Lec #16 28 September 2011 Chapters 1 & 3

Part 1. Basic Astronomy and Measuring Properties

TODAY: Internal Processes in Gasses.

- Thermodynamics
- Thermal Equilibrium
- The 4 TE Distributions

FRIDAY: Atomic Physics. I.

- The Bohr Atom
- Bound-Bound and Bound-Free Processes

THERMODYNAMICS

- 0[th] Law: defines equilibrium temperature
- First Law: $dE = dW + dQ + d(\text{Internal})$
  - dE is total energy; dW is macroscopic, mechanical energy (“work”); dQ is “thermal energy”
  - What is *thermal energy*? Total kinetic energy of a large collection of internal particles, constantly in motion. Temperature characterizes their state of motion. How? Average kinetic energy/particle.
  - There’s a lot more going on; lumped into “Internal”. These can all be described as potential or kinetic energy. Let’s come up with some examples...

- coulomb interactions between free, charged particles (P)
- orbital motion of electrons (K)
- atomic excitation (P)
- nuclear excitation (P)
- molecular rotations, vibrations (K)
- molecular excitation (P)
- radiant energy (photons) !!
- others?

- Second Law: net effect of all changes is to drive system to “thermal equilibrium”
  - steady state; all processes balanced by inverse processes; energy shared equally among all possible states
  - what drives the changes toward TE?
  - what drives the direction of change?
  - why does (net) change *stop* happening at TE?
  - it’s all about COLLISIONS
- Third Law: defines “absolute zero”

COLLISIONS

- Short range v. Long range
- can collide particles and photons
- conserve Energy, Momentum, # of particles (not photons)
- Let’s run through a bunch of examples....

[classroom discussion]

- *On average*, energy is transferred from high->low
- Keeps happening until every “*degree of freedom*” (think: energy storage mode) has kT of energy
- Collisions keep happening after that, but net energy transfer stops, because all modes have equal energy
- This defines “thermodynamic equilibrium”