

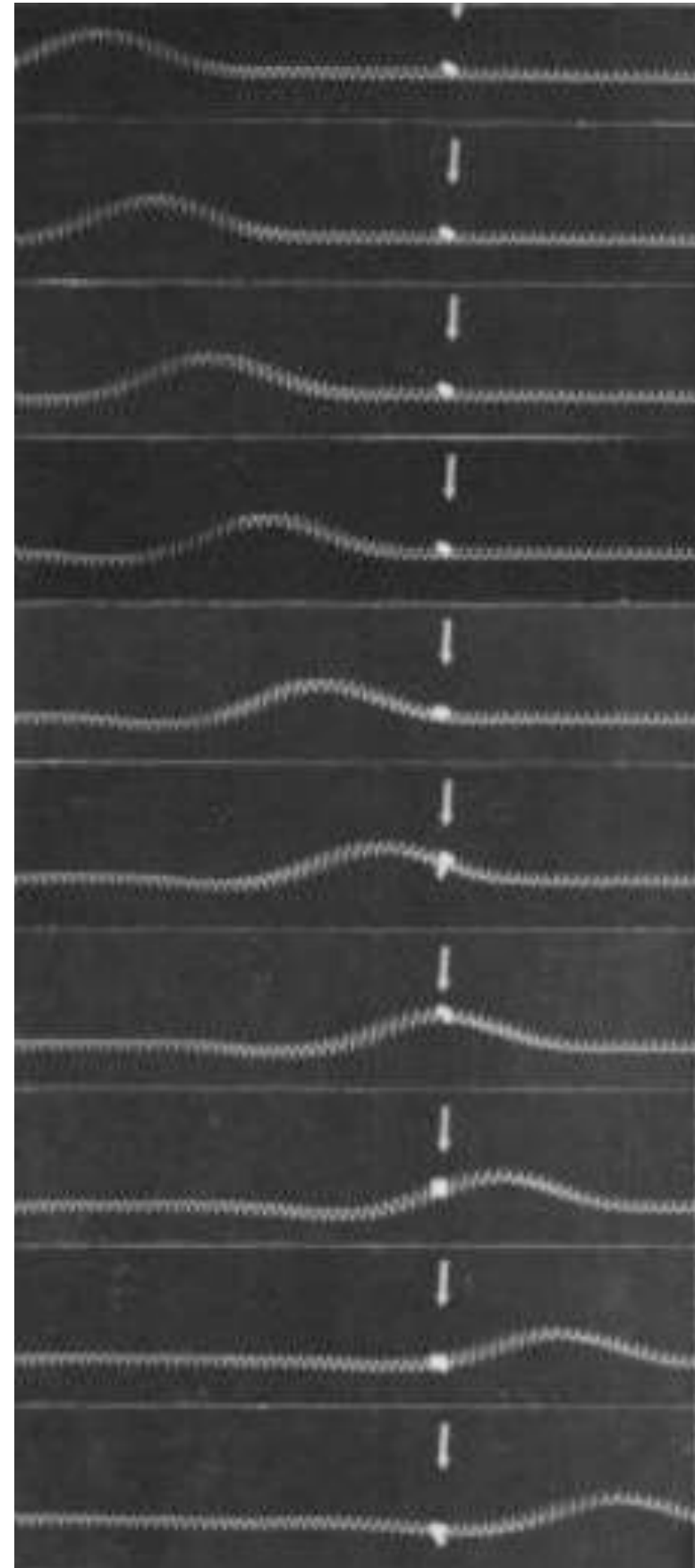


Katsushika Hokusai (1760-1849)

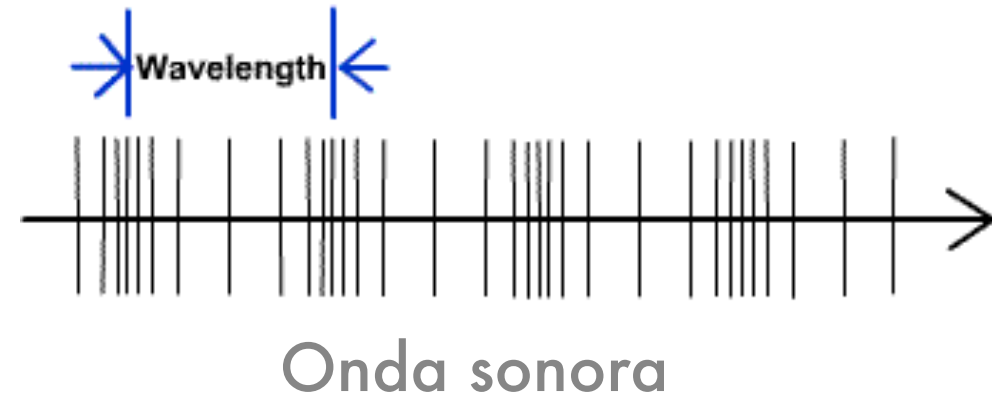
A natureza ondulatória da luz

O QUE É UMA ONDA

- Propagação de uma perturbação, sem transporte de matéria
- Na foto: a pequena bolinha presa à mola, oscila apenas verticalmente, enquanto a onda se propaga para a direita.
- Não há deslocamento na direção de propagação da onda



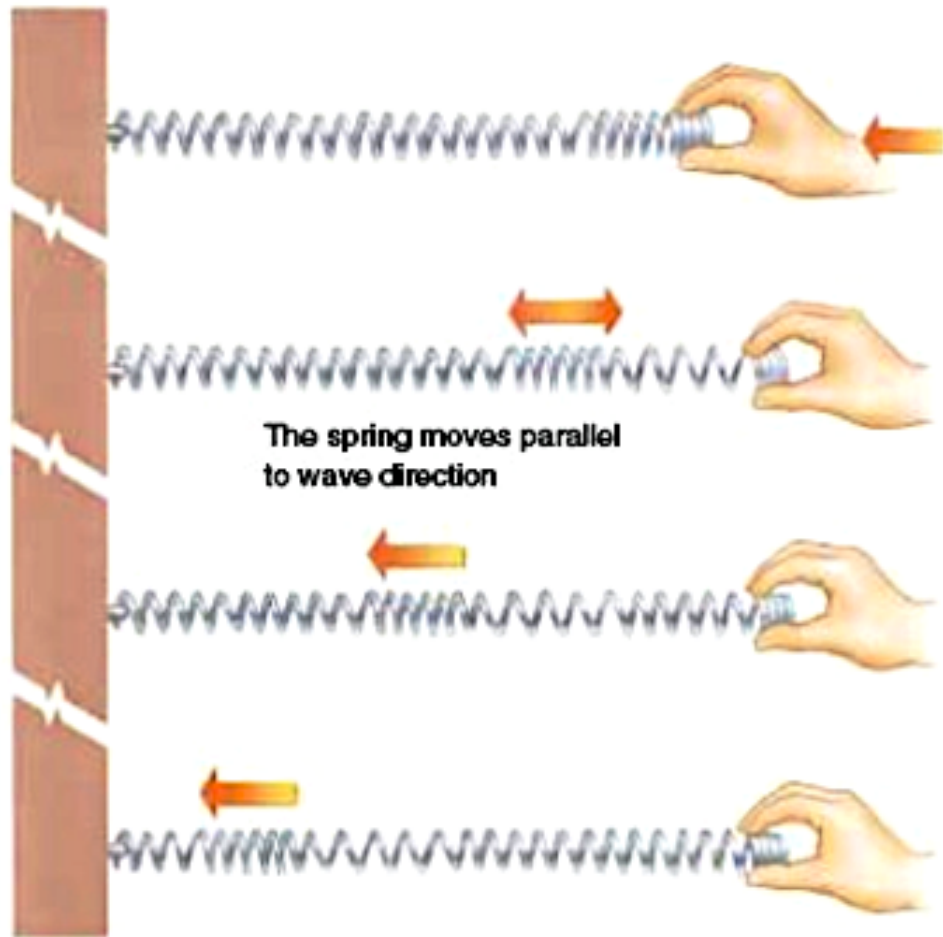
ONDAS LONGITUDINAIS



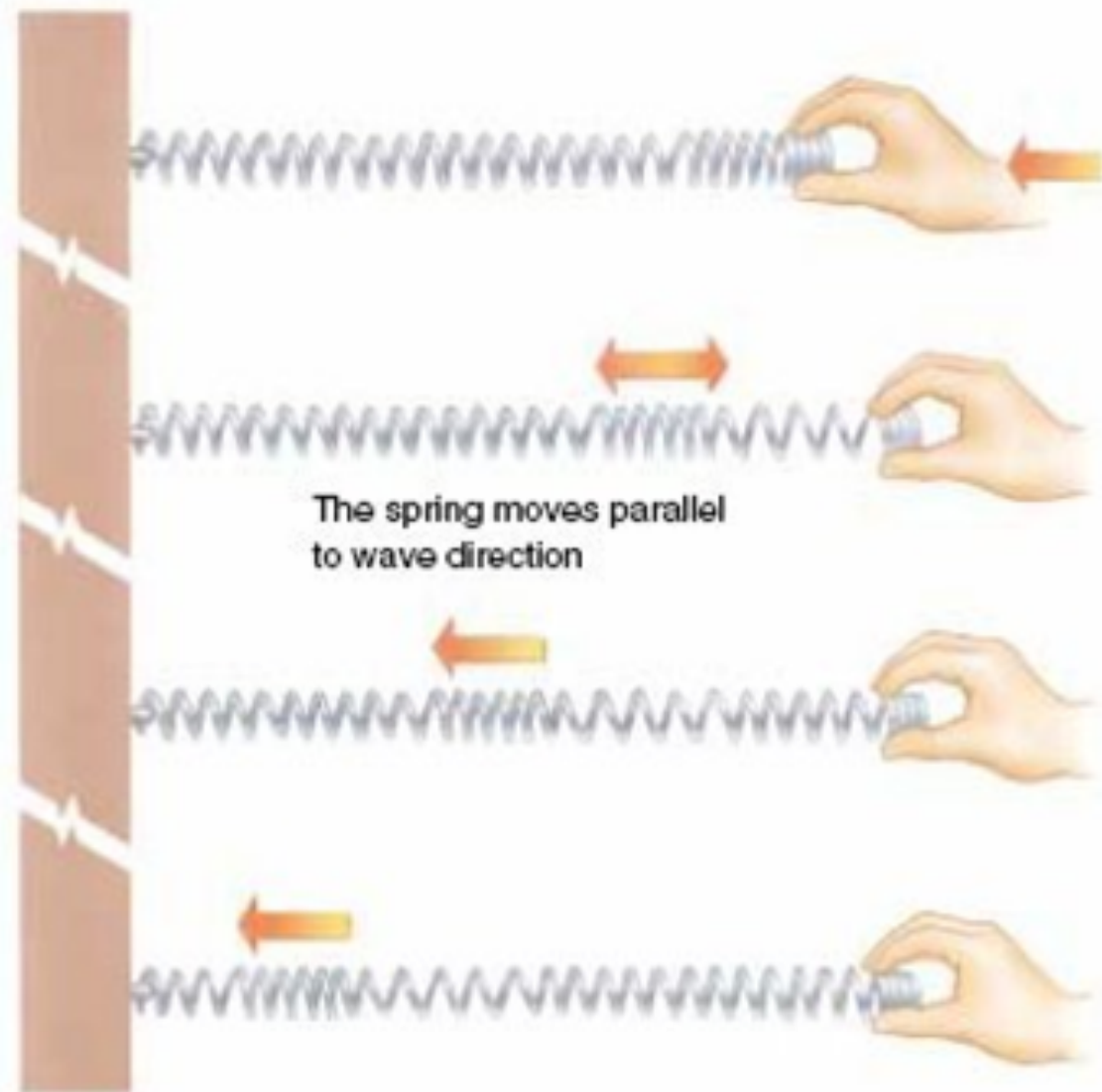
As partículas do ar se movem para frente e para trás na mesma direção de propagação da onda, mas em média elas permanecem na mesma posição.

Oscilação das partículas na direção de propagação da onda.

