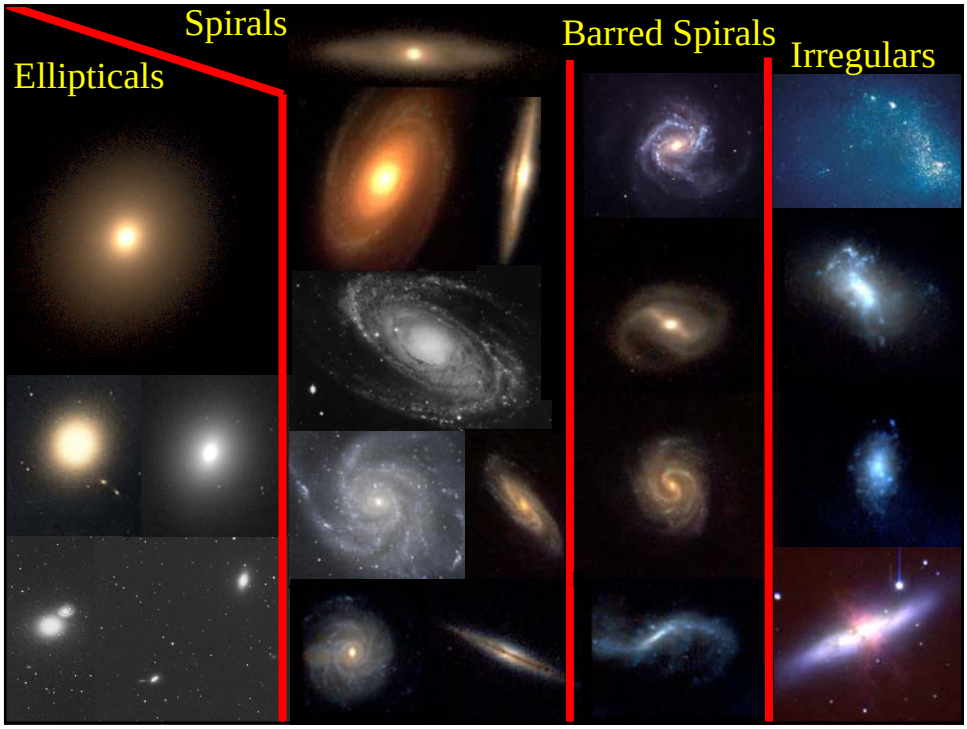
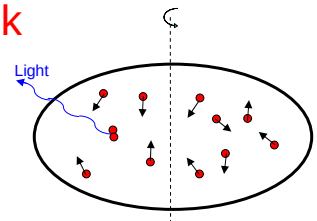
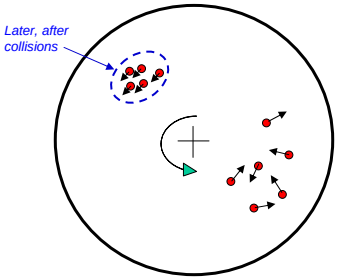


Why a collapsing gas cloud forms a spinning disk

- Collisions convert kinetic energy to light
  - Light carries away energy.
  - Nebula gets cooler
  - Contracts because of gravity.
- But: *angular momentum*
  ➔ cannot collapse in direction perpendicular to spin axis
  ➔ disk.



Side view -- as many atoms move up as move down.



Top view -- net rotation superimposed on random motions.

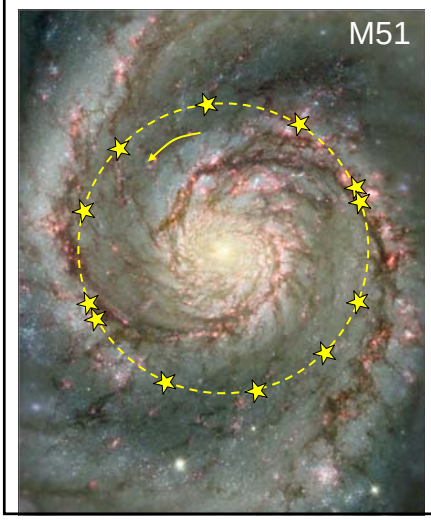
See [Fig. 6.15]

