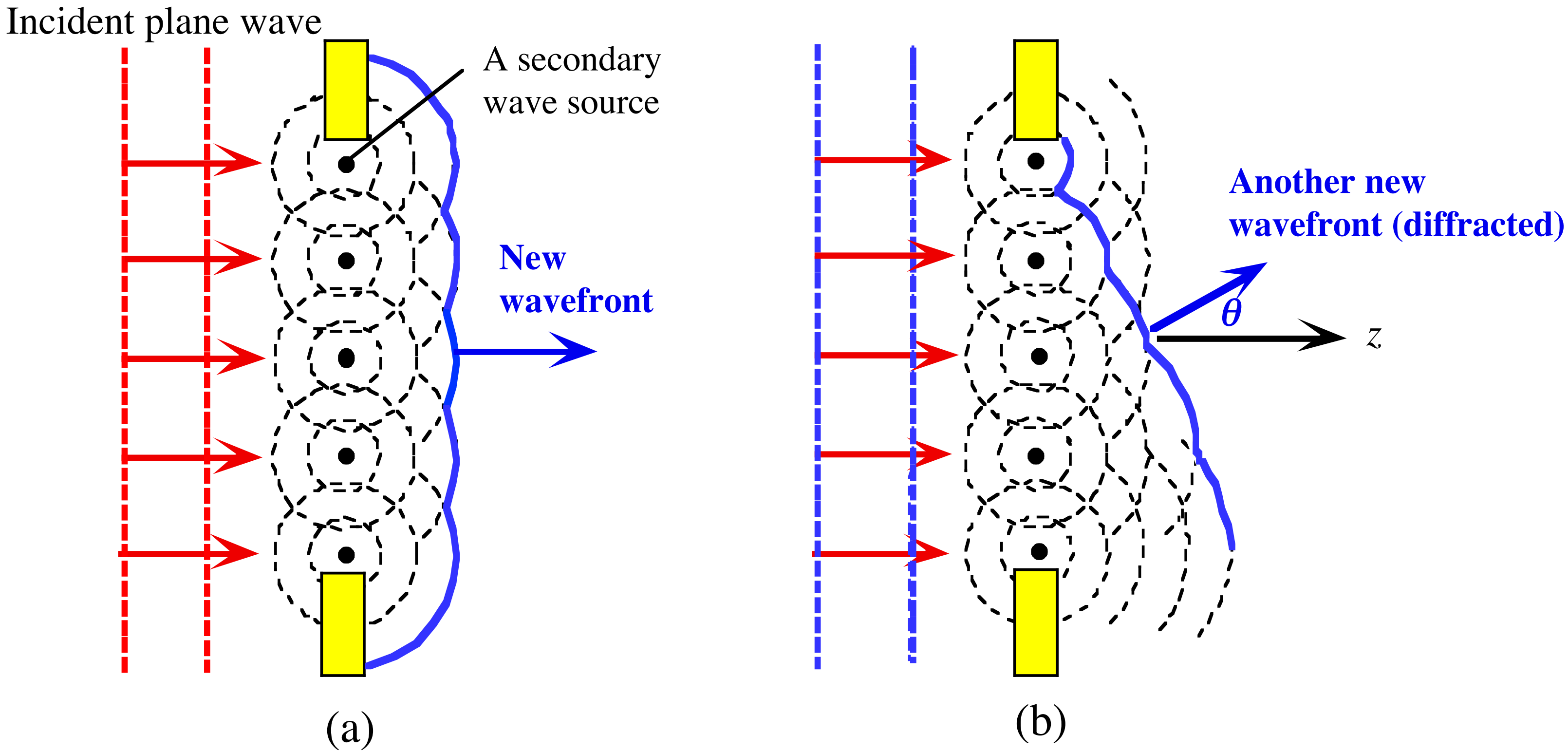
(a) A sine wave is perfectly coherent and contains a well-defined frequency υ_o. (b) A finite wave train lasts for a duration Δt and has a length l. Its frequency spectrum extends over $\Delta\upsilon = 1/\Delta t$. It has a coherence time Δt and a coherence length l. (c) White light exhibits practically no coherence.



