The Cosmic Landscape

Earth

- Base from which we observe
- Many geologic processes:
  - Lava flow; plate tectonics
  - Magnetic field generation
- Serves to compare/constrast w/ other planets
- Is Earth unique? Central?

The Moon

- Earth's only moon
- 384,000 km away
- ¼ Earth's diameter, 1/80 Earth's mass
- Different from Earth
  - Airless
  - Pitted surface
  - Ball of rock
- Farthest into space mankind has reached

Other Planets

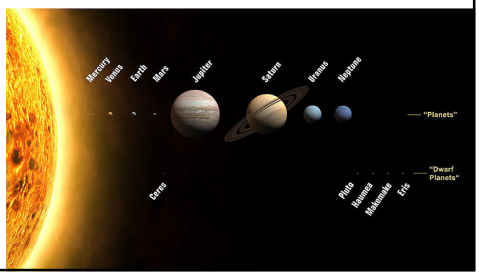
- Mercury—airless, scarred surface
- Venus—acid rain, hot
- Mars—canyons and deserts
- Jupiter—atmospheric storms, red spot
- Saturn—rings of icy fragments
- Uranus—dark rings around tipped over spin
  - Neptune—deep blue, methane clouds

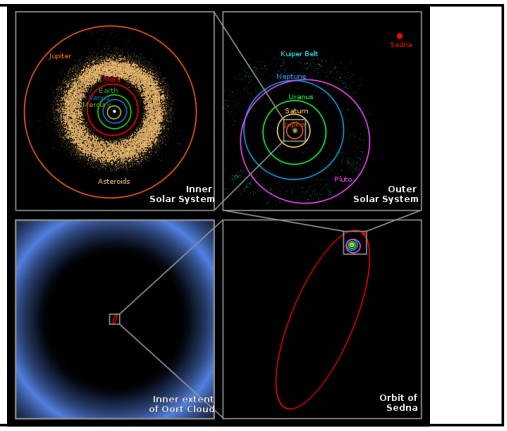
Sun

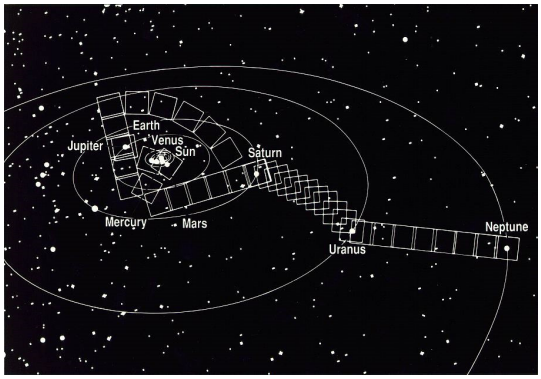
- Closest star
- 300,000 times the mass of Earth, > 100 times diameter
- Nearly all the mass of the solar system
- Its nuclear-generated energy warms the planets
- Mid-life crisis—will burnout in 5 billion years

Solar System

- Sun, planets, dwarf planets, moons, asteroids, comets
- 4 billion miles to Pluto's orbit
- Mostly flattened disk which includes planetary orbits







Astronomical Unit

- Proliferation of units depending on scale
- Average distance between Earth and Sun…93 million miles

Milky Way

- Several 100 billion stars
- Flattened like the solar system
- Solar system moving at 140 miles/sec w/r/t center of Milky Way
- 240 million years to orbit
- Immense clouds of gas and dust
- ~100,000 ly in diameter
- Sun is about 30,000 ly from center

Light Year

- Measuring distances with units of time
- Speed of light in empty space—c, a constant
- 3x10^8 m/s or 186,000 miles/s
- 1 ly—distance light travels in one year
- 6 trillion miles (6x10^12 miles)

Galaxy Clusters and Superclusters

- Galaxies cluster together
- Milky Way in the Local Group
- Galaxy clusters cluster into superclusters
- The Local Group is part of the Virgo Supercluster

Universe

- 14 billion years old
- 14 billion ly defines roughly the size of the visible Universe
- Structures at all levels
- Can there be other Universes?

Gravity

- Anything with mass or energy attracts all other objects
- Very weak, importantly on large scales because it adds together and because of large masses

Other Forces

- Fundamental forces—not defined in terms of something else (e.g. friction, someone's fist, etc)
- Four fundamental forces:
  - Gravity
  - Electromagnetism—force between electric charges and magnets
  - Weak—plays a role in radioactive decay of atoms
  - Strong—holds nucleus together

Atoms

- Smallest unit of matter
- Two parts:
  - Electrons
  - Nucleus—contains the nucleons
    - Protons—positive charge
    - Neutrons—no charge

Much unknown

- Contents of universe:
  - Dark matter—can't see except for the gravitational pull
  - Dark energy—exotic, invisible stuff that drives Universe to expand
- Neutrinos
- Big Bang
- End of universe? Big crunch? Rip?

Scientific Method

- Usually:
  - Hypothesize
  - Test
  - Refine idea and repeat
- Bit different for astronomy since hard to repeat a test
- Flaws, mistakes, and fraud happen…science is an open process that generally self-corrects