Cosmology

- History of the Universe
  - 13.7 billion years old
    - Light is only viewable for 13.7 billion light-years
  - Big Bang
    - Began as as a dense plasmic universe of quarks and electrons
      - Decoupling
        - Neutral particles (hydrogen atoms) and visible light
        - Cosmic Microwave Background
          - high-frequency photons that are now redshifted by z=2065 and are everywhere
    - created equal amounts of matter and antimatter
  - Euclidean geometry
  - Expansion

- Possible Fates of the Universe
  - Accelerating Universe
    - Due to dark energy, the universe will accelerate faster and faster for infinity
  - Decelerating Universe
    - Due to gravitation, the rate of expansion decreases, then reverses into the "Big Crunch"
      - Gravity: warping of space & time
  - Constant Universe
    - Due to gravity, acceleration decreases, reverses, "crunches", then causes another big bang
    - due to big bang, expansion will not speed up but stay the same speed

- Structure of the Universe
  - Isotropic and homogeneous distribution of galaxies
    - Due to gravitation, galaxies can merge
  - Infinite
    - No center, no edge
    - Space expands between matter
      - evidenced by red-shifted light from supernovae
        - Supernovae provide standard candles, and are the origins of heavy elements (and us)
  - Composition
    - Dark Energy: 74%
      - increases strength with space; does not dilute; accelerates space expansion
    - Dark Matter: 22%
      - does not interact with light; accounts for galaxy filaments
    - Matter: 4%
      - consisting mostly of baryonic matter
        - photons
          - high frequency to low: CMB, gamma, xrays, ultraviolet, visible, infrared, microwave, radio,
          - carry energy; can also be seen as waves
        - fermions
          - quarks
            - up quarks have charge 2/3+
            - down quarks have charge 1/3-
            - proton: 2 up quarks, 1 down quark
              - +1 charge, defines elements
            - neutron: 1 up quark, 2 down quarks
              - no charge; purpose unresolved
          - leptons
            - electrons
              - -1 charge, defines elemental behavior
            - neutrinos
              - created in supernovae
            - muons
              - heavy electrons that prove the Spec. theory of relativity
      - unjustified lack of antimatter (antiprotons, positrons, etc.)

- affected by 4 forces
  - strong force
    - holds quarks together; works over small distances
  - weak force
    - holds electrons in atom
  - electromagnetic
    - binds electrically charged particles
  - gravity
    - "the acceleration you feel due to the curvature of space-time"
    - possibly due to gravity waves or gravitons, or both
    - only works with large enough masses
    - extremely weak compared to other forces and loses strength with distance

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