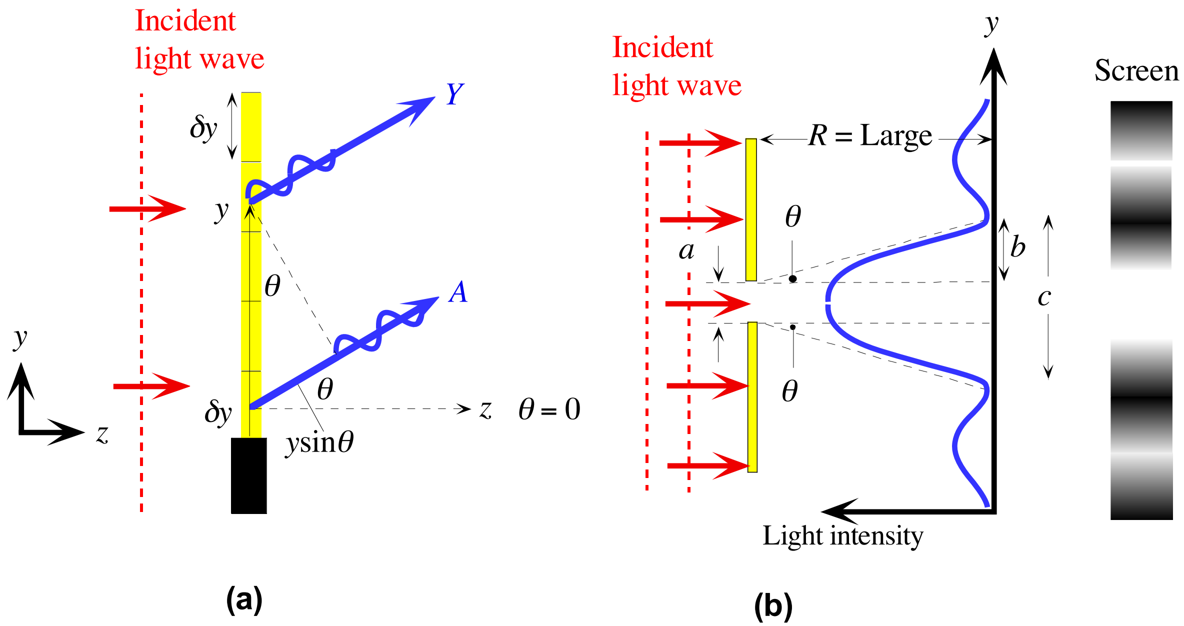
(a) Two waves can only interfere over the time interval Δt. (b) Spatial coherence involves comparing the coherence of waves emitted from different locations on the source. (c) An incoherent beam.



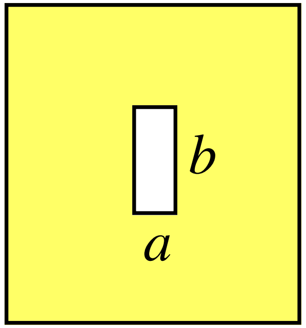
A light beam incident on a small circular aperture becomes diffracted and its light intensity pattern after passing through the aperture is a diffraction pattern with circular bright rings (called Airy rings). If the screen is far away from the aperture, this would be a Fraunhofer diffraction pattern.

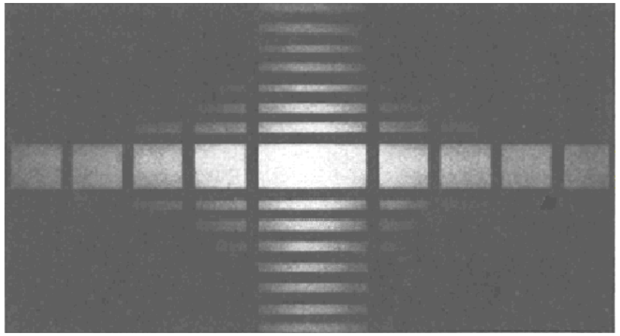


(a) Huygens-Fresnel principles states that each point in the aperture becomes a source of secondary waves (spherical waves). The spherical wavefronts are separated by λ. The new wavefront is the envelope of the all these spherical wavefronts. (b) Another possible wavefront occurs at an angle θ to the z-direction which is a diffracted wave.

