Introduction to Astronomy

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MWF 12-1 W-3.502
Star: A glowing ball of gas that generates heat and light through nuclear fusion

Nearest star= Our Sun

Evolution of a star on H-R diagram
Planet: A moderately large object which orbits a star; it shines by reflected light. Planets may be rocky, icy, or gaseous in composition.
Moon: An object which orbits a planet.
Star-forming nebulae: Clouds where young stars are forming from dense cold gas and where hot massive young stars are heating and ionizing the gas.

Part of Eagle Nebula
(5 ly across)

Orion Nebula
Planetary nebulae: Brightly glowing gas produced when low-mass stars die, cast off their outer layers of gas, and the remaining hot core ionizes and heats the gas surrounding it.

Connection to white dwarf?
Supernova remnant: Expanding hot clouds of gas produced when a high-mass star undergoes a supernova explosion at the end of its life. The gas is enriched with heavy elements like C, O, S.

- Cygnus loop SN remnant; 130 ly; optical
- HST/optical: Visible ionized O, Atomic H, ionized S

Crab Nebula; VLT/ Optical
First observed in 1054
Galaxy: Collection of few times \((10^8 \text{ to } 10^{12})\) stars orbiting a common center and bound by gravity. Made of gas, stars, dust, dark matter.

Many types of galaxies with different structure, and amounts of gas, stars, SF. Spirals (barred and unbarred), Ellipticals, Dwarfs, Irregular, Peculiar/Interacting, etc
A spiral galaxy can appear different due to different inclinations

NGC 6744
Spiral, Face on

NGC 4414
Spiral
Moderately inclined

Sombrero NGC 4594
Spiral, large bulge, dusty disk
Edge on
**Spirals:** Disk galaxies with significant amounts of gas, dust, ongoing star formation. They can be unbarred or barred. Bars play key role in galaxy evolution.

**Ellipticals:** Spheroidal systems, smooth appearance. Have little gas, dust, and recent SF
Irregular galaxies: Galaxies which have irregular, peculiar morphologies in terms of gas dust and SF. Often dusty and patchy.

LMC; Irr; 30,000 ly across

NGc 1313; Irr; 50,000 ly across

SMC; Irr; 18,000 ly across
**Interacting galaxies:** Galaxies which are interacting with others. Interactions can induce dramatic changes in morphology.

- **Polar ring galaxy**
  - NGC 4650

- **Cartwheel galaxy**
  - Head-on collision

- **Ring galaxy**
  - AM 0644-741
  - 50,000 ly across