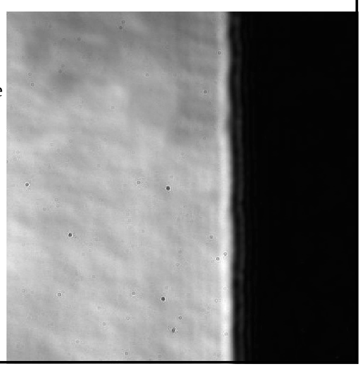
Monday, October 15

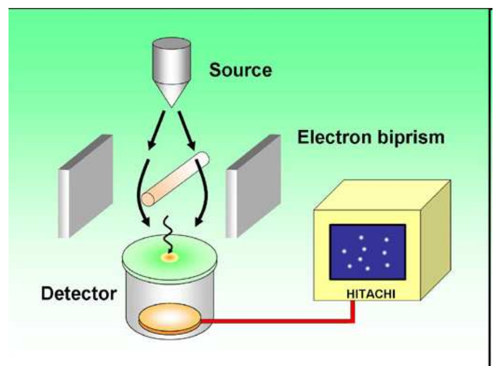
Ford Chs: 4&5

Agenda

- Announce:
  - Read Chs. 6 & 7
- Some cool movies
- Ch. 4
- Ch. 5

- This movie shows the material ejected following a 50-femtosecond laser pulse with a central wavelength of 800 nanometers hitting an aluminum surface. The field is 170 x 170 microns, and there are 12 images (not evenly spaced in time) covering the time from 0 to 9 nanoseconds (the fifth image is at 1 nanosecond).





Ch. 4

- Quarks
  - Similar in some ways to leptons
    - Fundamental
    - Half-integer spin
    - Pointlike
  - Wide range of masses (3 orders of magnitude)
  - Link up in pairs (mesons) or threes (baryons)
  - Fractional charges +/- 1/3 or +/- 2/3
  - Form composite particles of integer charge (0 or +/-1)
  - Baryon number (charge) is conserved (each quark is 1/3 baryon number)
  - Color charge-red, green, blue

Force Carriers

- Particles associated with each of four fundamental forces
- No conservation law applies to them
- Force is communicated via absorption and emmission

Force: Gravity

- Weakest force
- Graviton
  - Never observed
  - Massless
- Weakest force but important because
  - Always adds (only positive charge)
  - Lots of mass in universe
- No relevance to subatomic realm
- Lots of research into why it's relatively so weak

Force: Weak

- W and Z particles
  - Very massive
  - Discovered only in 1983
- Responsible for:
  - Radioactivity
  - Neutrino interactions

Force: E&M

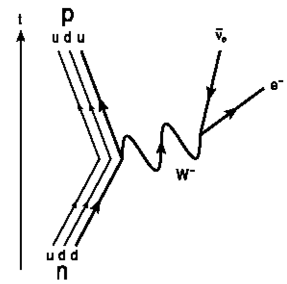
- Massless photon
- Affects only charged particles
- Part of unified electroweak force (Salom,Glashow, Weinberg)
- Huge force, so big that charges tend to equilibrate

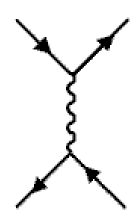
Force: Strong

- Gluons
  - Massless
  - 8 types
  - No electric charge, but have color charge
  - Gluons act on gluons making theory "nonlinear" (hard)
- Holds nucleus together
- Quarks never in isolation…asymptotic freedom

Feynman Diagrams

- Pictorial of particle interactions
- Spacetime diagrams w/ line segments representing particle paths
- Vortices—3 line segments meet
- Key: "every interaction in the world results ultimately from the emission and absorption of force carriers by leptons and quarks"
- Arrows represent either a particle of antiparticle





Review

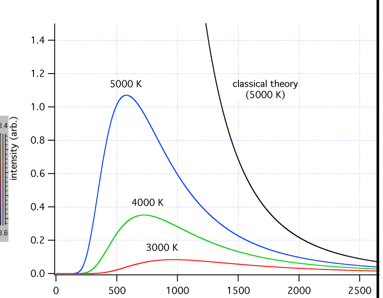
- Covered intro particle physics
  - Standard Model
  - Interactions via absorption/emission
  - Fundamental particles
  - Conservation laws
  - Force carriers
- Now, birth of quantum mechanics

Ch. 5

- Birth of Quantum Mechanics
  - Marriage of light w/ thermodynamics
  - Experiments showed
    - Spectrum depended only on temp, not material
    - Higher temp meant more intensity & higher average frequency
  - Classical Theory predicted spectrum increasing to infinity!
- Planck

$$I(\nu,T)=\frac{2h\nu^3}{c^2}\frac{1}{e^{\frac{h\nu}{kT}}-1}$$

  - Found a fit to data (just like you could in Excel)
  - Tried to explain in terms of classical theory
  - Could match fit if assumed E=hf
  - Planck's constant h found from fit
  - Didn't understand nor accept quantum significance…that's what Einstein did in 1905



Quantum Mechanics

- Key: Size of h sets the scale of what is small
- If someone increased h, then at some points we would behave quantum mechanically
- Birth of quantum mechanics because people couldn't understand/explain:
  - Unpredictable radioactivity
  - Spectral lines
  - Black body radiation

Quantization

- Stuff is quantized
- Properties are quantized:
  - Charge
  - Direction of spin
  - Mass
  - Energy is quantized…ground state