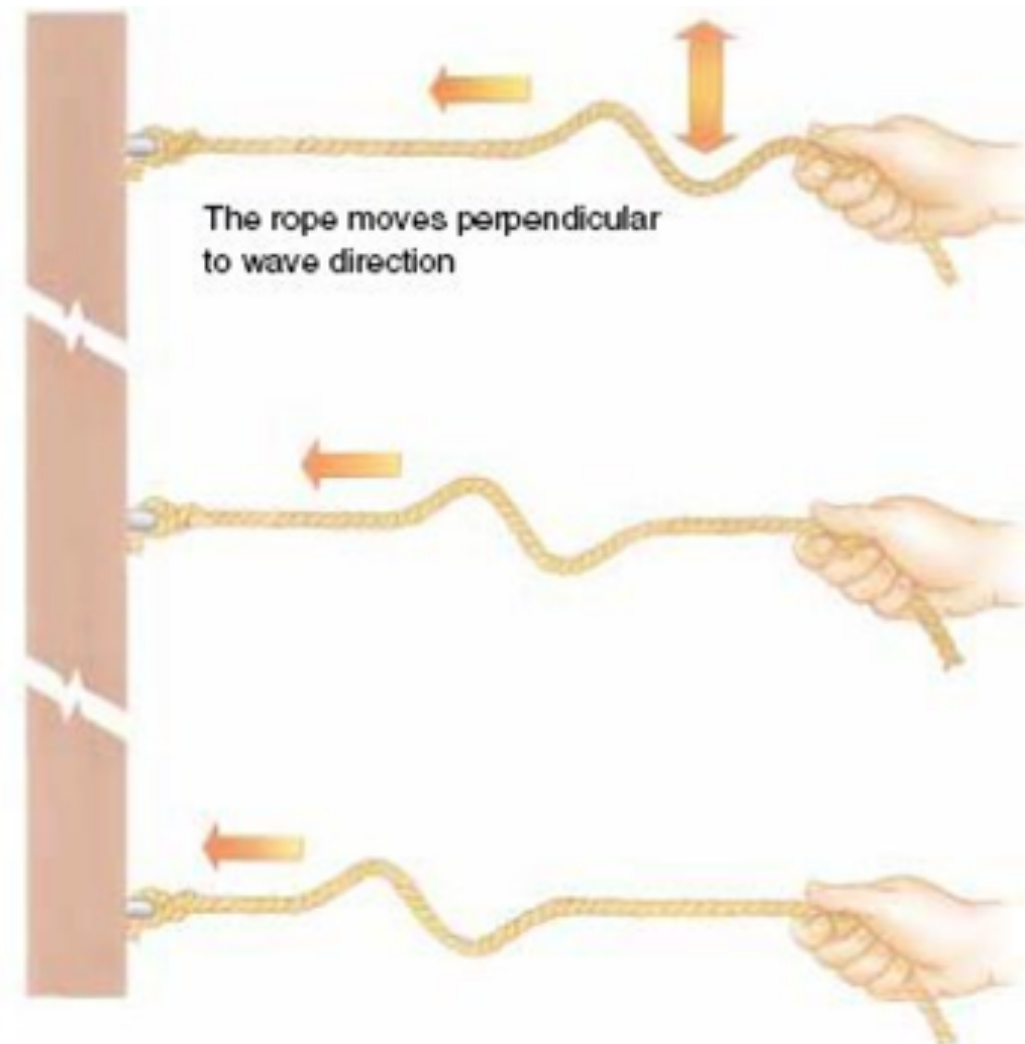
ONDAS LONGITUDINAIS



Exemplos de ondas longitudinais e transversais



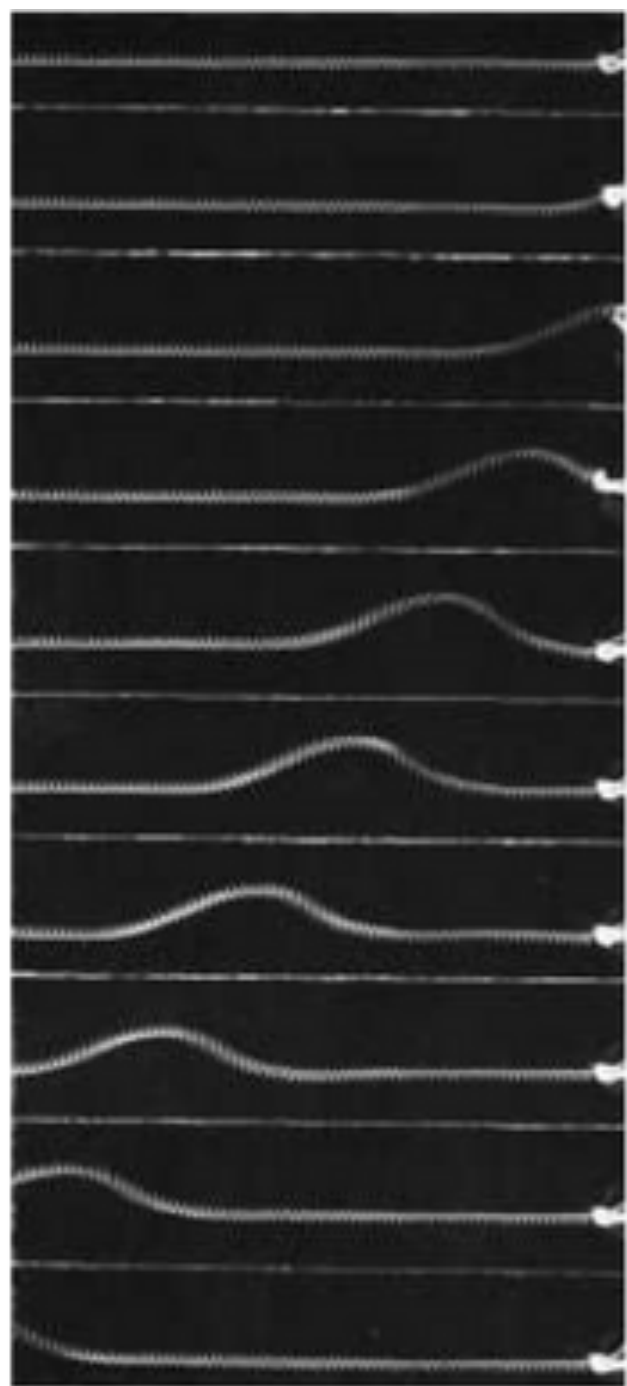
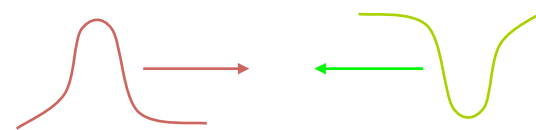
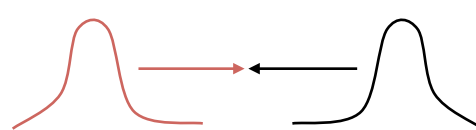
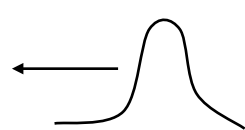
Longitudinais