Spiral Arms

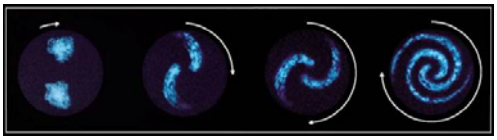
Regions of higher density in disk

➔ higher gas density

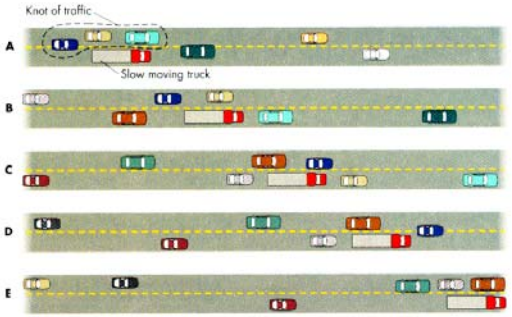
➔ star formation



How are arms formed?



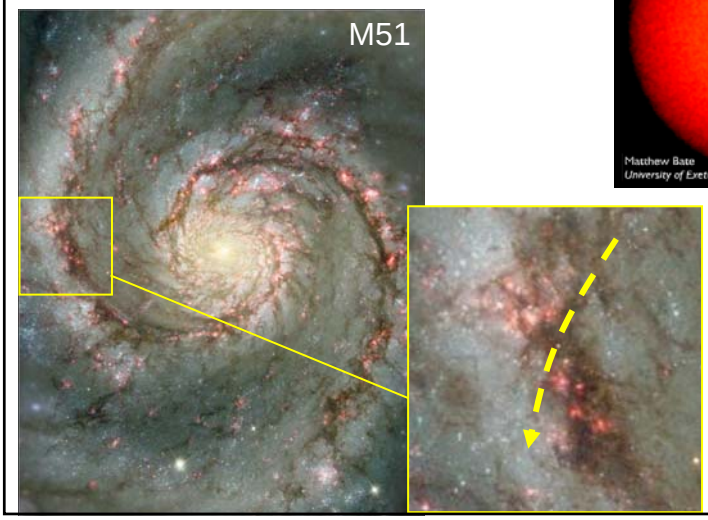
Differential rotation



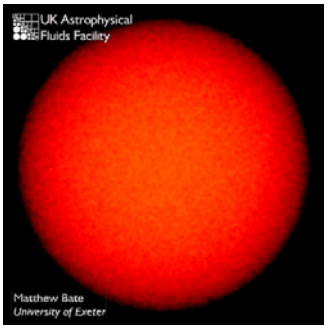
Density Wave

Giant Molecular Clouds

Dense concentrations of H_2, CO and other molecules, **+** dust.

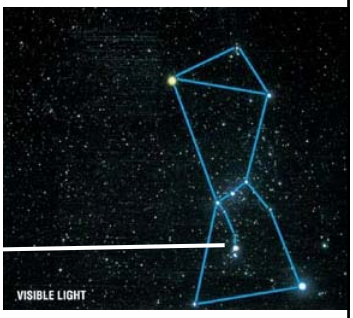


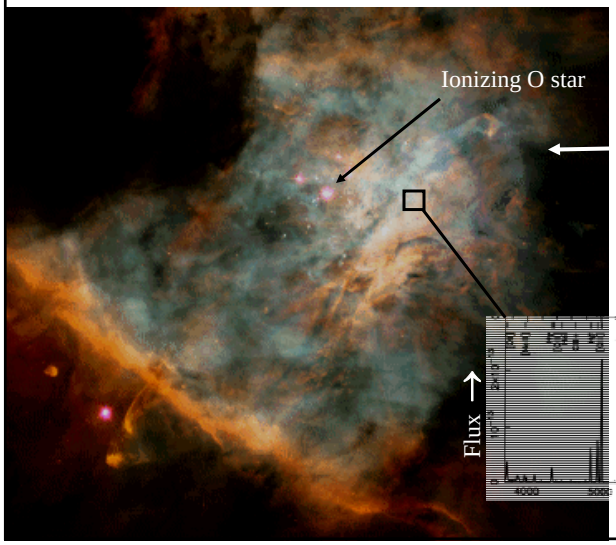
Star Formation



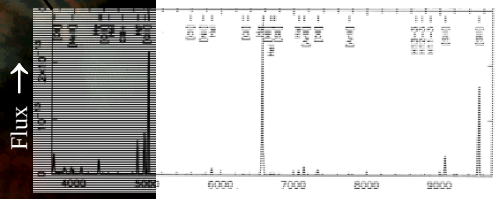
Example: The Orion Nebula

- 1500 LY away from us
- The central "star" in Orion's sword.

