**Star Formation**

- Star Formation
  - Stars form from large interstellar clouds of gas and dust...
  - Nebula
  - Stars are found to range in mass from 0.1 of solar mass to 30 times solar mass
    - Below 0.08 solar mass
    - Brown Dwarfs – “failed stars”
  - Collapse around dense part due to gravity
  - Central region becomes hot; radiates in IR
  - Can be seen with IR telescopes through surrounding gas and dust
  - Rotates faster; causes bipolar flows

**General Properties**

- Observed fact: massive stars are more luminous than low-mass stars
- Higher mass - stronger inward pull of gravity
- Need higher internal pressure for balance
- Higher internal temperature needed to maintain higher pressure
- Therefore high-mass stars are hotter

Being hotter, they radiate more energy

\[ L = M^3 \]

**South Pole Infrared Explorer**

**South Pole Infrared Explorer**

- This eerie, dark structure, resembling an imaginary sea serpent's head, is a column of cool molecular hydrogen gas (two atoms of hydrogen in each molecule) and dust that is an incubator for new stars. The stars are embedded inside finger-like protrusions extending from the top of the nebula. Each "fingertip" is somewhat larger than our own solar system.
Star Formation - Continued

- Protostars are stars in the process of formation.
- Herbig-Haro objects form where bipolar flows meet surrounding cool gas
- T Tauri stars
  - Young objects
  - Enveloped in gas & dust
  - Show large, erratic variations in brightness
  - Have powerful star-spots
- Bok Globules
  - Seen in star-forming clouds
  - Protostars still within gas cocoons
  - Appear dark against glowing gas

Arrival on Main Sequence

- A Star is Born when nuclear reactions start
- Temperature high enough to fuse protons
- Internal heat source
  - Provides needed temperature and pressure
  - Replenishes lost energy
- Gravitational contraction stops
- Will use the hydrogen in core but not outside (amounting to 10% of mass)
Life on the Main Sequence

Main Sequence Lifetime

Available fuel ÷ rate of use

Sun has a main-sequence lifetime of about 10 billion years

Less massive stars live longer