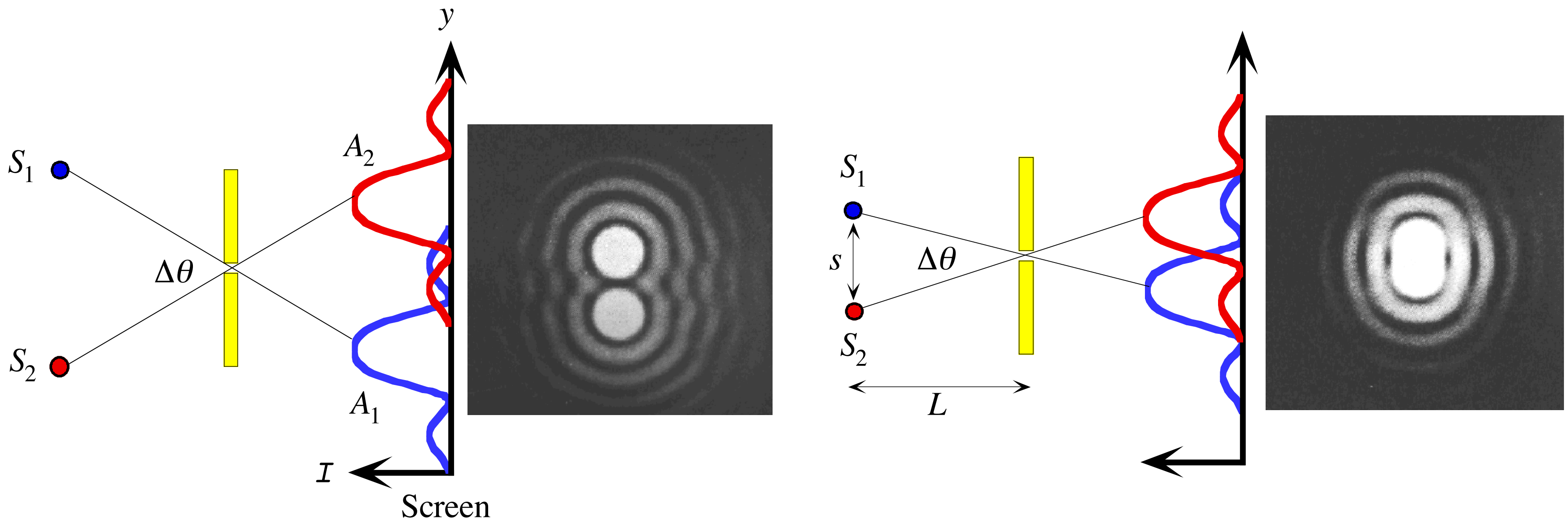


(a) The aperture is divided into N number of point sources each occupying δy with amplitude $\propto \delta y$. (b) The intensity distribution in the received light at the screen far away from the aperture: the diffraction pattern