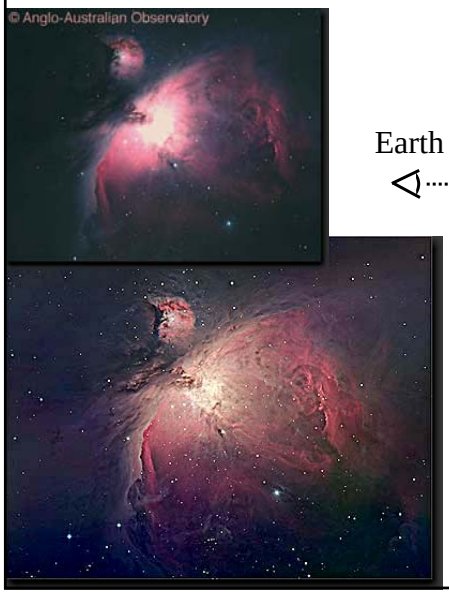


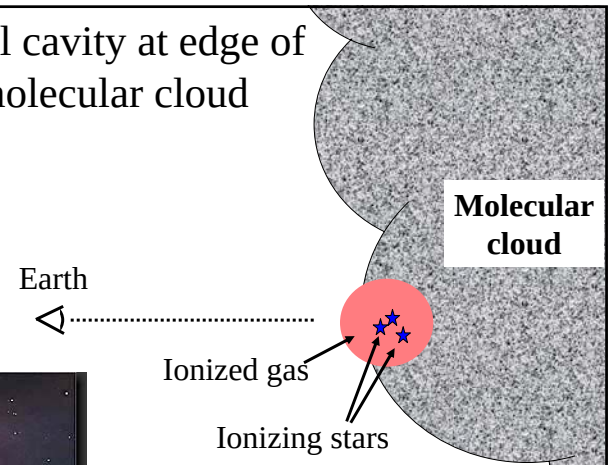


An "H II" region:
ionized gas excited by recently-formed O stars.



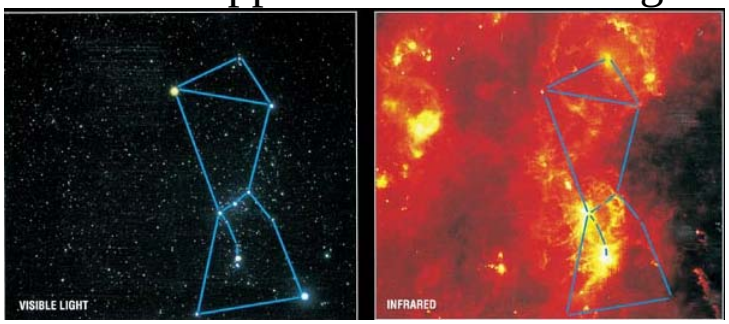
HII region is small cavity at edge of much bigger molecular cloud





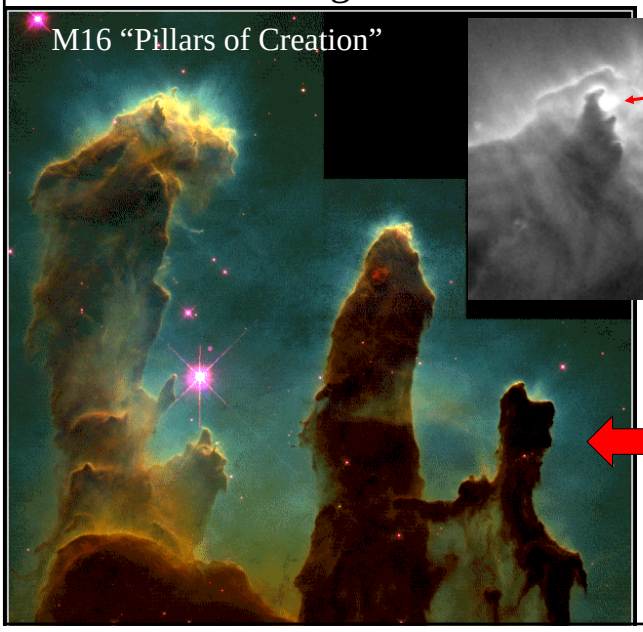
- Ionized region has "blown out" of near side of dense cloud.
- Many more similar star-formation regions buried deep inside cloud.