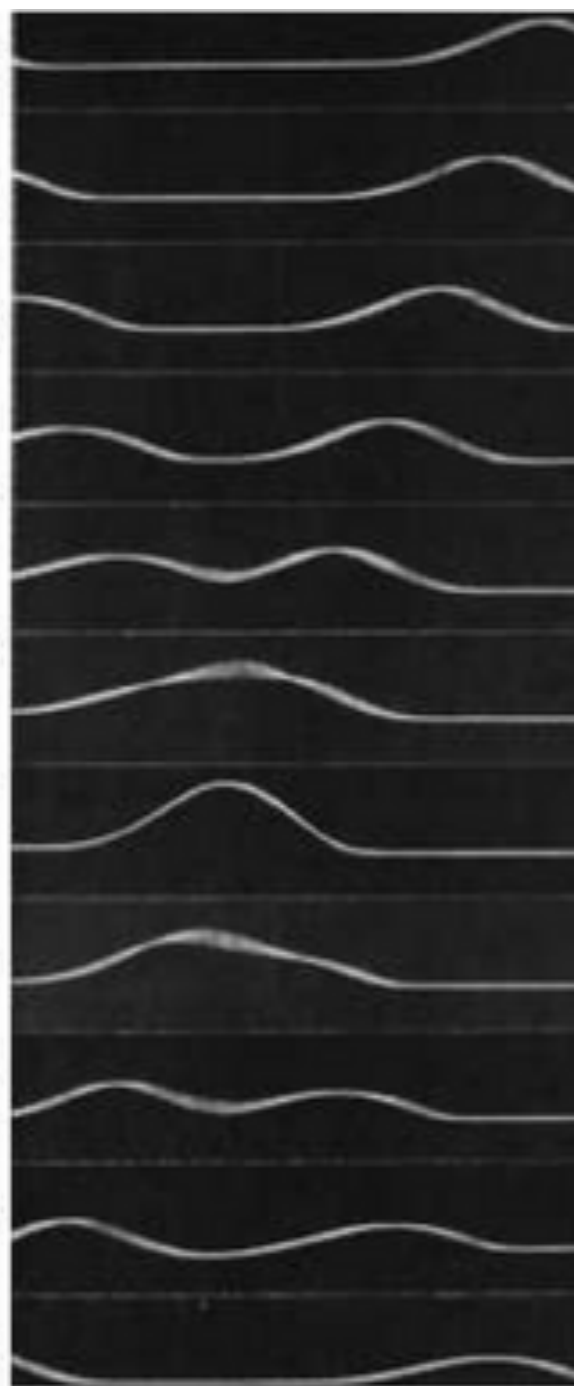
Transversais



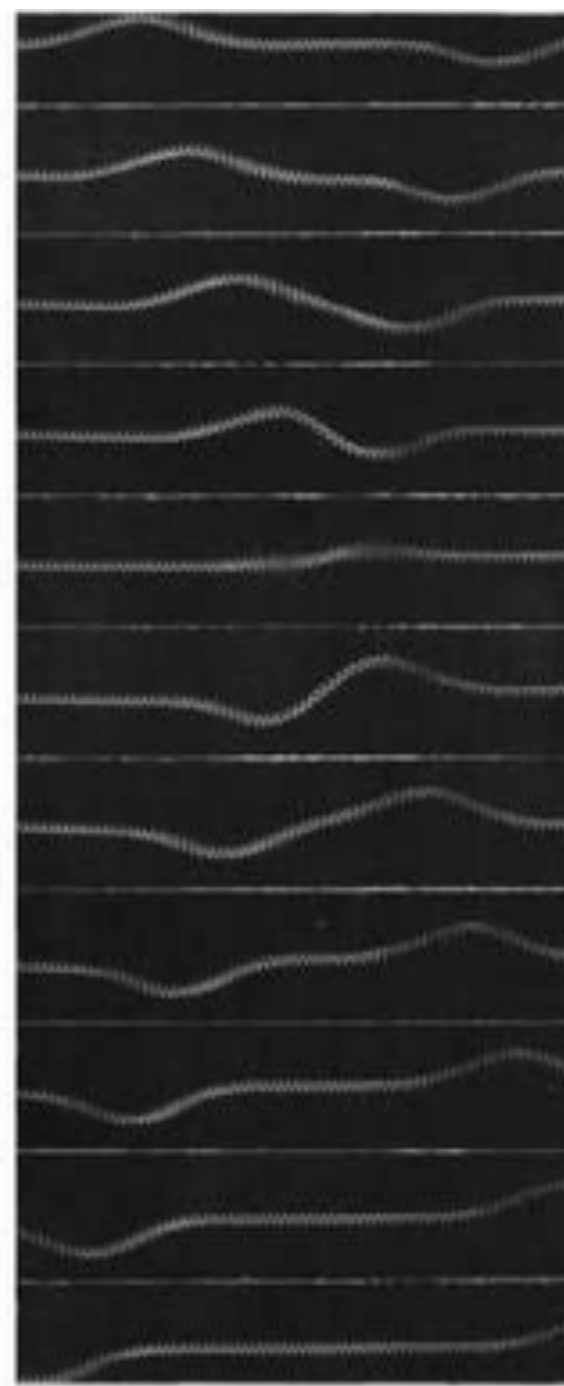
Princípio de superposição



1



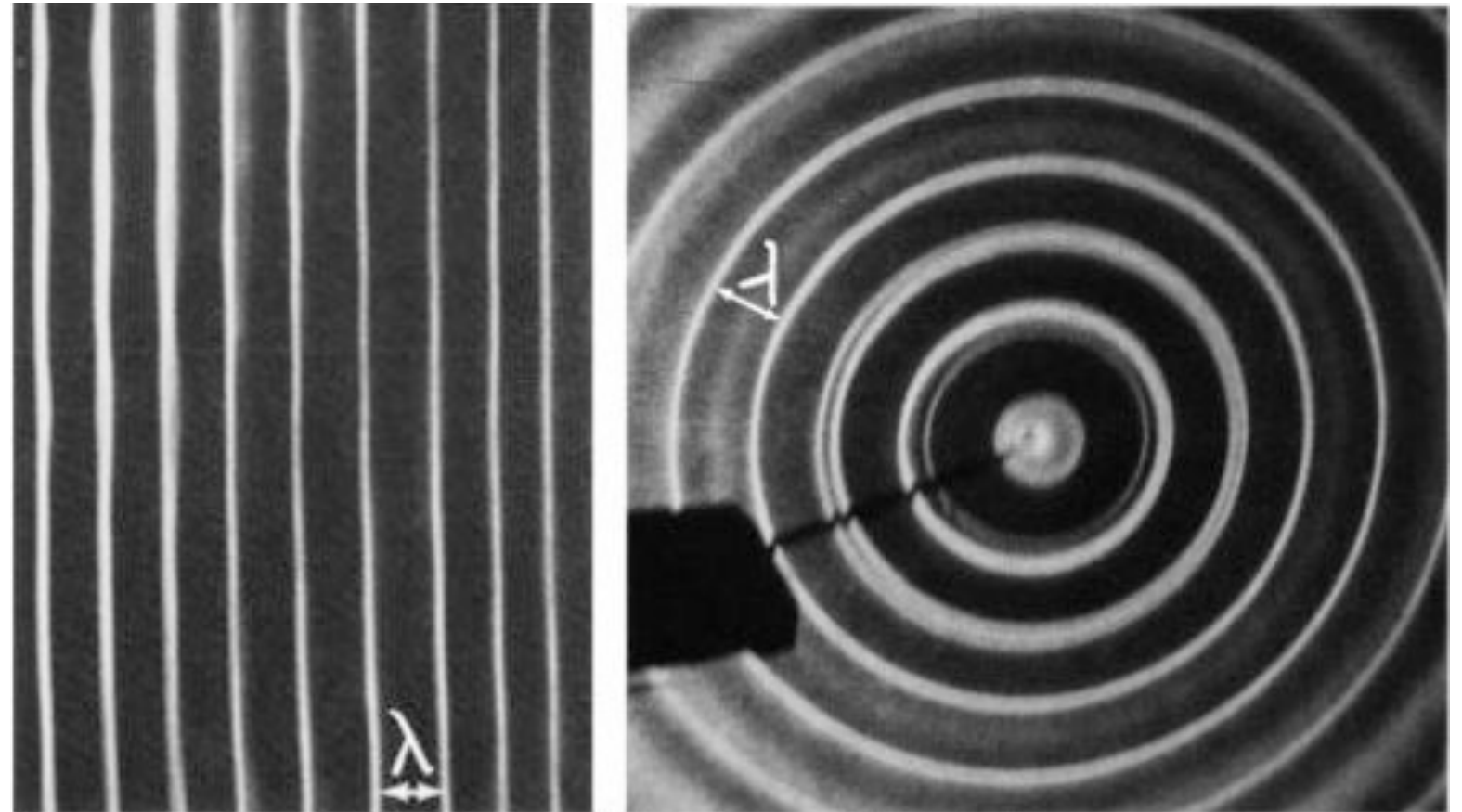
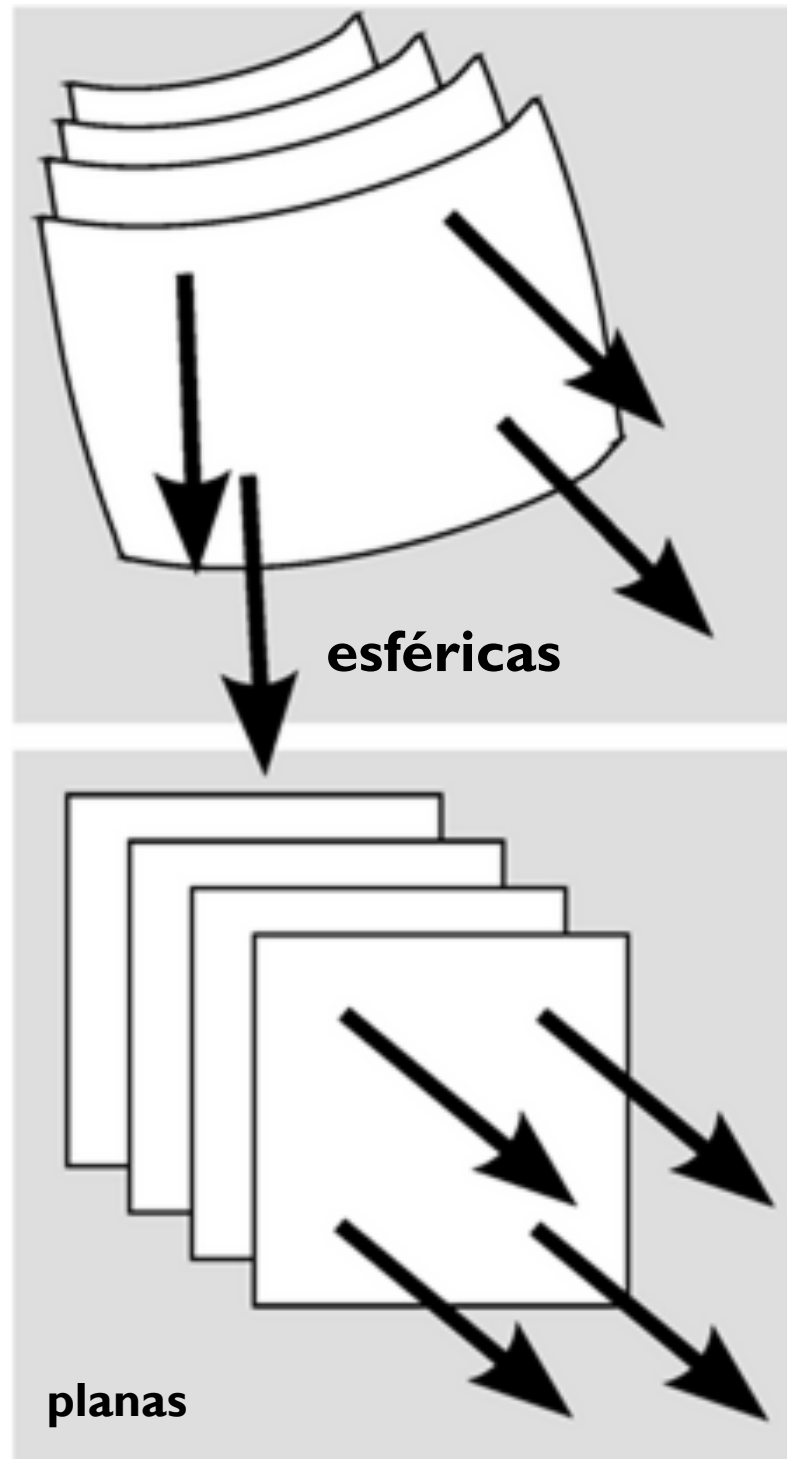
2