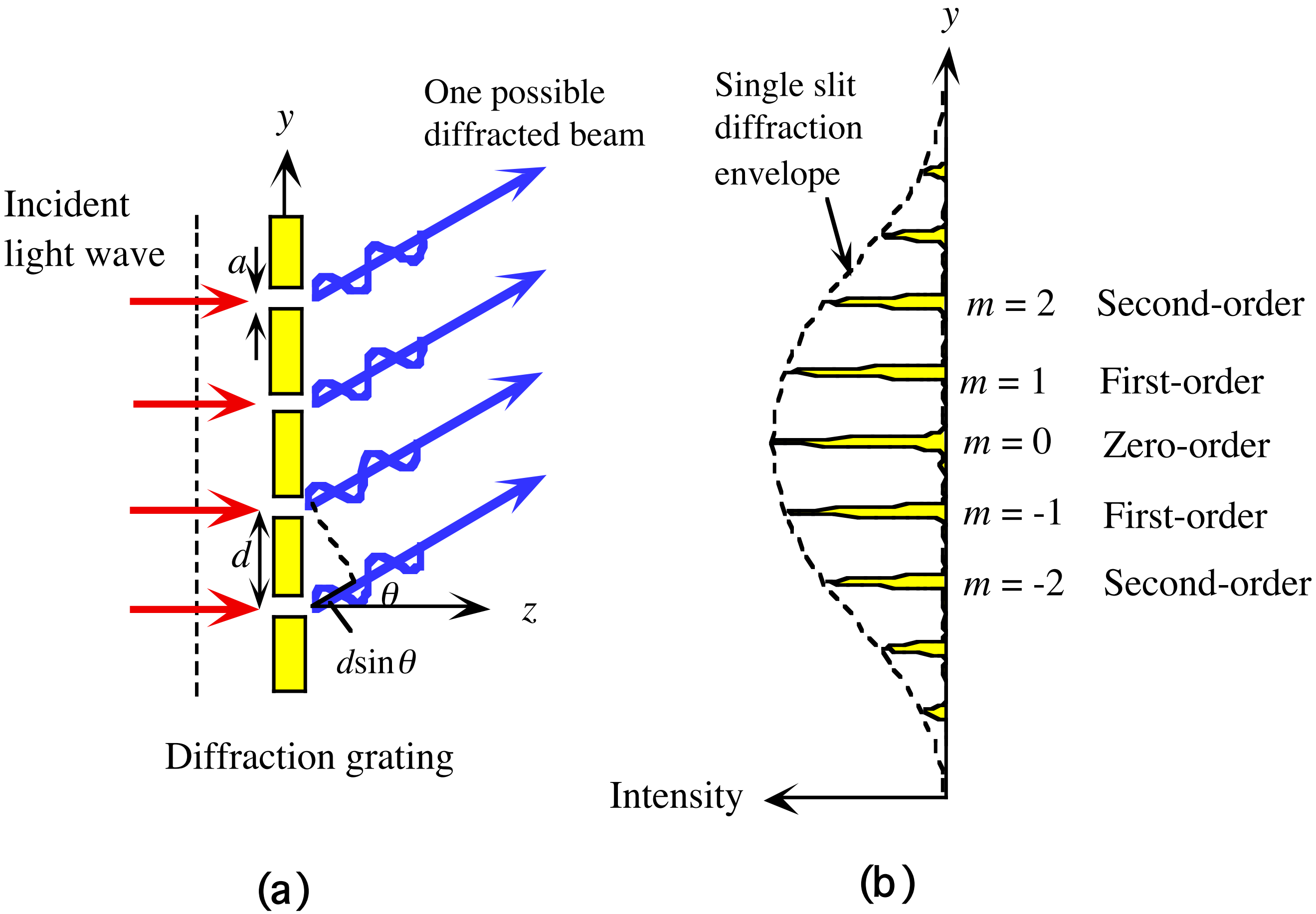




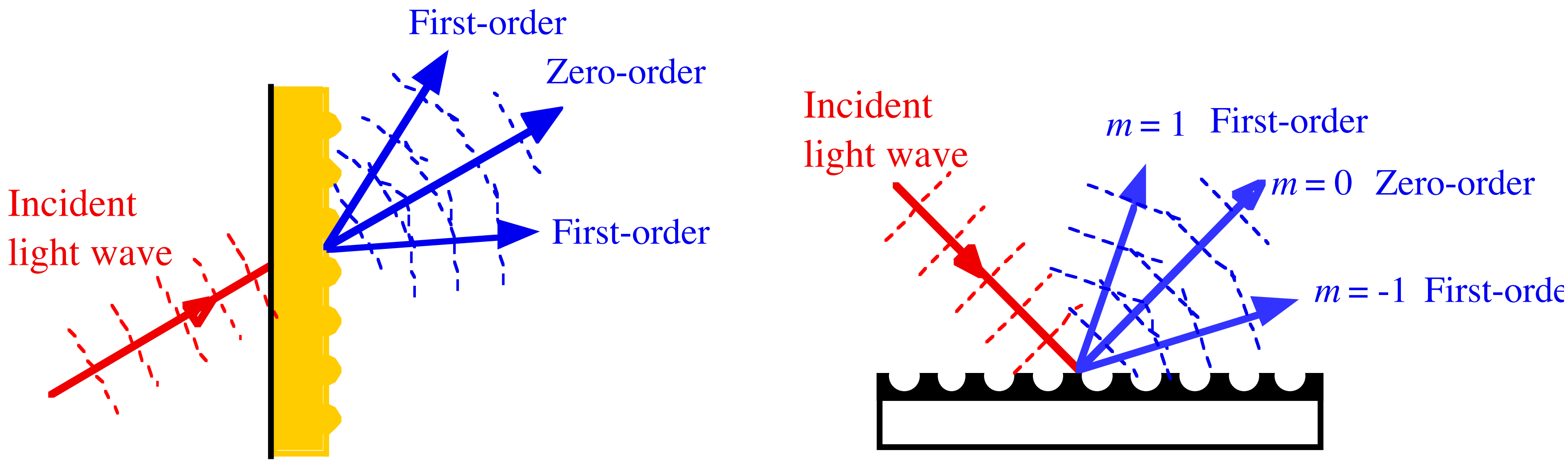
The rectangular aperture of dimensions $a \leftrightarrow b$ on the left gives the diffraction pattern on the right.



Resolution of imaging systems is limited by diffraction effects. As points S_1 and