THE BIRTH OF ASTROPHYSICS

• THE CLASSICAL ERA: RISE AND FALL

• ELECTRICITY AND MAGNETISM
  → LIGHT IS AN ELECTROMAGNETIC WAVE!!

• SPECTRA AS CHEMICAL FINGERPRINTS
  → STARS ARE MADE OF CHEMICALS

• MODELING THE ATOM
  → BOHR AND QUANTUM JUMPS
• PHYSICS AT LATE 19TH CENTURY:
  ➤ Classical era: Newtonian mechanics and Electromagnetism
    • Newtonian mechanics: motion of objects and fluids gravitation
    • Classical Electromagnetism: behavior of electric charges and currents
      ➤ effects felt through space: FIELDS [fields substitute for “action at a distance”]
ELECTROMAGNETIC WAVES AND LIGHT

• 1820: Oersted: electric current $\rightarrow$ magnetism
• 1831: Faraday: moving magnet $\rightarrow$ electric current

$\rightarrow$ Electricity and magnetism are related by motion!!

• around 1860: Maxwell unifies electricity and magnetism into ELECTROMAGNETISM

* accounts for: Coulomb’s law
  Forces between current-carrying wires
  No magnetic “charges”
  Changing B field produces E field
  Changing E field produces B field

• And there was LIGHT!!
Oscillating (accelerating) charge creates electromagnetic waves

Electromagnetic waves travel at speed of light
\[ c = 300,000 \text{ km/sec} \]
LIGHT IS AN EM WAVE !!!
(in empty space -- but Maxwell didn’t know that)
where do light waves travel?
THE ELECTROMAGNETIC SPECTRUM

• Visible light is a small window in the EM spectrum

Wavelength of visible light $\approx 10^{-7}$ m
Frequency of visible light $\approx 10^{14}$ Hz
(Hertz = cycles/sec)

• We perceive a very small portion of physical reality
Spectral Lines

• If accelerated charges radiate and substances can glow, substances are made of electric charges in motion!

• around 1814: Joseph Fraunhofer finds missing lines in solar spectrum

• Late 1850’s: Bunsen and Kirchhoff find emission lines substances emit at same wavelength they absorb!

chemical finger prints...

Same chemistry in heavens and Earth!!

But where do lines come from?
THE EMERGENCE OF THE QUANTUM WORLD

• 1895: W. Röntgen and x rays

• 1896: H. Becquerel and radioactivity

• 1897: J. J. Thomson and the electron

• 1900: M. Planck and the quantum

• 1905: A. Einstein and the photoelectric effect

• 1911: Rutherford discovers “nucleus”

All led to the inescapable conclusion that the atom had internal structure and that in order to understand it radical new physics had to be developed
• 1913: The Bohr Atom: Quantum Jumps!!
  explains hydrogen atom spectrum