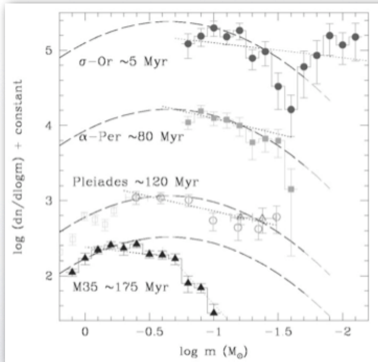
Brown dwarf formation

December 4, 2006

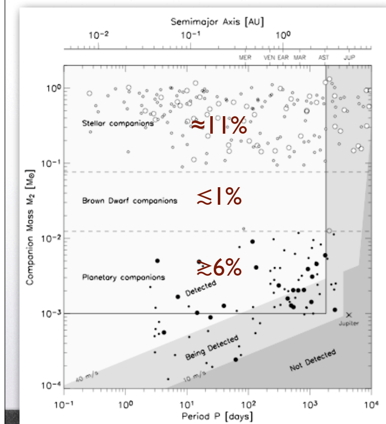
Formation

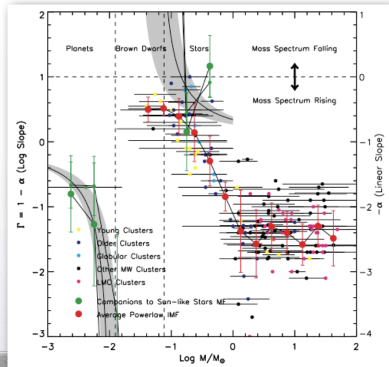
- Ingredients: Initial conditions:
  - density: gas, stars
  - metallicity
  - magnetic field
- Consequences:
  - IMF
  - disks, jets
  - binarity: mass ratio, fraction
  - kinematics
  - spatial distribution



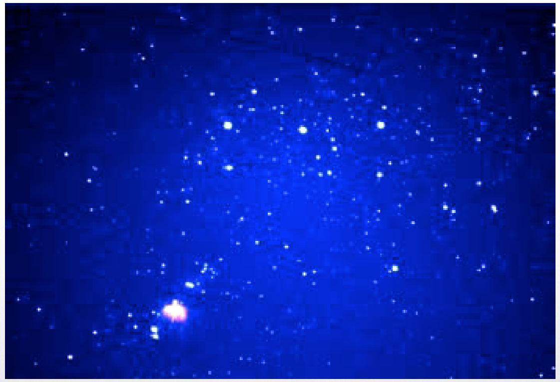
Chabrier (2003)

Binarity





Grether & Lineweaver (2006)



http://haydenplanetarium.org/resources/ava/page/index.php?file=S0801starform

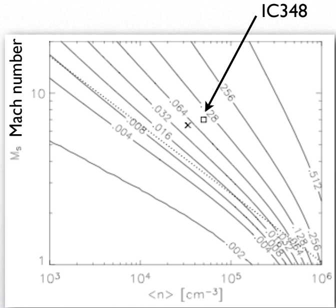
Core collapse models

- Jeans (1902,1928), Hoyle (1953), Low & Linden-Bell (1976),…
- The Jeans mass is:

$$M_{\mathrm{Jeans}} \propto \frac{c_s^3}{\sqrt{G^3 \rho}}$$

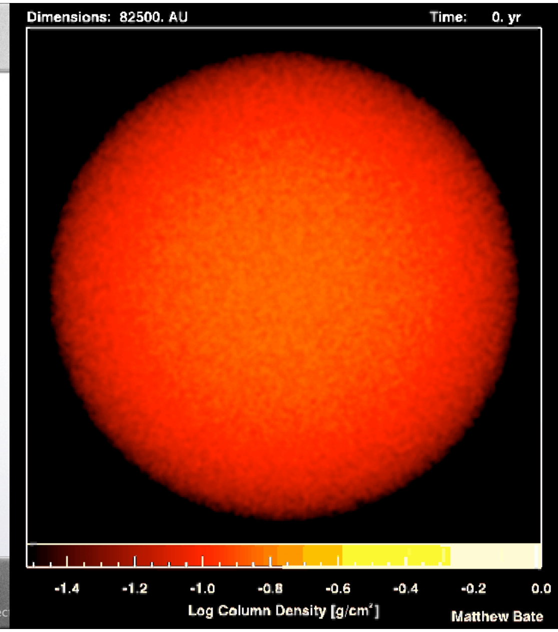
- also used, the Bonnor-Ebert mass:

$$M_{\mathrm{BE}} = 0.33 \left(\frac{T}{10\mathrm{K}}\right)^2 \left(\frac{n}{10^3\,\mathrm{cm}^{-3}}\right)^{-1/2} \mathrm{M_{sun}}$$