3

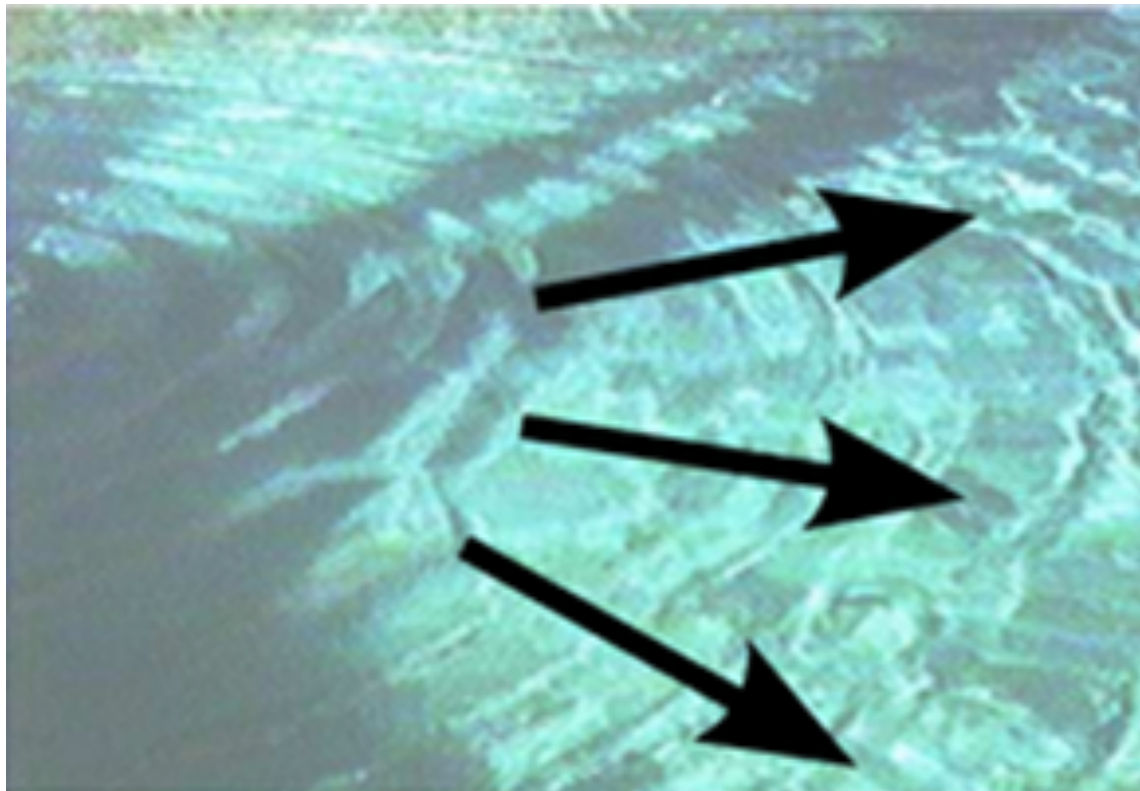


Representação de frentes de ondas

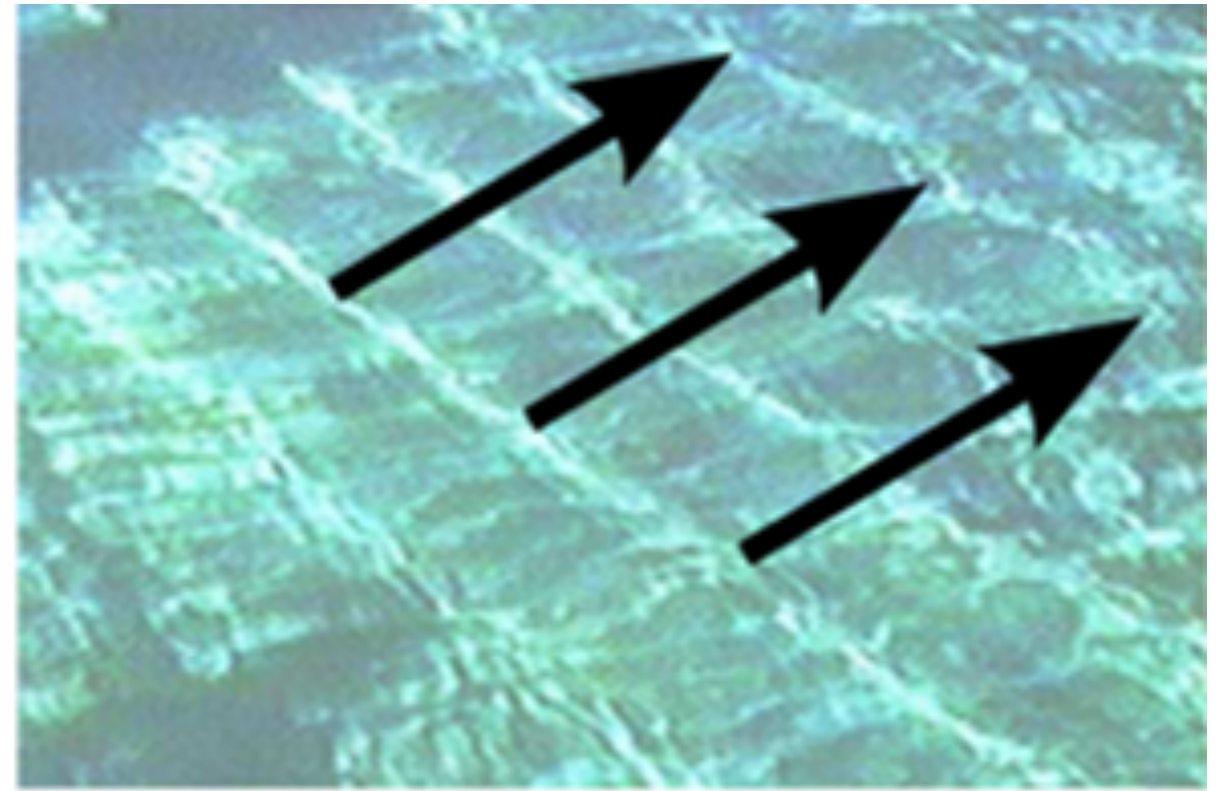


Frentes de ondas

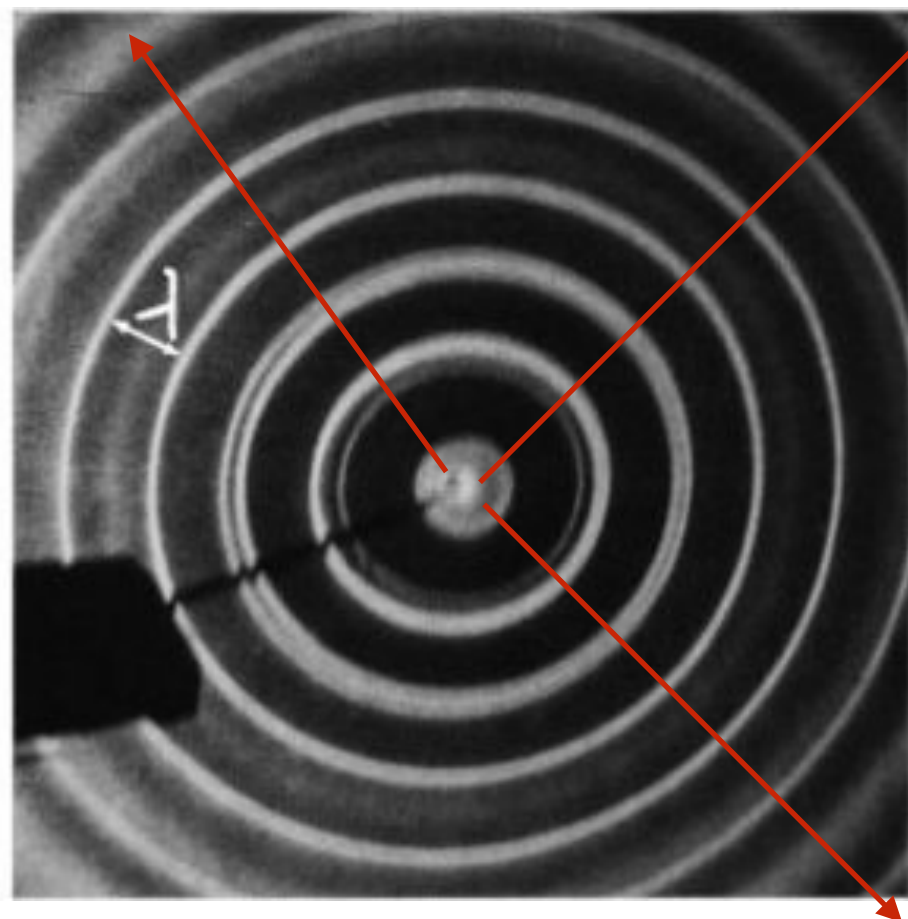
circulares



retas



Frente de onda esférica

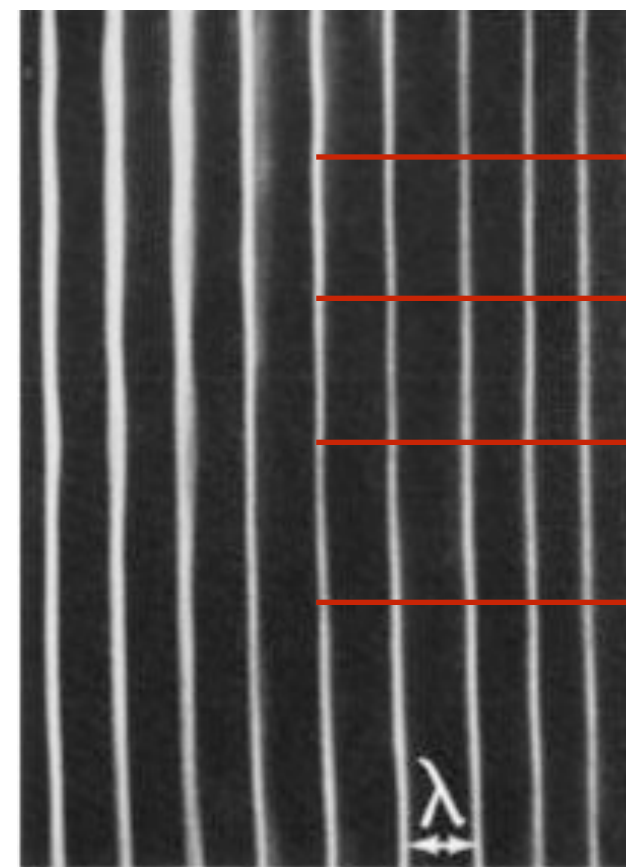


raios de luz

fonte puntual

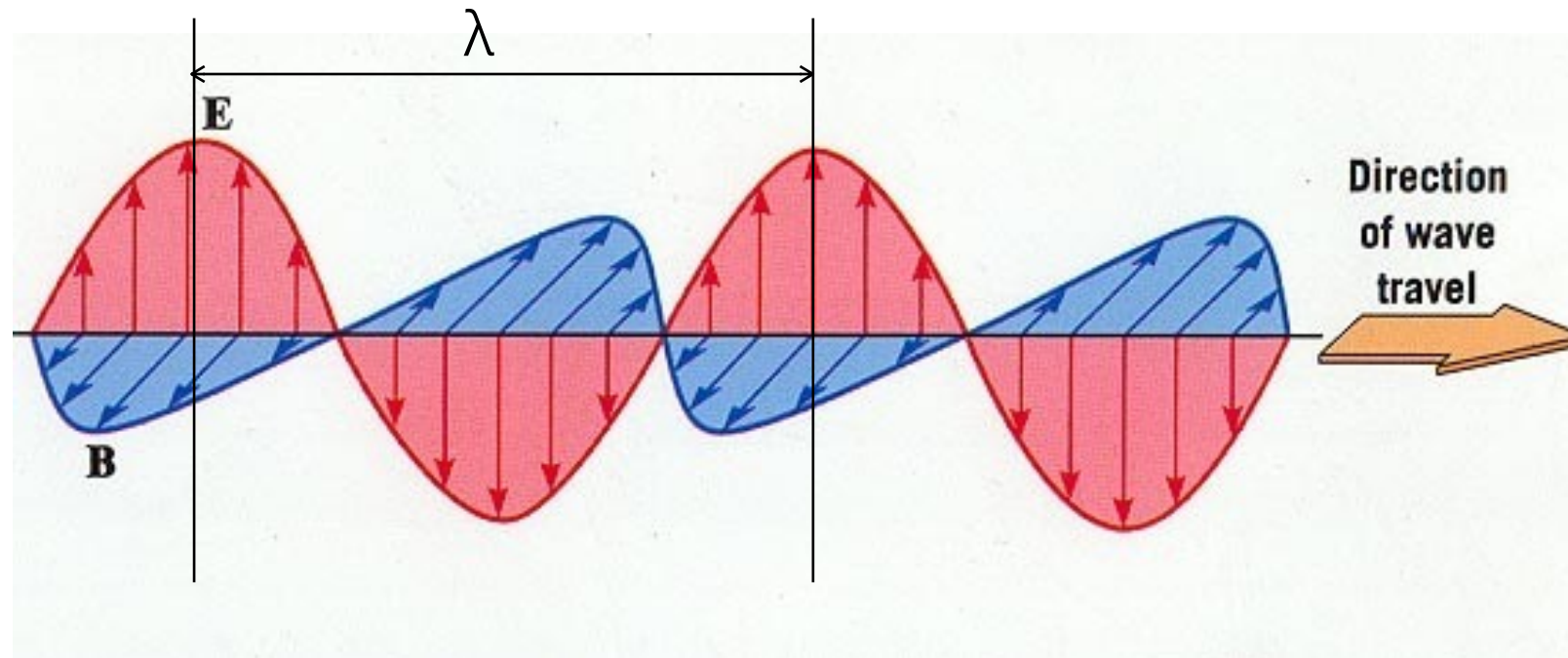
Os raios de luz são perpendiculares a frente de onda e indicam a direção de propagação da luz

Frente de onda plana



raios de luz

Ondas Eletromagnéticas periódicas



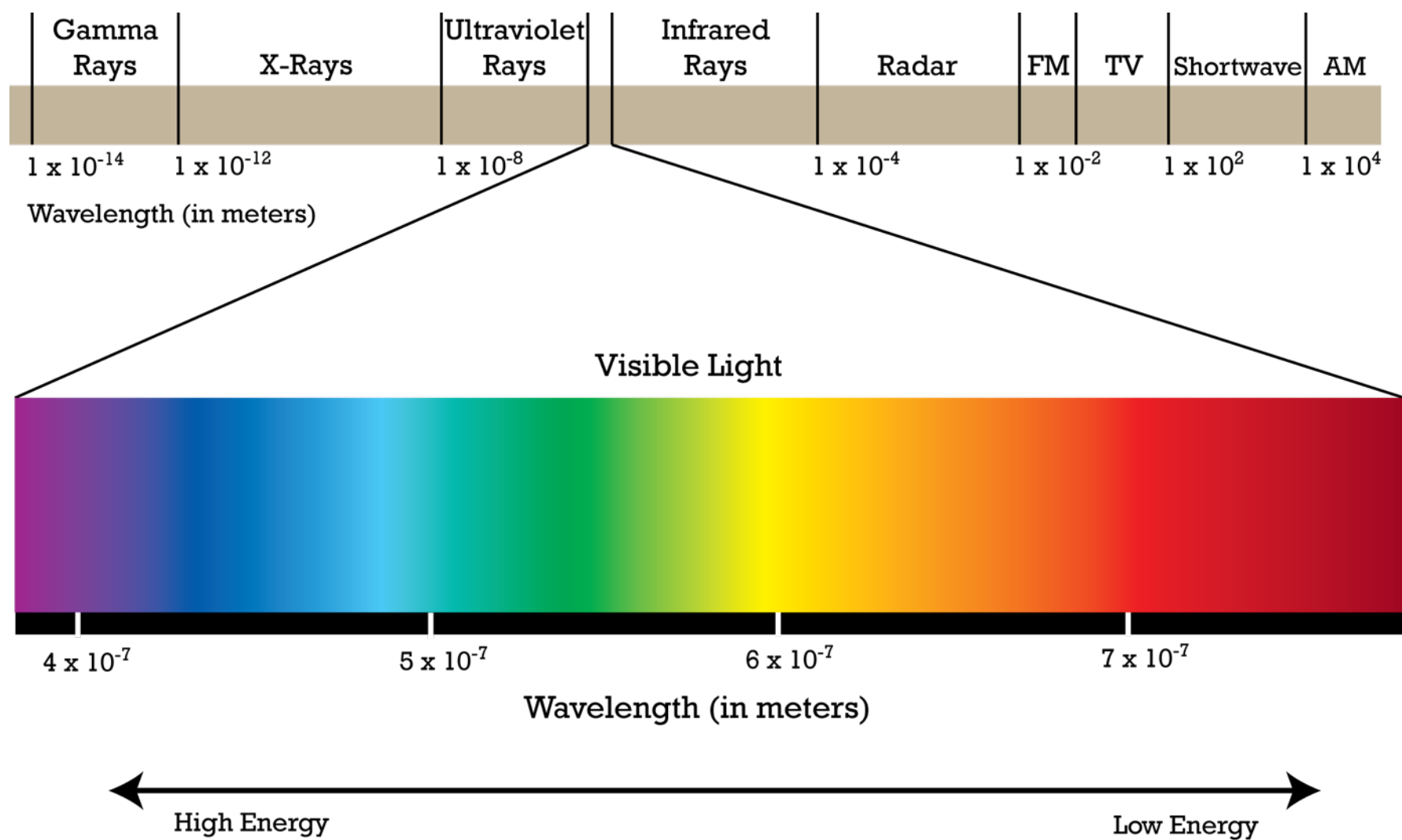
$$c = \lambda f$$

c = velocidade de propagação da luz = 3×10^8 m/s

f = frequência da onda (unidade: Hz = s⁻¹)