S_2 get closer, eventually the Airy disks overlap so much that the resolution is lost.



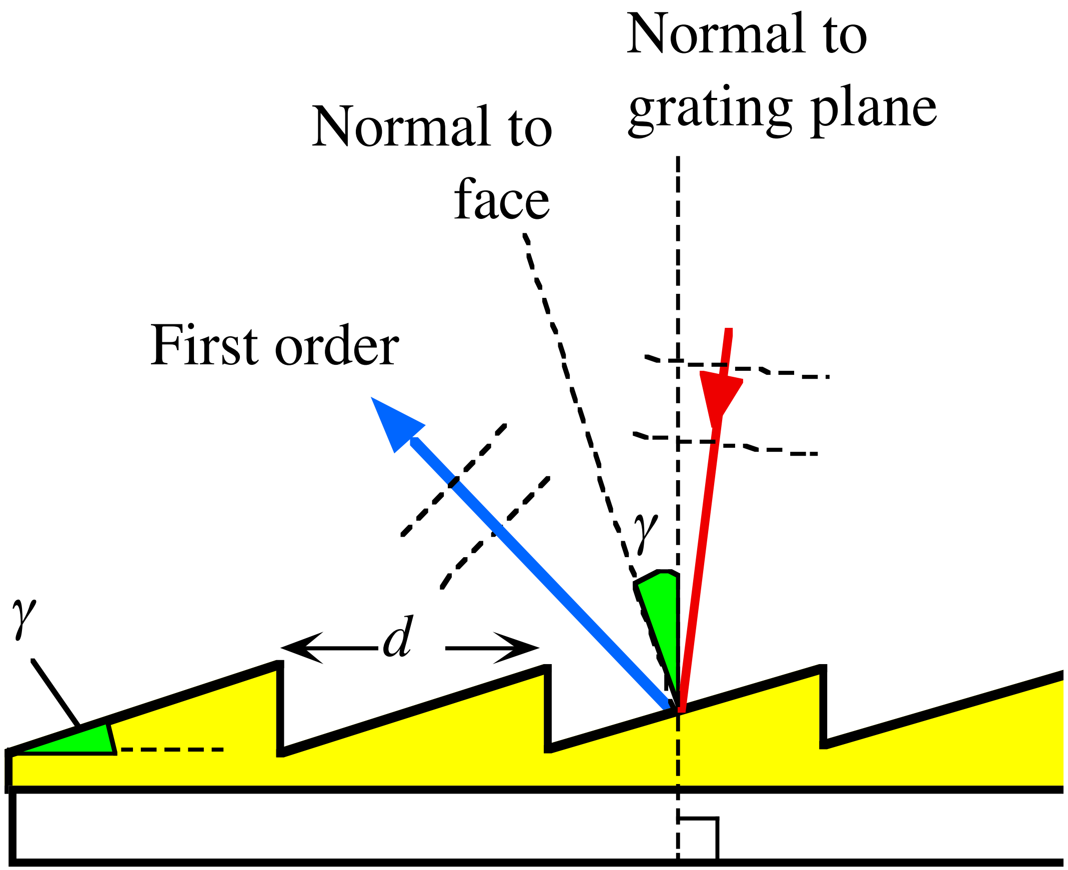
(a) A diffraction grating with *N* slits in an opaque scree. (b) The diffracted light pattern. There are distinct beams in certain directions (schematic)



