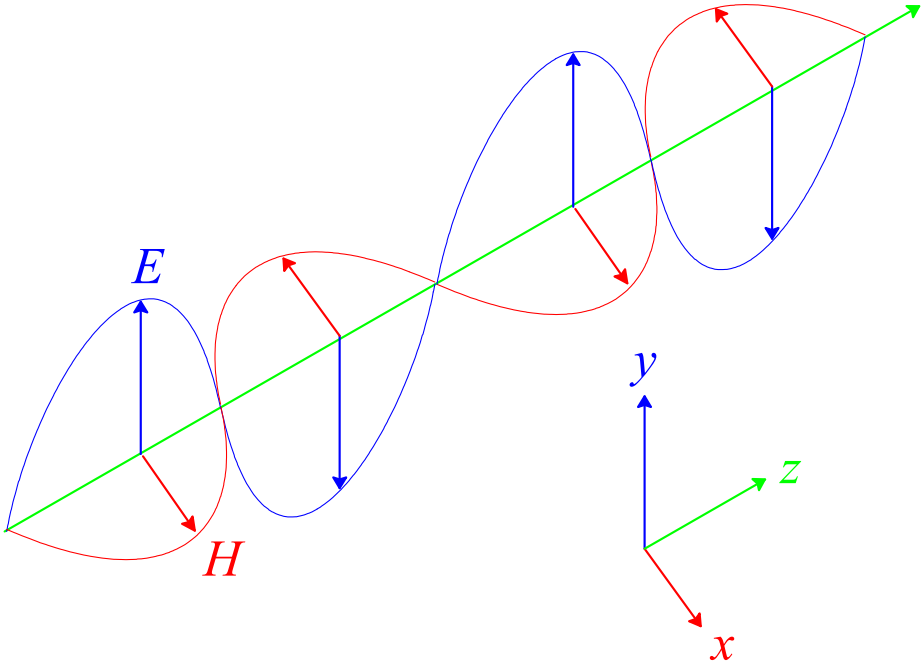
Need for a "New Physics"

- The nuclear model demonstrated by Rutherford's gold foil experiments did not make sense in terms of the physics known at the time.

- The "new physics" that was needed to understand atomic structure grew out of studies of radiant energy.

- In the 1860s James Clerk Maxwell proposed that radiant energy is propagated in waves of fluctuating electric (E) and magnetic (H) fields.
  - Radiant energy is **electromagnetic radiation**.
  - Maxwell's electromagnetic hypothesis was confirmed by Heinrich Hertz in 1887.

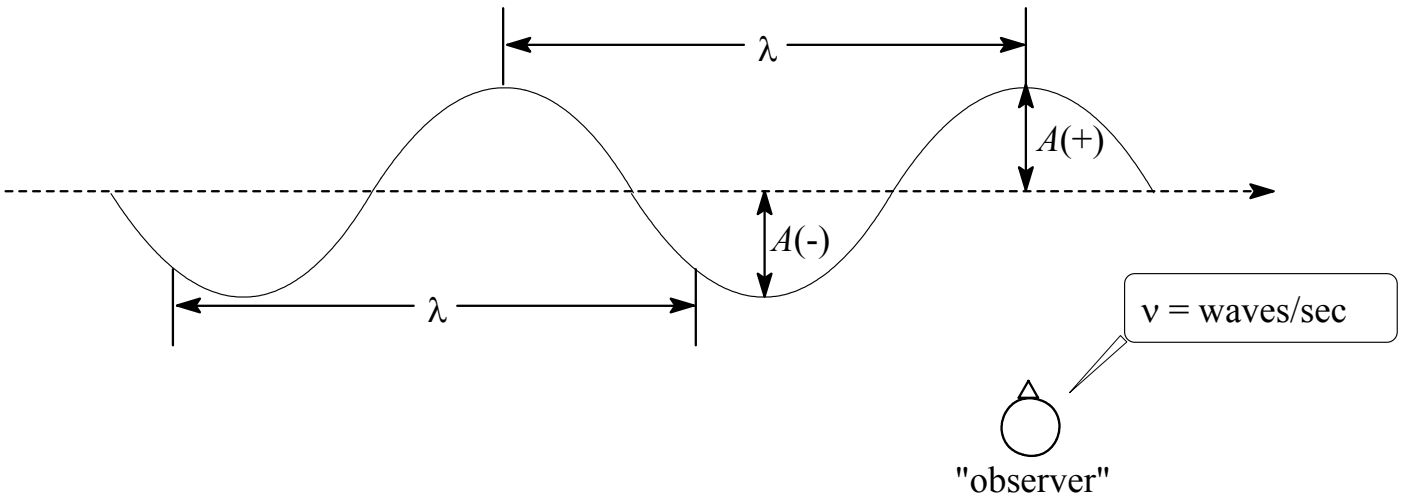
Electromagnetic Wave



E = electric field vector

H = magnetic field vector

Parameters of a Wave



λ = wavelength (m, nm, Å)
ν = frequency (1/sec = s^{-1} = Hz)
A = amplitude

Intensity is proportional to amplitude squared:

$$I \propto A^2$$

Key Equations and Constants

Speed of light in vacuum:

$$c = 2.9979 \times 10^{8}\ \text{m@s}^{-1}$$

Relationship between ν and λ in vacuum:

$$\nu = c/\lambda$$

Wavenumbers (cm^{-1}):

$$\tilde{\nu} = 1/\lambda$$

Energy:

$$E = h\nu = hc/\lambda = hc\tilde{\nu}$$

Planck's constant:

$$h = 6.626 \times 10^{-34}\ \text{J@s}$$

The Electromagnetic Spectrum