λ = comprimento de onda

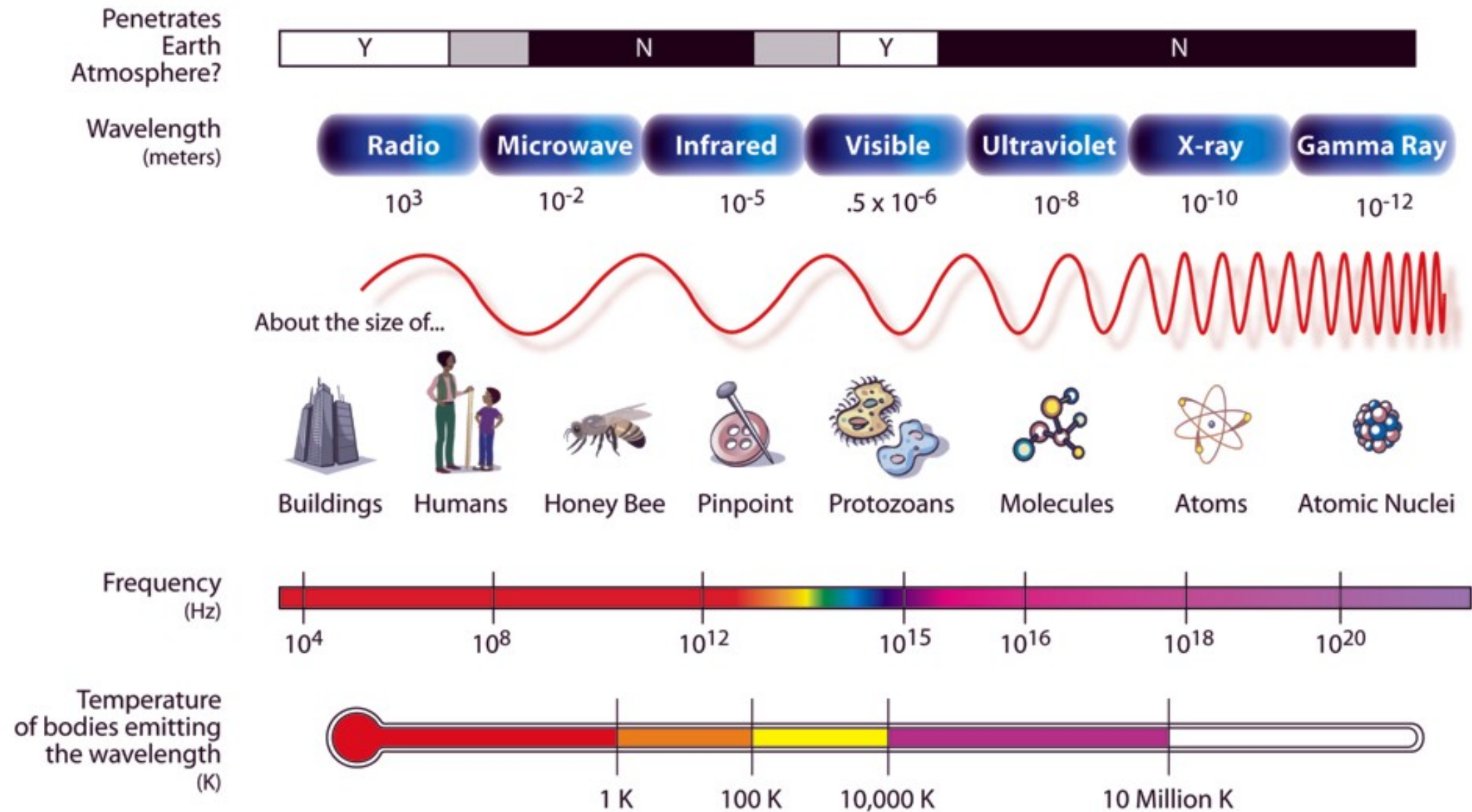
Espectro Eletromagnético



comprimento de onda

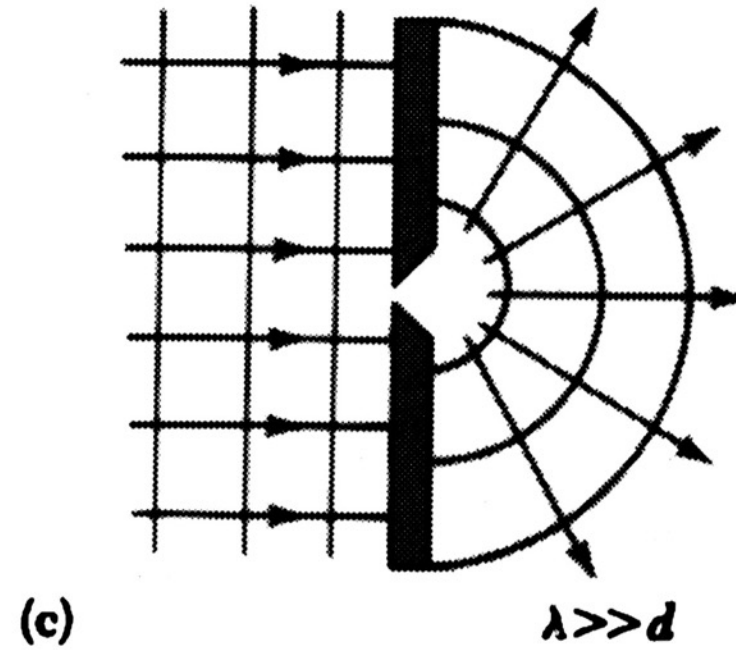
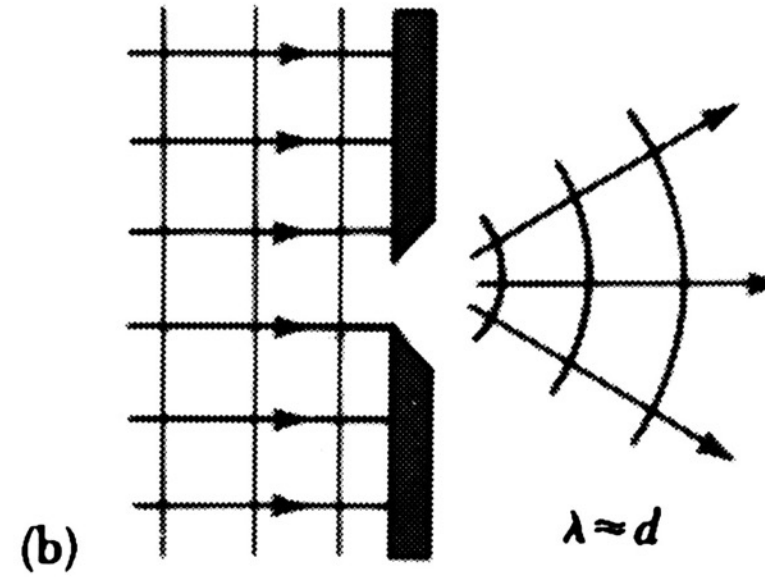
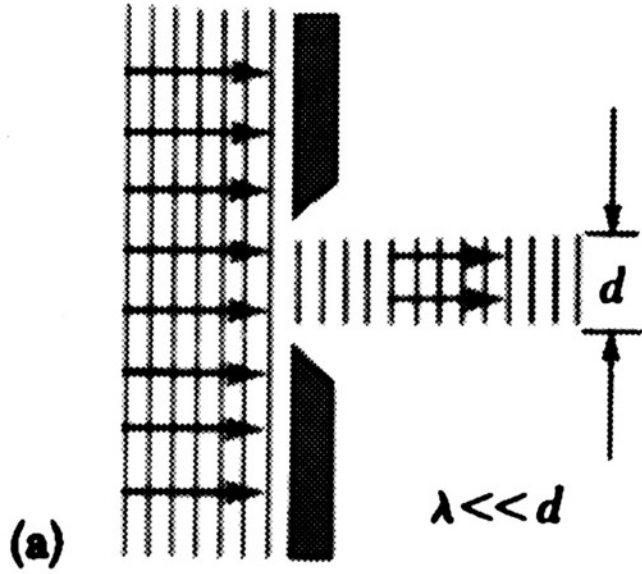
Espectro Eletromagnético

THE ELECTROMAGNETIC SPECTRUM



http://my.nasa.gov/images/EM_Spectrum3-new.jpg

Difração de ondas mecânicas

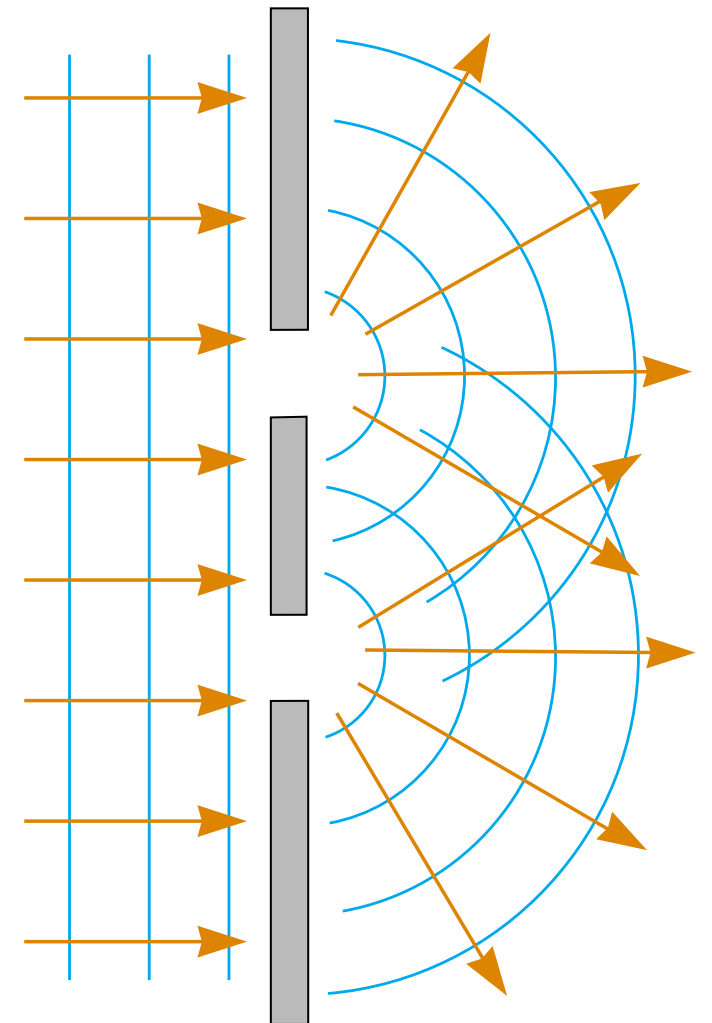


Interferência de ondas mecânicas

Courtesy of Sabina Zigman/Benjamin Cardozo High School

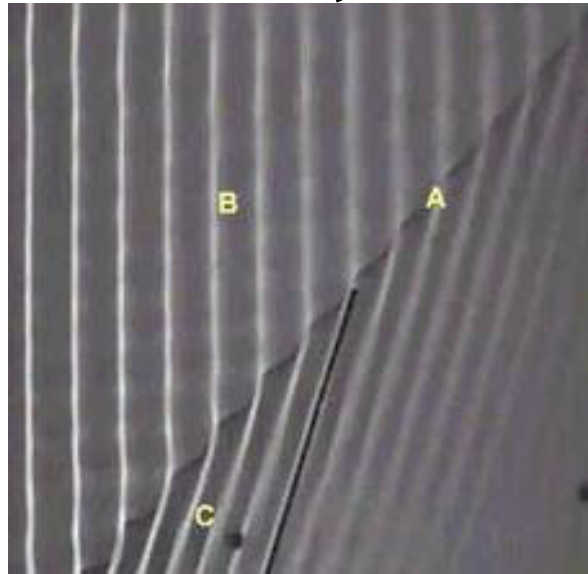


At a beach in Tel Aviv, Israel, plane water waves pass through two openings in a breakwall. Notice the diffraction effect—the waves exit the openings with circular wave fronts, as in Figure 37.1b. Notice also how the beach has been shaped by the circular wave fronts.



Experimento na Cuba de ondas

Refração

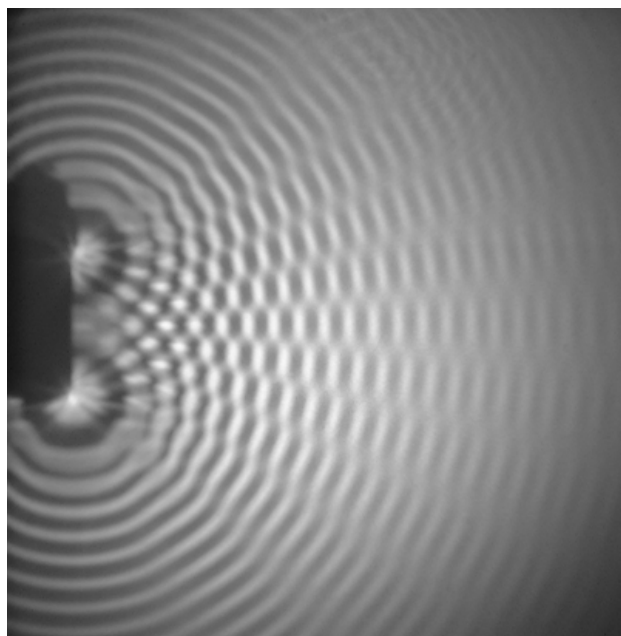


Difração



diminuindo abertura da fenda

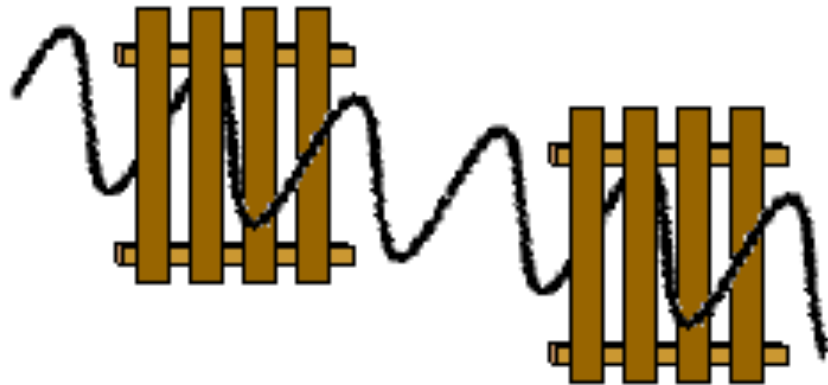
Interferência



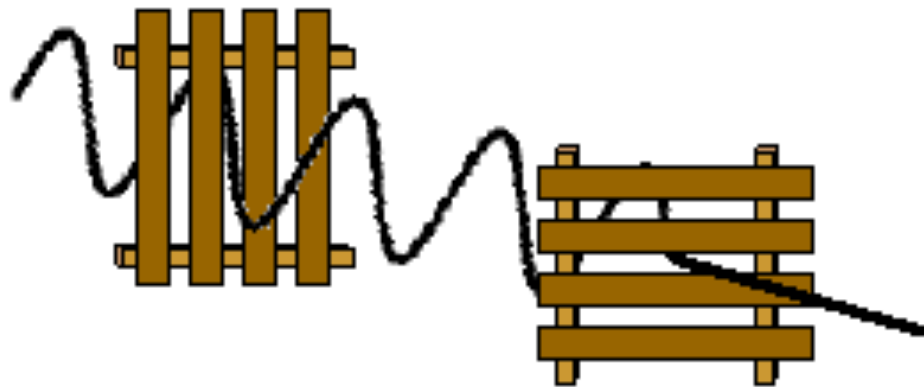
Polarização

Ondas mecânicas

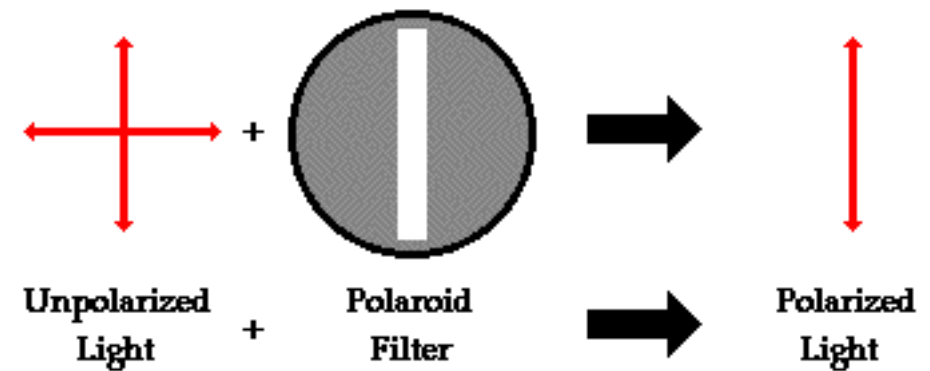
The Picket Fence Analogy



When the pickets of both fences are aligned in the vertical direction, a vertical vibration can make it through both fences.

