Handout 23: Star Formation

Review – collapse of a star

- Conditions for collapse (Jeans)
 - If gravity > thermal pressure collapse
 - i.e. not hydrostatic equilibrium
- \Box For a given cloud with (ρ ,T)

• M > M_{Jeans} ~
$$T^{3/2}\rho^{-1/2}$$

- Note: such regions are found in molecular clouds
 - Masses ~ 1 to 100 solar masses

□ Therefore, we expect stars to start forming

Collapsing star

Initial collapse proceeds on f-f timescale

- □ ~ 10,000 y
 - Very quick, c.f. K-H timescale of 10 My
- Such clouds very opaque
 - Dust extinction hides regions from direct view
 - We're just now learning about the details
- Major complication Angular momentum
 - During collapse, rot'n must increase to conserve angular momentum
 - Eventually, gravity can't overcome centripetal acceleration
 - Collapse stops in direction perpendicular to spin axis
 - A **disk**, rather than spherical star, forms

Examples of star formation

Rosette Nebula

- Later stage, stars have formed
 - Hot, O and B stars emit UV radiation
 - Remnant gas becomes ionized
 - □ HII region
 - □ Gas glows in recombination lines of H
 - Balmer series
 - □ Collisionally excited levels of OII, OIII, NII, etc.
 - Forbidden lines, [OIII] at 5007 Angstroms
- □ Note thin, dark lanes
 - Dust extinction
 - High density regions, optically thick
- Cloud is very non-uniform



Rosette nebula (NGC2237, <u>NOAO)</u> in the constellation Monoceros (the Unicorn). hydrogen alpha, OIII oxygen, and SII sulfur respectively red, green and blue.

The Rosette is a prominent star formation region, glowing due to ultraviolet light from the young, hot, blue stars whose winds also cleared the central hole. It is enormously large on the sky, covering more than six times the area of the full moon.

Orion Nebula (Handout 21)

Trapezium O stars excite nebula

- □ 1 arcminute away, the core of the Orion Molecular Cloud
 - Calculate distance, Orion is 500 pc distant
- □ Intense 10 micron emission → heated dust
 - Internal power sources
- Becklin-Neugebauer object
 - Very young B star
 - □ 50 mags of visual extinction
- Kleinmann-Low nebula
 - Cluster of newly forming stars
- O star HII region may trigger new star formation
 - Shock compression