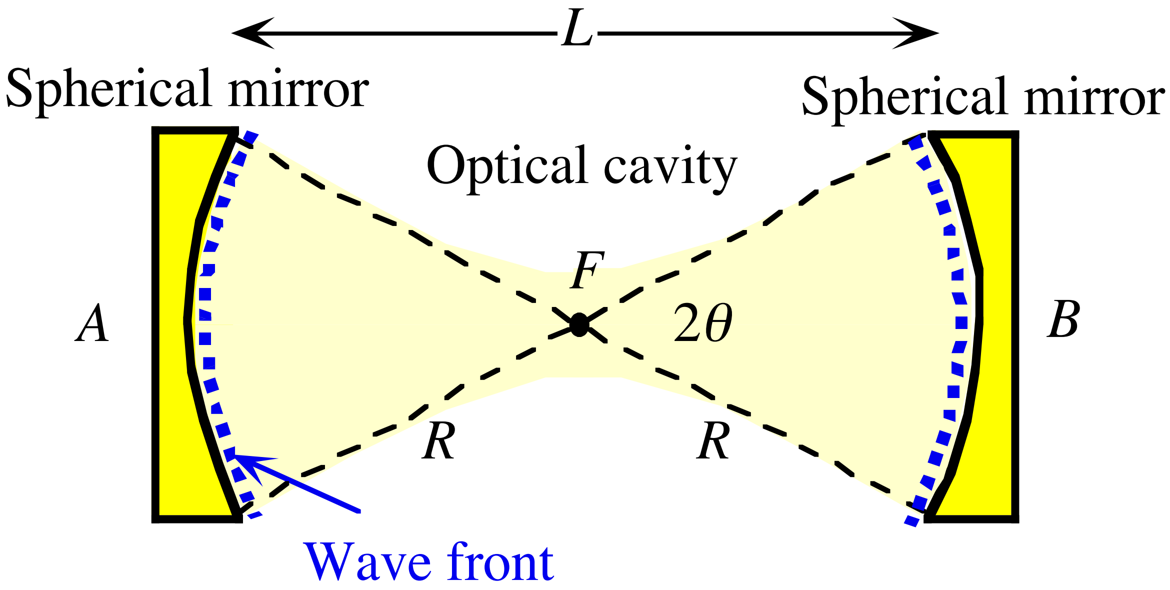
(a) Transmission grating

(b) Reflection grating

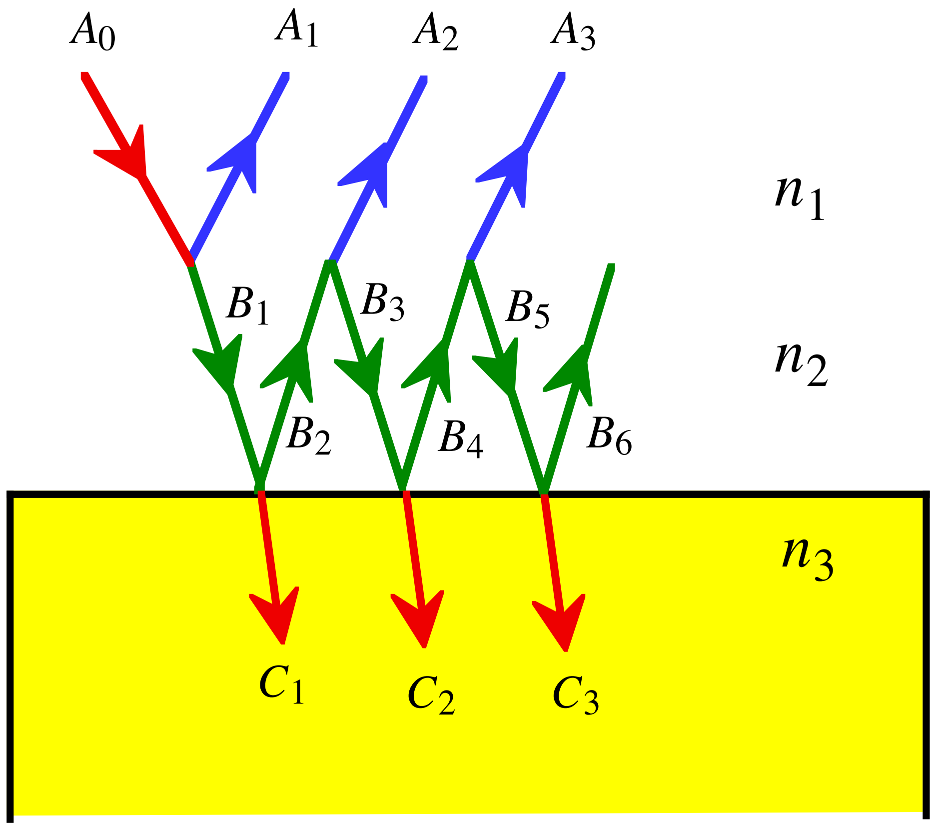
(a) Ruled periodic parallel scratches on a glass serve as a transmission grating. (b) A reflection grating. An incident