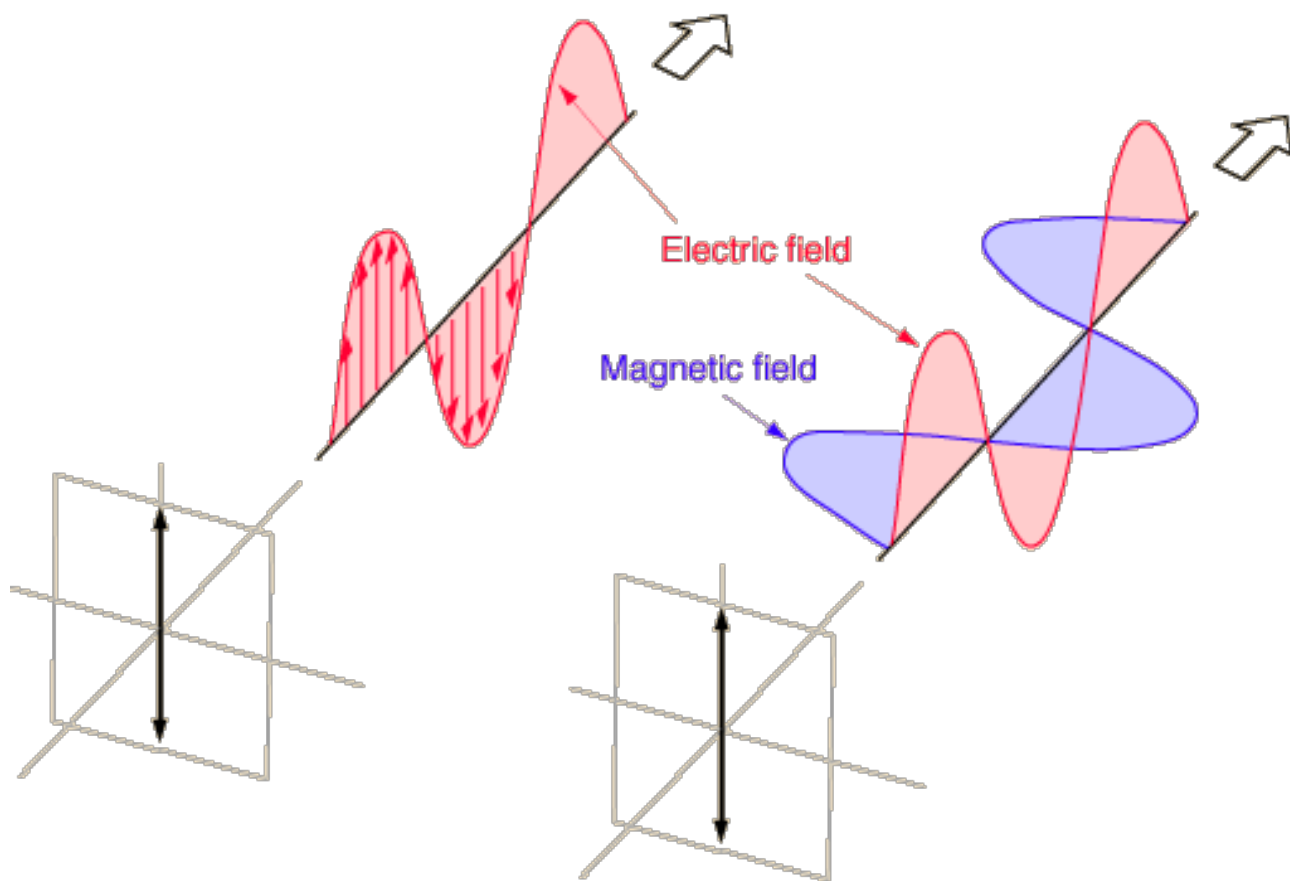


When the pickets of the second fence are horizontal, vertical vibrations which make it through the first fence will be blocked.

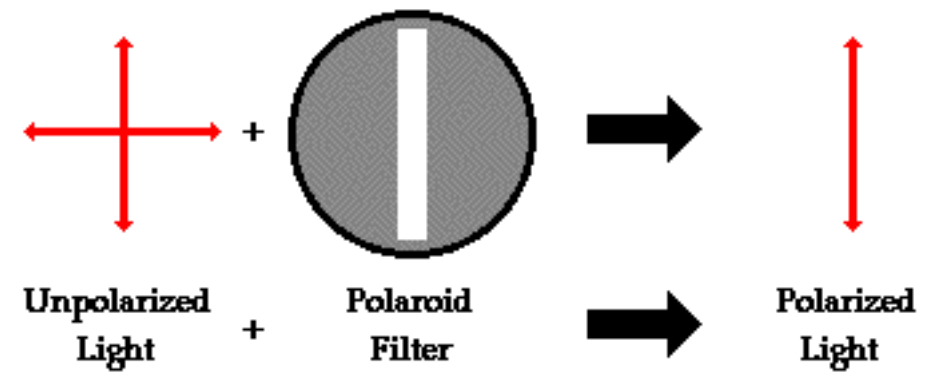


Polarização

Ondas Eletromagnéticas



luz linearmente polarizada

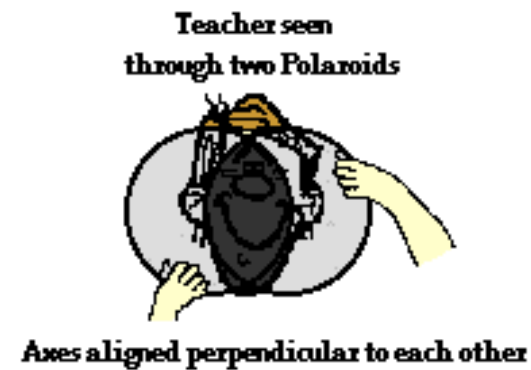
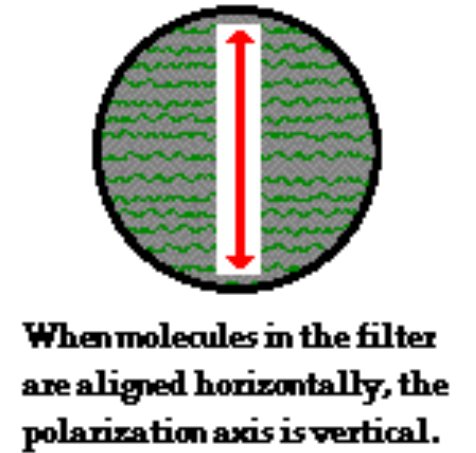
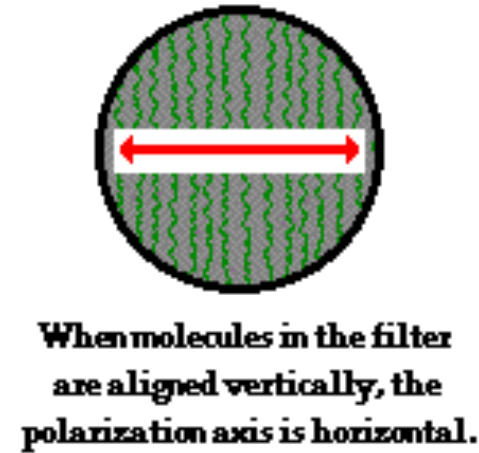
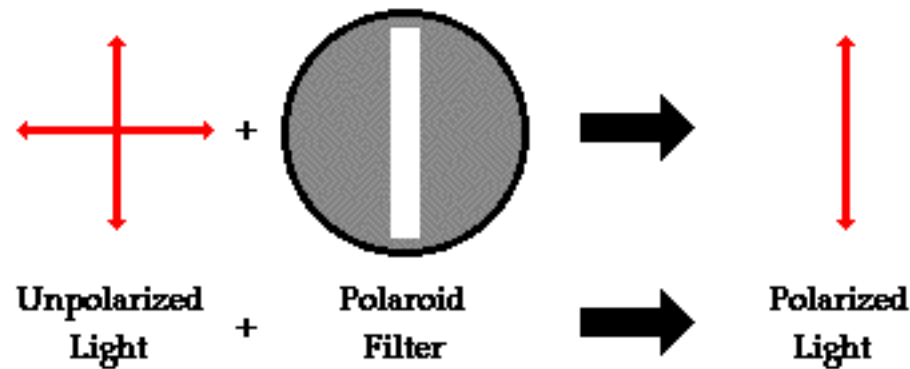


luz não polarizada

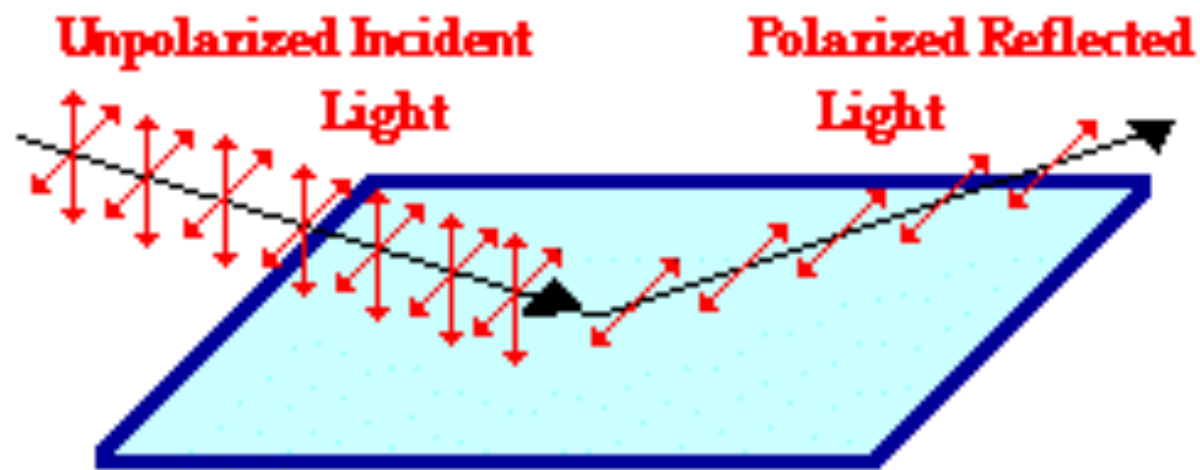
Polarizadores ou filtros de polarização

luz não polarizada

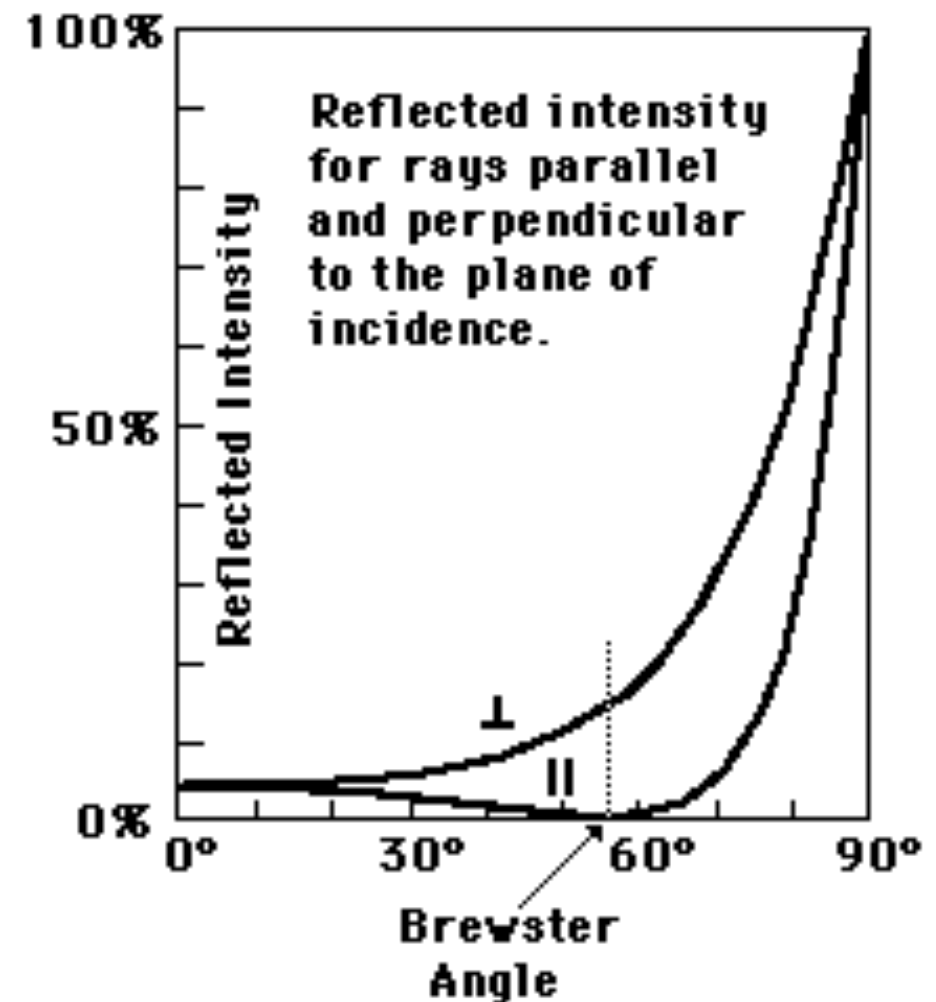
Polarizadores



Polarização da luz por reflexão



Reflection of light off of non-metallic surfaces results in some degree of polarization parallel to the surface.