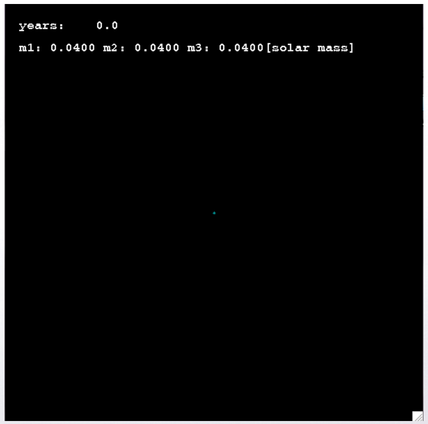
Padoan & Nordlund (2004)

Turbulence



The ejection scenario

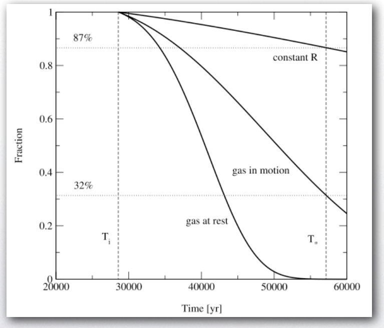
- Most triple systems are unstable
- Ejection occurs as a radioactive decay

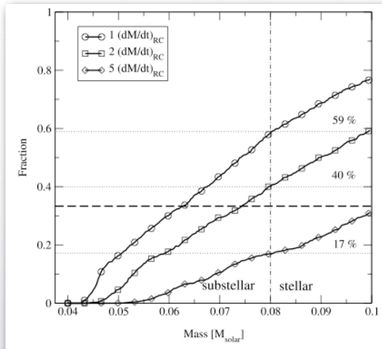


Umbreit et al.

Input parameters' sensitivity

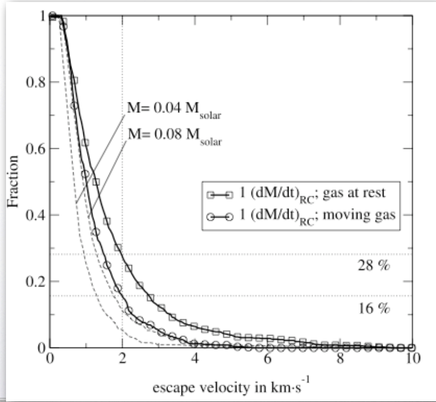
- Importance of accretion





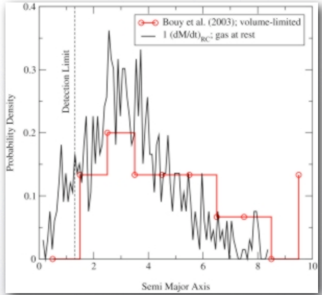
Umbreit et al. (2005)

Escape velocities



Umbreit et al. (2005)

Binaries in the ejection scenario



Umbreit et al. (2005)

Disks in the ejection scenario

- Truncation is expected, but really observed
- Truncation depends on encounter type:
  - hyperbolic: not efficient
  - parabolic: efficient, expected in large clusters

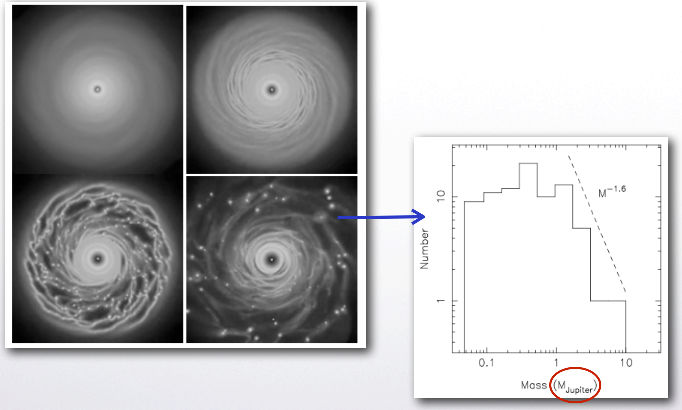
The photo-erosion scenario

- A bright star (typically O or B star) errodes a collapsing core

$$M \simeq 0.01\,\mathrm{M}_\odot \left(\frac{a_1}{0.3\,\mathrm{km\,s^{-1}}}\right)^6 \times \left(\frac{\dot{N}_{\rm LyC}}{10^{50}\,\mathrm{s^{-1}}}\right)^{-1/3} \left(\frac{n_0}{10^3\,\mathrm{cm^{-3}}}\right)^{-1/3}$$

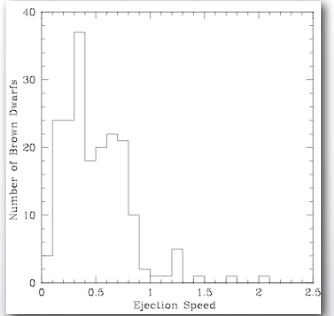
- e.g. Kroupa & Bouvier (2003), in Orion

Fragmentation in circumstellar disks



Rice et al. (2003)

Fragmentation in circumstellar disks



Jiang et al. (2004)

Next lecture

- Monday, December 11, 15:15
- Brown dwarfs in their infancy:
  - Kirkpatrick et al., 2006, ApJ 639, 1120: young field BD
  - Mohanty et al., 2005, ApJ 626, 498: accretion
  - Sterzik et al., 2004, A&A 427, 245: disk evolution