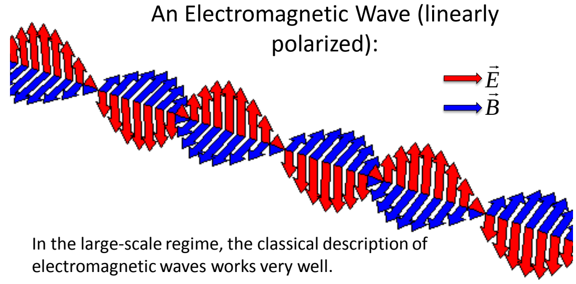
PHY385-H1F Introductory Optics

Class 2 – Outline: Ch.2

- One dimensional wave function $\psi(x,t) = f(x - vt)$
- The differential wave equation: $\frac{\partial^2\psi}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2\psi}{\partial t^2}$
- Harmonic Waves
- Phasors
- Plane waves
- 3-D Wave equation
- Spherical waves
- Cylindrical Waves (if time)

An Electromagnetic Wave (linearly polarized):



In the large-scale regime, the classical description of electromagnetic waves works very well.

In the subatomic domain, the quantum mechanical treatment must be applied.

Both the classical and quantum-mechanical treatments of light make use of the mathematical description of waves.

In-Class Vote

- Consider the function:

$$\psi(x,t) = f(x - vt)$$

- Where v = 300 m/s, and: $f(y) = \frac{1}{y^2+1}$

Consider the time t = 0. At what value of x is $\psi(x,0)$ a ***minimum***?

1. 0
2. $-\infty$
3. $+\infty$
4. Both $-\infty$ and $+\infty$

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In-Class Vote

- Consider the function:

$$\psi(x,t) = f(x - vt)$$

- Where v = 300 m/s, and: $f(y) = \frac{1}{y^2+1}$

Consider the time t = 1 s. At what value of x is $\psi(x,1)$ a ***minimum***?

1. 0
2. $-\infty$
3. $+\infty$
4. Both $-\infty$ and $+\infty$
5. 300 m

In-Class Vote

- Consider the function:

$$\psi(x,t) = f(x - vt)$$

- Where v = 300 m/s, and: $f(y) = \frac{1}{y^2+1}$

Consider the time t = 1 s. At what value of x is $\psi(x,1)$ a ***maximum***?

1. 0
2. +300 m
3. −300 m
4. Both $-\infty$ and $+\infty$

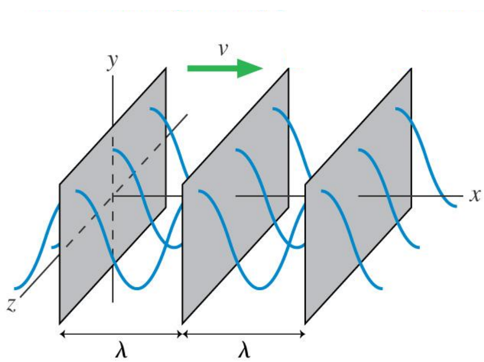
Some math identities

Cartesian Laplacian: $\Delta f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2}.$

Cylindrical Laplacian: $\Delta f = \frac{1}{\rho}\frac{\partial}{\partial \rho}\left(\rho \frac{\partial f}{\partial \rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 f}{\partial \theta^2} + \frac{\partial^2 f}{\partial z^2}.$

Spherical Laplacian: $\Delta f = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \frac{\partial f}{\partial r}\right) + \frac{1}{r^2 \sin\varphi}\frac{\partial}{\partial \varphi}\left(\sin\varphi \frac{\partial f}{\partial \varphi}\right) + \frac{1}{r^2 \sin^2\varphi}\frac{\partial^2 f}{\partial \theta^2}.$

Curl of the curl: $\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2 \mathbf{A}$



What is a “phasor”?

1. The initial phase of a sinusoidal wave at the origin.
2. A vector in the complex plane, the real part of which is the amplitude of a sinusoidal wave.
3. The argument of the cosine or sine function used to represent a wave.
4. A weapon used on Star Trek.