<http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/polar.html#c1>

<http://www.physicsclassroom.com/class/light/Lesson-1/Polarization>

Princípio de Huygens

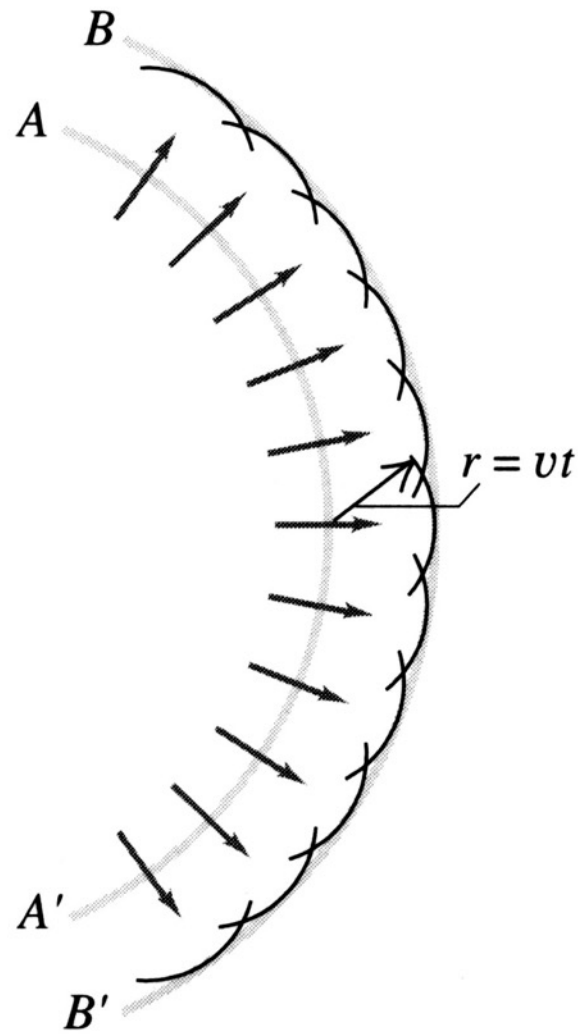
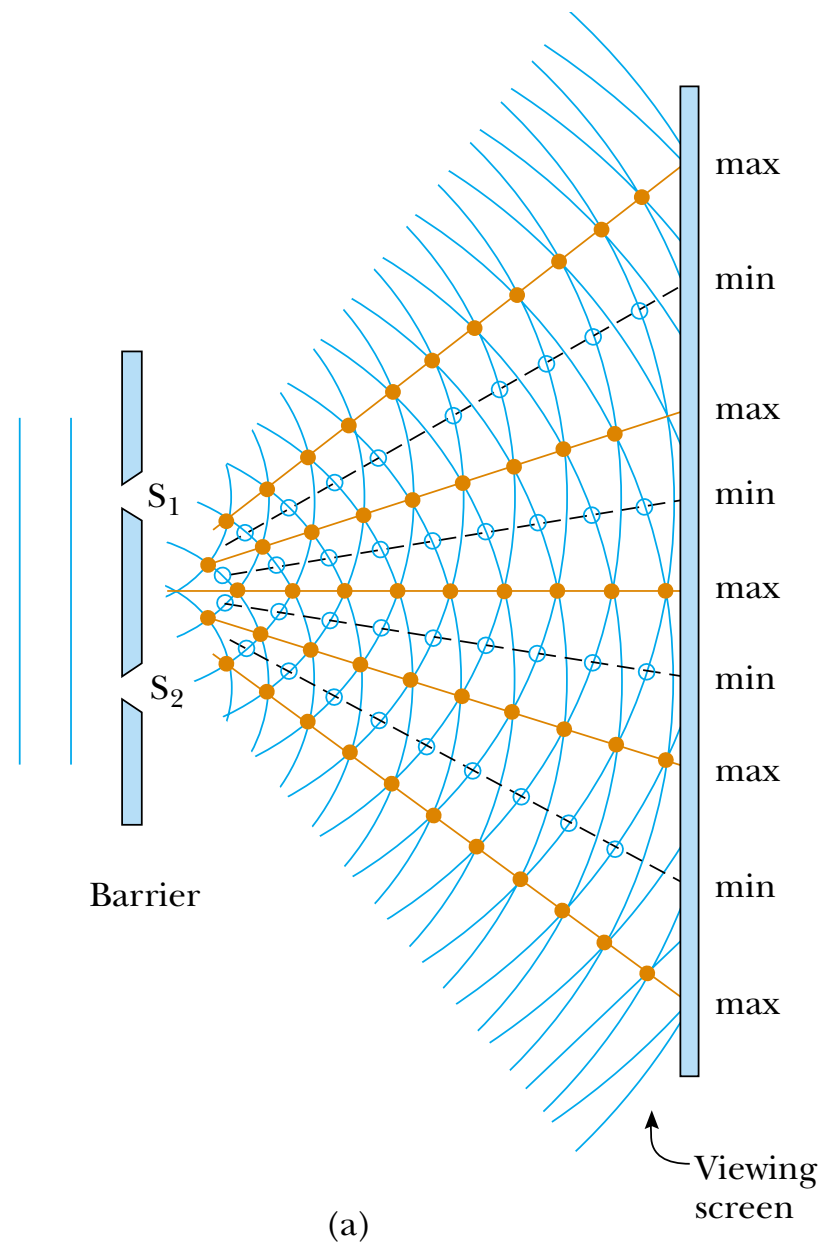
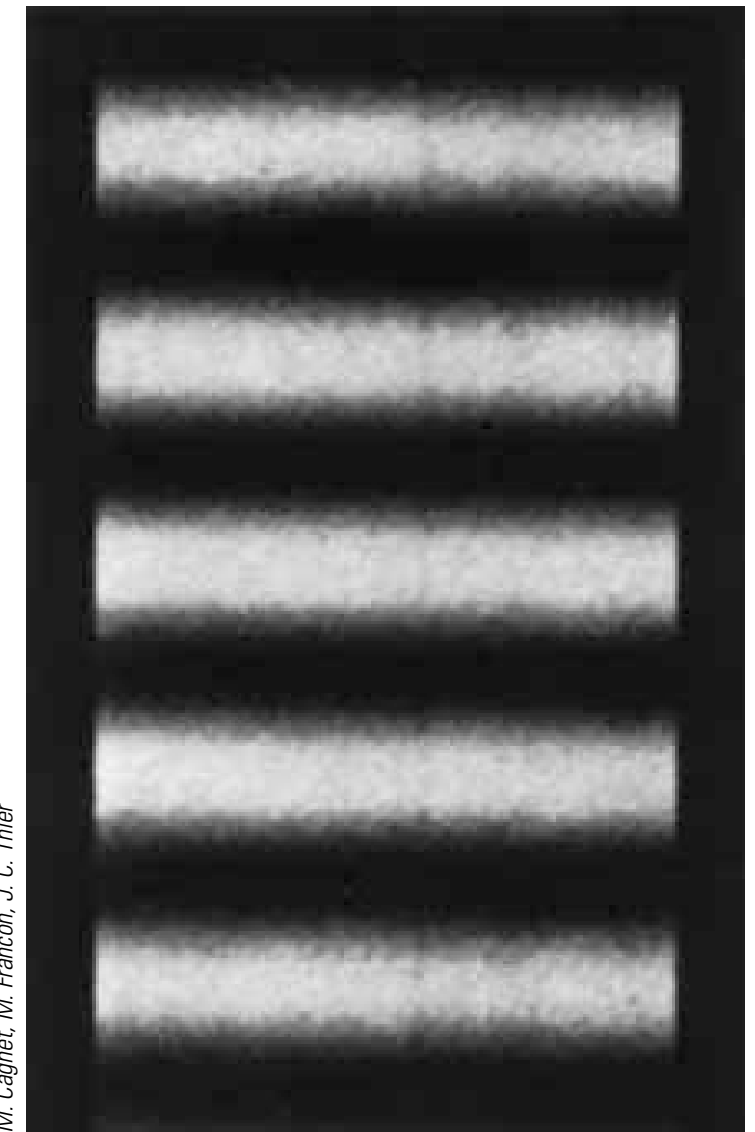


FIGURA 34.26 Aplicação do princípio de Huygens para construir uma nova frente de onda BB' a partir de uma frente de onda AA' .



(a)



(b)

Franja clara
Interferência construtiva

Franja escura
Interferência destrutiva

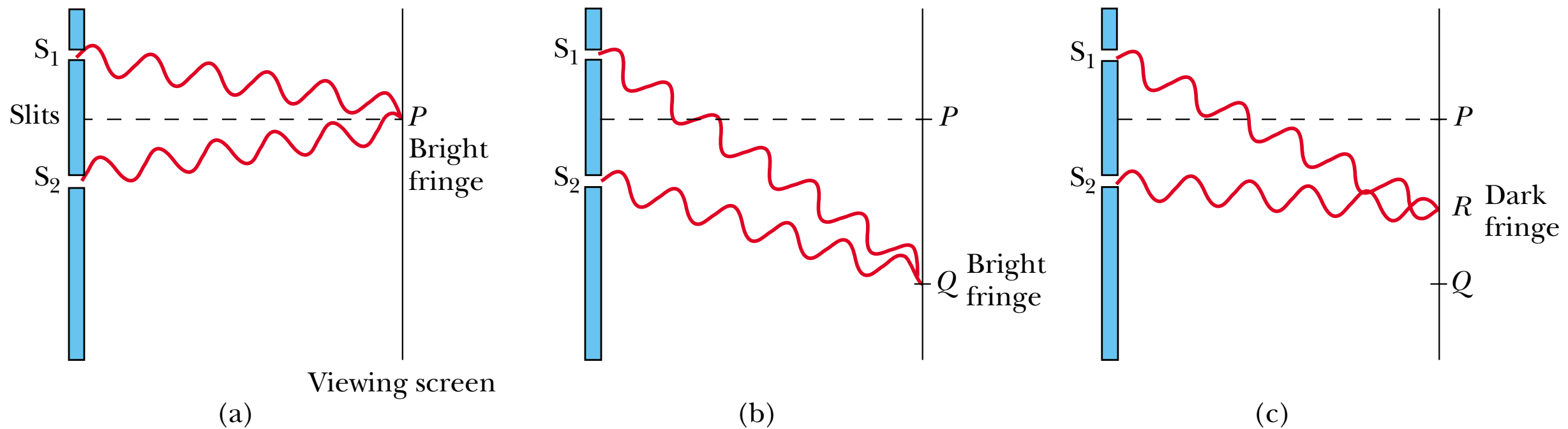
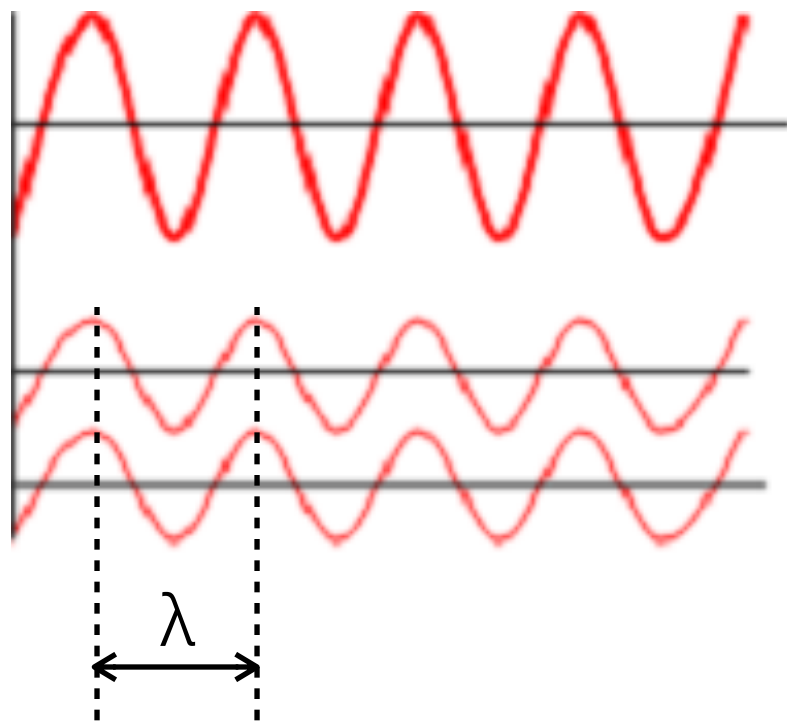


Figure 37.4 (a) Constructive interference occurs at point P when the waves combine. (b) Constructive interference also occurs at point Q . (c) Destructive interference occurs at R when the two waves combine because the upper wave falls half a wavelength behind the lower wave. (All figures not to scale.)