light beam results in various "diffracted" beams. The zero-order diffracted beam is the normal reflected beam with an angle of reflection equal to the angle of incidence.



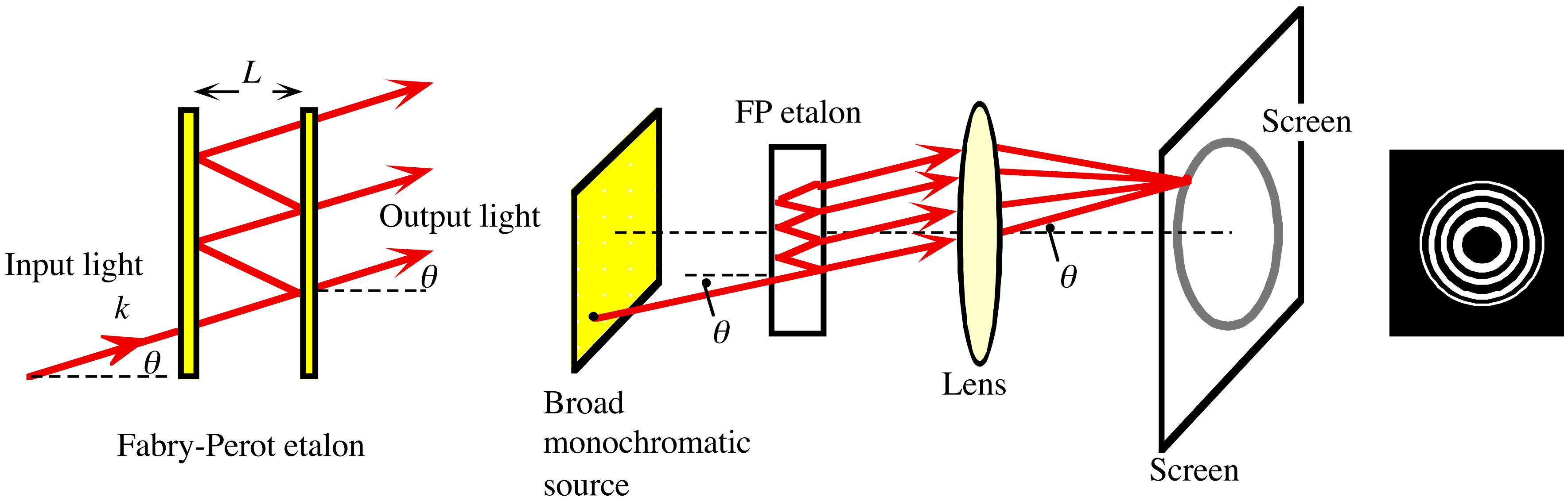
Blazed (echelette) grating.