Full extent of star-formation region becomes apparent in infra-red light.



- 100 LY across
- 200,000 $M_{\odot}$
- Only a few of its stars close to the near edge can be seen in visible light.
  - Infrared light penetrates dust & shows many more stars.

Light from newly-formed stars "evaporates" surrounding molecular cloud material

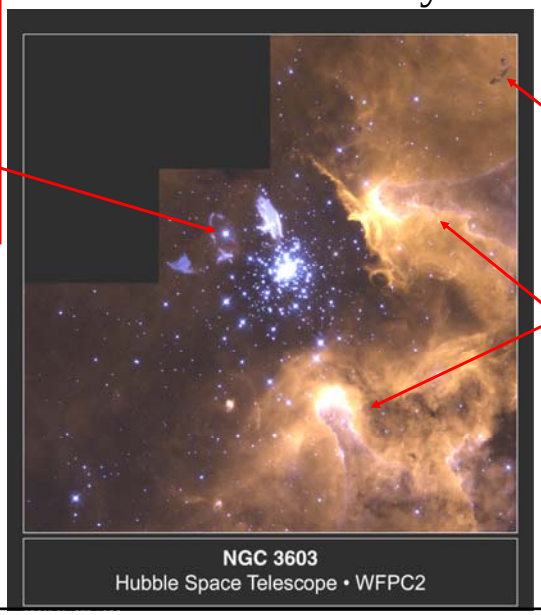


EGGs: Evaporating Gaseous Globules.

Dense molecular clouds being eroded away by ionizing radiation from newly-formed stars.

A recently formed cluster of stars in our own Galaxy

This more massive star has already gone through its life cycle and blown off its outer layers.



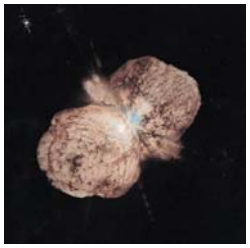
"Bok globules" still condensing into stars.

Dense fingers of molecular gas, just like in M16.

http://hubblesite.org/ then search for "NGC 3603"

Stars return processed material to the Interstellar Medium

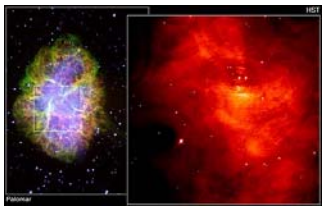
Planetary Nebulae



Eta Carinae
An unstable high-mass star

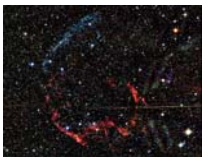
Supernova Remnants

Crab Nebula.
1054 AD.
Ripples are due to energy being dumped into gas by beam from pulsar.

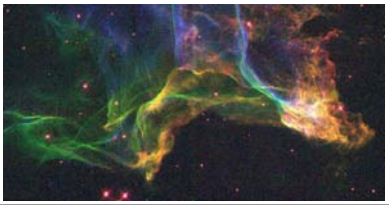


We expect one supernova in Milky Way every 25-100 yrs.

IC 443
8000 yrs old

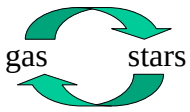


Cygnus Loop
20,000 yrs old.



The Galaxy

- Originally all gas
- Now ~10^{11} stars similar to our sun.
- Stars are born, evolve, then die.
- Material processed through stars.
  - Galactic ecology



- This is source of all chemical elements

  except Hydrogen (H)
  Helium (He)
  Lithium (Li)

  made in "big bang"