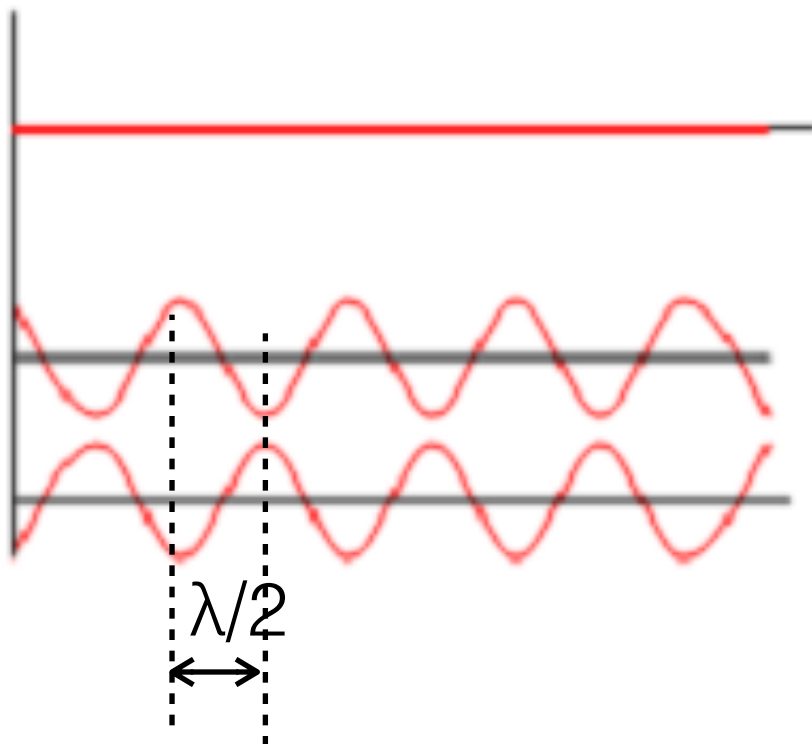
Duas ondas em fase



Interferência construtiva

diferença de caminho de λ = diferença de fase de 2π

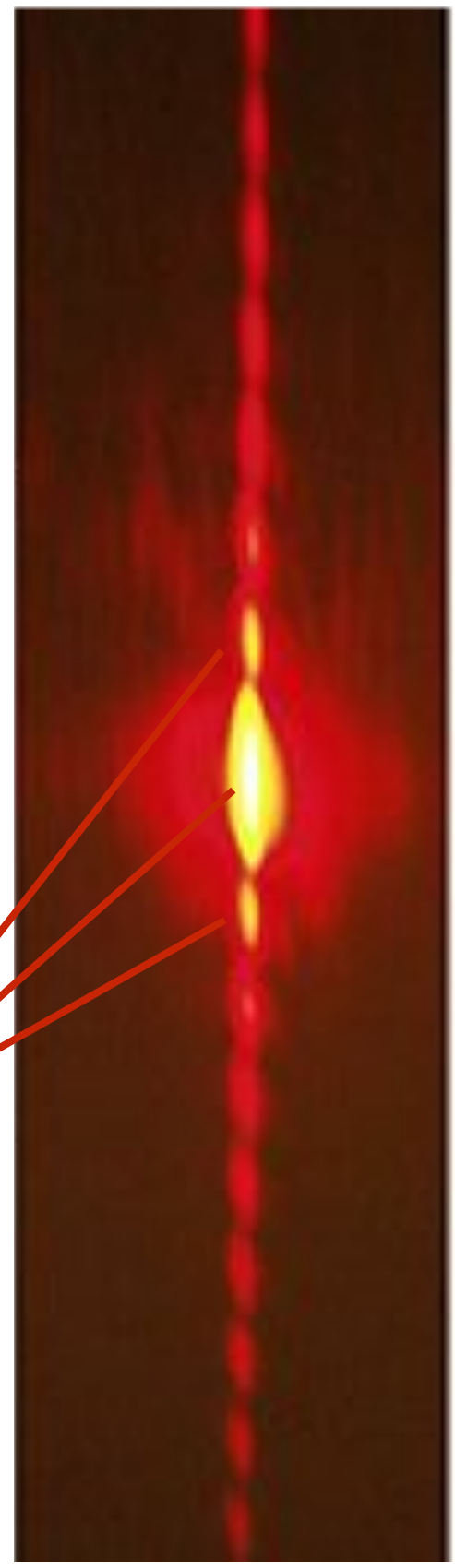
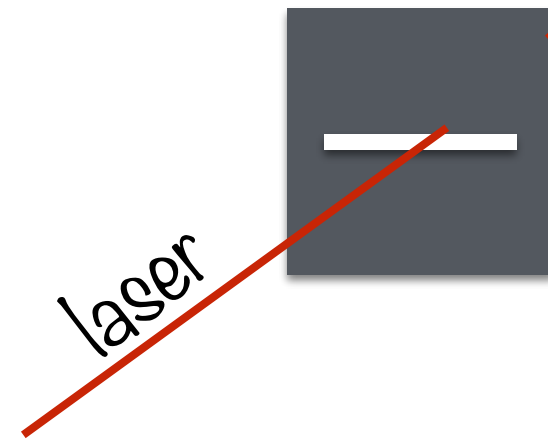
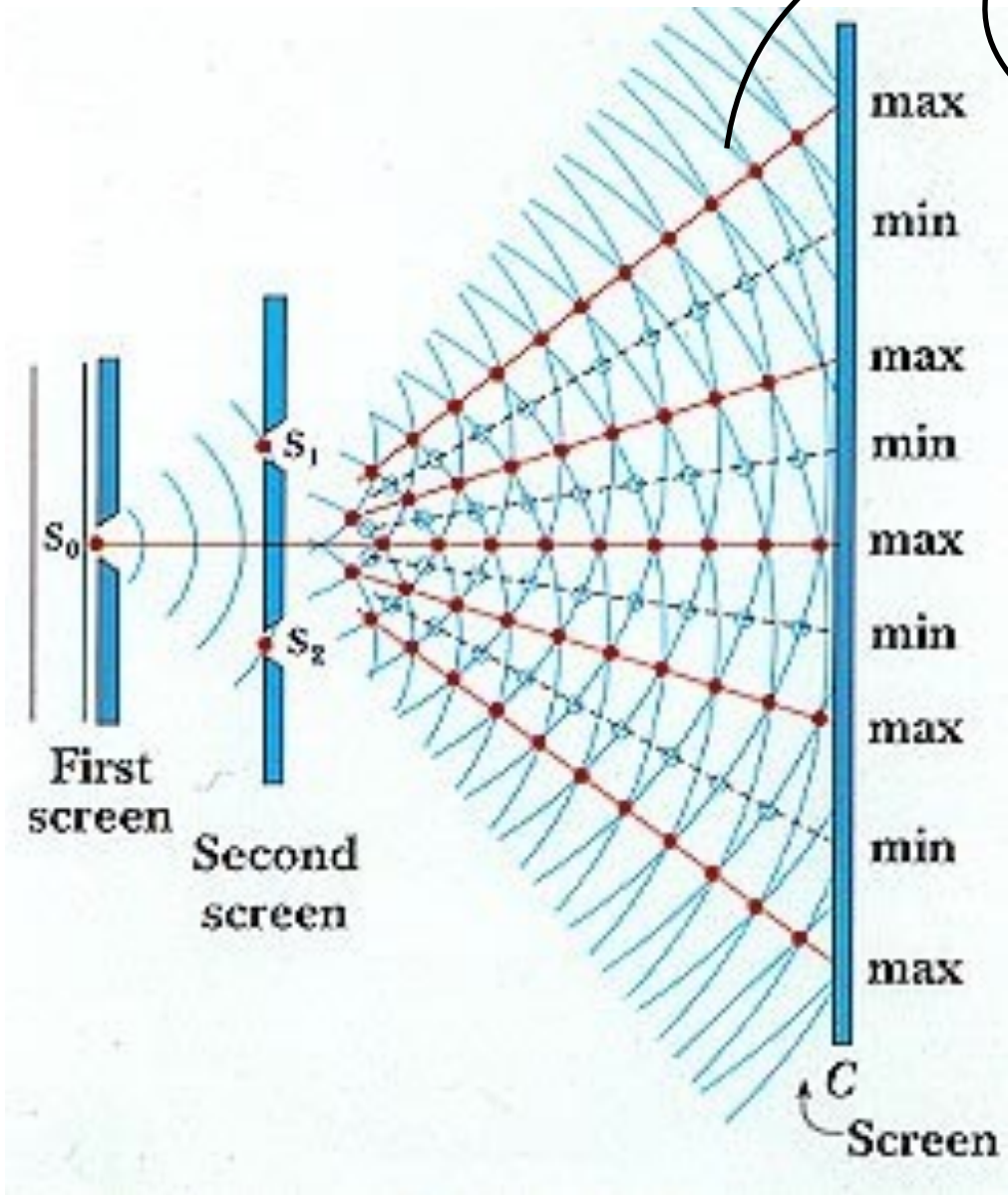
Duas ondas fora de fase



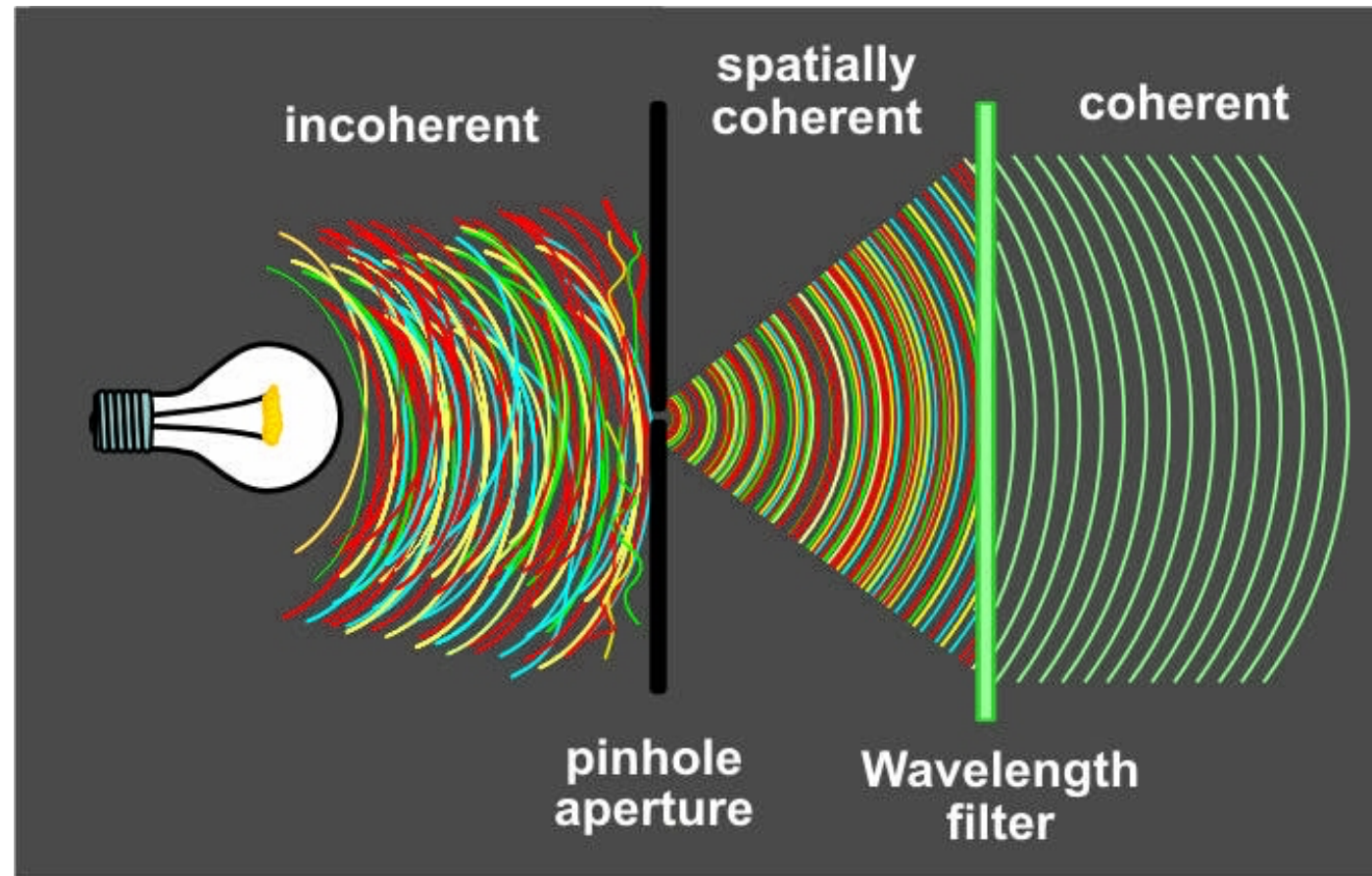
Interferência destrutiva

diferença de caminho de $\lambda/2$ = diferença de fase de π

franjas claras=interferência construtiva



Coerência



- Raios de luz que nunca se cruzam, sejam eles paralelos ou radiais
- “Trem” de onda perfeito em três dimensões, esferas concêntrica ou planas