Introduction

- Syllabus
  - Online, but a printed copy is available, the first lecture only, in class
- Grading
  - Summarizing (see webpage: 30% each in-class exam, 40% final (comprehensive))
    - Exams and final – calculators, pencils, scantron (bring your own) and ID only – follow posted rules or “F”
    - NO MAKE-UP EXAMINATIONS
  - I repeat NO MAKE-UP EXAMINATIONS
  - NO EXTRA CREDIT WORK SUBSTITUTIONS
  - I repeat NO EXTRA CREDIT WORK – extra credit is NO SUBSTITUTE for knowing the course material

Introduction (continued)

- Web notes
  - Will be updated routinely; check back often
- Observing Sessions
  - Offered on campus for your learning experience and enjoyment
- F&K Chapters 4 & 5 Review
  - Basic ideas reviewed in this lecture
    - Read textbook and think about what is being said

Kepler’s Laws of Planetary Motion

- Kepler’s First Law of Planetary Motion
  - planets orbit sun in an ellipse with sun at one foci
- Kepler’s Second Law of Planetary Motion
  - planets sweep out equal areas in equal times
    - travel faster when closer, slower when farther
- Kepler’s Third Law of Planetary Motion
  - orbital period squared is proportional to semi-major axis cubed
    - \( P^2 = a^3 \)

Newton’s Laws of Motion and Gravity

- Newton’s First Law of Motion
  - body at rest tends to stay at rest and body in uniform motion will stay in straight line uniform motion unless acted upon by an outside force
- Newton’s Second Law of Motion
  - the acceleration of a body is proportional to the force being applied
    - \( F = m \ a \)

Newton’s Laws of Motion and Gravity

- Newton’s Third Law of Motion
  - for every force there is an equal and opposite force (action and reaction)
- Newton’s Law of Gravitational Attraction
  - force is proportional to masses and inversely proportional to the distance squared
    - \( F = \frac{G \ m \ M}{r^2} \)
**Wien’s Law**
- Peak wavelength is inversely proportional to the temperature of the blackbody

**Stefan-Boltzmann Law**
- Energy radiated by blackbody is proportional to the temperature to the 4th power
  \[ E = \sigma T^4 \]

**Kirchoff’s Spectral Laws**
- Kirchoff’s Spectral Laws (empirical)
  - Continuous Spectrum
    - what produces them?
  - Emission Spectrum
    - what produces them?
  - Absorption Spectrum
    - what produces them?

**Kirchoff’s First Spectral Law**
- Any hot body produces a continuous spectrum
  - if it’s hot enough it looks something like this
  - digitally like this

**Kirchoff’s Second Spectral Law**
- Any gas to which energy is applied, either as heat or a high voltage, will produce an emission line spectrum like this
  - or digitally like this

**Kirchoff’s Third Spectral Law**
- Any gas placed between a continuous spectrum source and the observer will produce an absorption line spectrum like this
  - or digitally like this
The Photoelectric Effect

• A prelude to the Bohr atom
  – experiment explained by Einstein, but performed by others
    • what caused this strange result?

Prelude to Bohr

• Einstein used Planck’s quantized particles
  – energy of photon is related to frequency of light, not intensity
    • need high enough frequency to get electrons released from metallic surface
      – $E = hf$

Bohr’s Atom

• Best described the workings of the Hydrogen atom
  – one proton and one electron “around” the proton moving in orbits that are discretized (quantized) so that no intermediate orbits are allowed

Maxwell’s Electromagnetism

• Electricity according to Gauss
  – relates electricity to electric charge
• Faraday’s Law
  – relates electric fields to magnetic fields
• Magnetism according to Gauss
  – relates magnetism to electricity
• Ampere-Maxwell Law
  – relates magnetic field to electricity

Doppler Effect

• A change in measured frequency caused by the motion of the observer or the source
  – classical example of pitch of train coming towards you and moving away

Conclusion

• To understand the stars (and our Sun is a star), galaxies, and the universe at large (cosmology) you need to understand
  – Physics
    • Forces (gravity, electromagnetic, strong, weak)
    • Matter (protons, electrons, quarks, bosons, etc.)
    • Theories, Laws and Effects
      – Newton’s, Kepler’s, Kirchoff’s, Stefan-Boltzmann, Doppler, Photoelectric, Relativity, etc.
  – Chemistry
    • Atoms, elements, molecules and their models (e.g. Bohr)
    – And for Chapter 30, even a little biology