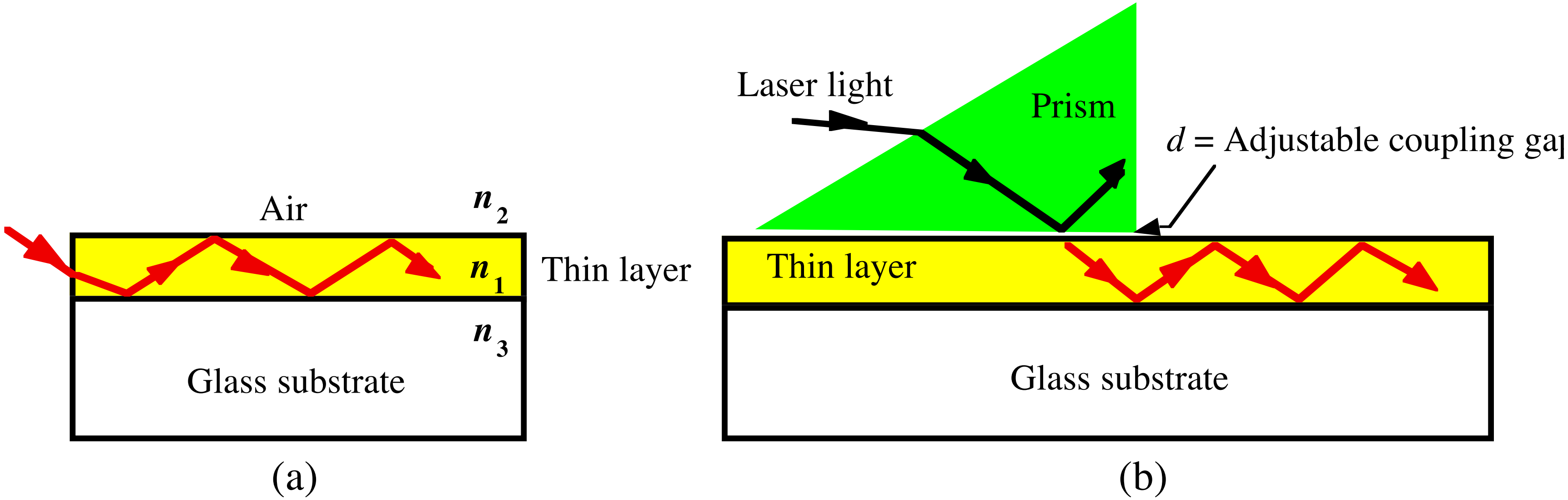
Two confocal spherical mirrors reflect waves to and from each other. *F* is the focal point and *R* is the radius. The optical cavity contains a Gaussian beam



Thin film coating of refractive index n_2 on a semiconductor device



Fabry-Perot optical resonator and the Fabry-Perot interferometer (schematic)



(a) Light propagation along an optical guide. (b) Coupling of laser light into a thin layer - optical guide - using a prism. The light propagates along the thin layer.