PHYS2600J Recitation Class 4

Week 11

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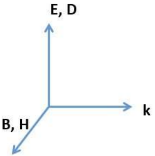
Basics of Waves

- Classical Wave Equation
  - $\frac{\partial^2 f}{\partial x^2} - \frac{1}{v^2}\frac{\partial^2 f}{\partial t^2} = 0$
- Sinusoidal Wave Function
  - $f(x,t) = A\cos(k(x-vt)+\varphi)$
  - Complex Notation: $\tilde{f}(x,t) = \tilde{A}e^{i(kx-\omega t)}$
  - Parameters:

A	amplitude
k	wave number
$k(x-vt)+\varphi$	phase
φ	phase constant ($0 \leq \varphi < 2\pi$)
$\lambda = k/2\pi$	wave length
$T = 2\pi/kv$	period
$\nu = 1/T$	frequency
$\omega = 2\pi\nu$	angular frequency

Basics of EM Waves

- Case 0: in Vacuum
  - $\nabla^2\vec{\mathbf{E}} - \mu_0\varepsilon_0\frac{\partial^2\vec{\mathbf{E}}}{\partial t^2} = 0$
  - $\nabla^2\vec{\mathbf{B}} - \mu_0\varepsilon_0\frac{\partial^2\vec{\mathbf{B}}}{\partial t^2} = 0$
- Case 1: in Conducting Medium
  - $\nabla^2\vec{\mathbf{E}} - \sigma\mu\frac{\partial\vec{\mathbf{E}}}{\partial t} - \mu\varepsilon\frac{\partial^2\vec{\mathbf{E}}}{\partial t^2} = 0$
  - $\nabla^2\vec{\mathbf{H}} - \sigma\mu\frac{\partial\vec{\mathbf{H}}}{\partial t} - \mu\varepsilon\frac{\partial^2\vec{\mathbf{H}}}{\partial t^2} = 0$
- Complex Notation
  - $\nabla = ik$
  - $\frac{\partial}{\partial t} = -i\omega$
  - $\tilde{\varepsilon} = \varepsilon - i\frac{\sigma}{\omega}$
- Poynting Vector
  - $\vec{\mathbf{S}} = \vec{\mathbf{E}} \times \vec{\mathbf{H}}$



Basics of Optics

- Reflection and Refraction
  - Snell's Law
  - Fresnel Equations
- Polarization
  - Malus's Law
- Interference
  - Young's Double-Slit Experiment
    $\frac{I}{I_0} = [\cos(\delta/2)]^2, \delta = \frac{2\pi d \sin\theta}{\lambda}$
- Diffraction
  - $\frac{I}{I_0} = [\frac{\sin(N\delta/2)}{\sin(\delta/2)}]^2, \delta = \frac{2\pi d \sin\theta}{\lambda}$

No one has ever been able to define the difference between interference and diffraction satisfactorily. It is just a quest of usage, and there is no specific, important physical difference between them. The best we can do is, roughly speaking, is to say that when there are only a few sources, say two interference sources, then the result is usually called interference, but if there is a large number of them, it seems that the word diffraction is more often used. (Richard Feynman)

Exercise 1

Exercise 2

Exercise 3

Thanks for listening!

References

D. J. Griffiths.
Introduction to Electrodynamics.
Cambridge University Press, 5 edition, 2023.