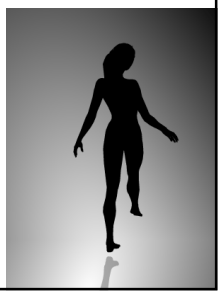
Wednesday, October 17

Ford Chs: 6&7

Agenda

- Announce:
  - Read Chs. 8 & 9
  - Project Ideas due by Halloween
  - Another project idea:

  Modern Physics in Modern Medicine
- Ch. 6
- Ch. 7



Probability Pre-Quantum

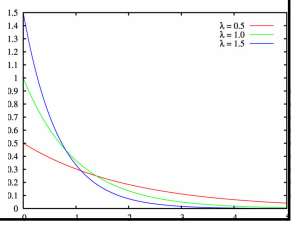
- Physicists accepted probability even before quantum mechanics, but where? And how was it "different" from that in QM?

Probability In QM

- Can be computed precisely
- All that one can compute…fundamentally limited in ability to predict (nondeterministic universe)
- Mathematics describes a probability wave
- Examples:
  - Jumps of electron to different states
  - Radioactive decays

Radioactivity

- Geiger counter makes activity at the level of the nucleus apparent!
- Characterized by half-life
- Wide range of half-lives
- All unstable particles follow same exponential curve



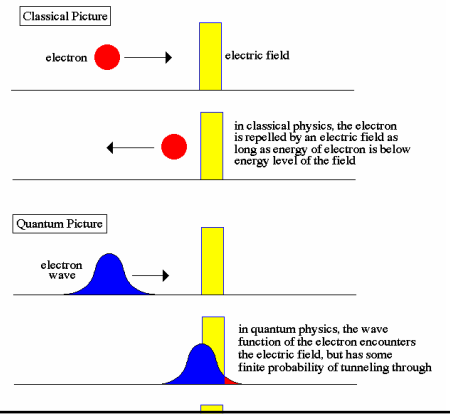
Nuclear Waste (spent fuel)

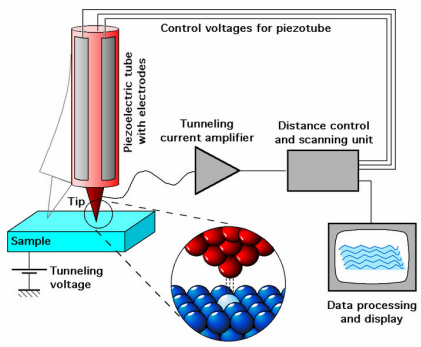
- Lots of nasty radioactive material left over from nuclear reactors
- Half-lives of years to hundreds of years
- Can't fix chemically
- Essentially never safe
- Need nuclear furnace

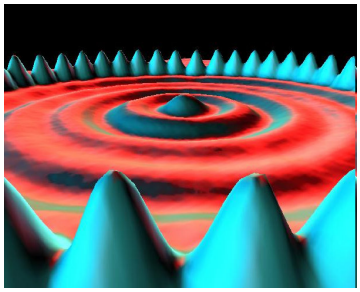
(e.g. Sun, nuclear reactor)

Quantum Tunneling

- Object can pass through barriers which classically they could not







Uncertainty Principle

- Fundamental limit to how well we can "know" certain pairs of quantities
- The better you know one, the less well you know the other
- E.g. position/momentum or energy/time
- Already saw when trying to compress electrons…so knew where they were meant we knew little about momentum
- Will see later on in the book (w/ waves)

Is quantum probability real or just reflect our ignorance?

Fermion/Boson

- Fermions—half-odd-integer spin (e.g. electron, proton, neutron)
- Bosons—integer spin (e.g. photon)
- Very different behavior

Quantum States

- Particles can be in specific states
- Such states have specific, quantized values for certain physical quantities (even if their motions are "fuzzy")
- Each state has certain quantum numbers (n, ℓ, m)

Pauli's Exclusion Principle

- No two fermions exist in the same state
- No two fermions share the same quantum numbers
- Predicted a fourth quantum number for the electron, spin
- Responsible for chemistry, why?

Bose-Einstein Condensate

- Einstein predicted that bosons, at low enough temperature, would share the same state
- Race in early 1990s to create one
- Won by Wieman and Cornell in 1995 (shared in the 2001 Nobel Prize)
- Practical applications?
  - Superfluidity
  - Atom lasers
  - superconductivity

Keys to QM so far…

- Interactions governed by?
  -
  -
  -
- Interactions & Jumps determined by?
  -
- Knowledge of these processes limited by?
  -

Keys to QM so far…

- Interactions governed by?
  - Fundamental particles
  - Absorbing and emitting force carriers
  - Following certain conservation laws
- Interactions & Jumps determined by?
  - probabilities
- Knowledge of these processes limited by?
  - Uncertainty principle