

Introductory Astronomy

Week 3: Solar System(s)

Clip 3: The Solar Nebula

In the Beginning

- Solar System begins in **molecular cloud**
- **Fragmentation** and **Gravitational Collapse** triggered by nearby **Supernova?**
- Fragment of **size 2000-20,000 AU** **mass** $3000M_{\odot}$
- Sun likely member of **open cluster** now dispersed
- Denser regions within cloud **collapse** when gravity overcomes **pressure**
- **Jeans instability**

$$k_B T \sim \frac{GMm}{R}$$

Making a Cluster

Density

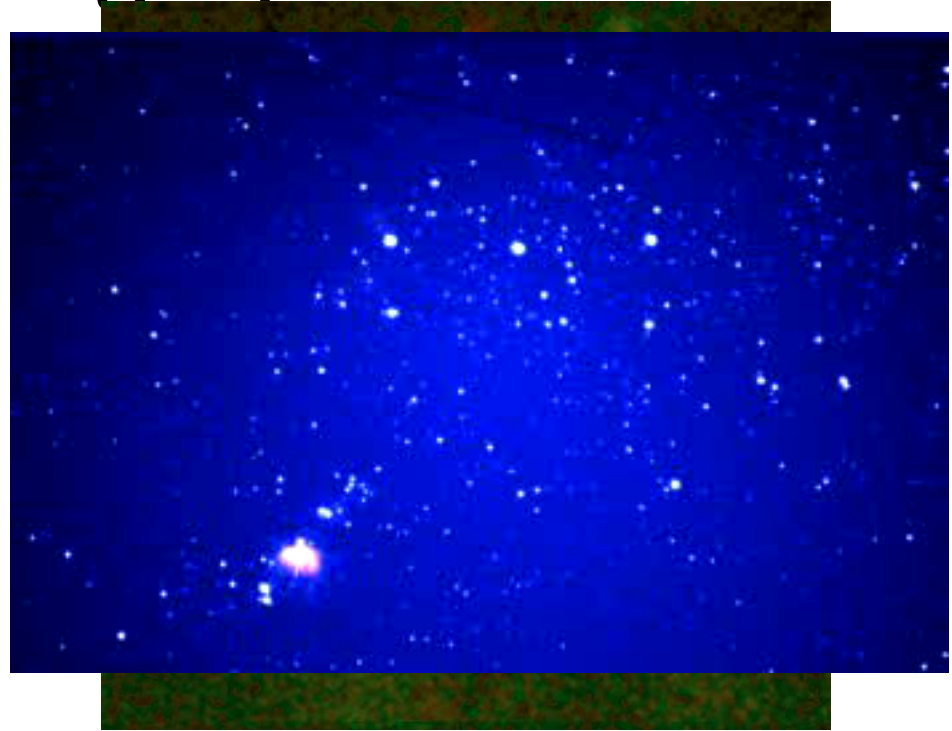


Temperature



Spinning Up

- Collapse speeds up initial rotation
- Collapse in plane inhibited by centrifugal barrier
- Nebula flattens into protoplanetary disk of radius $\sim 200 \text{ AU}$ within 100Ky

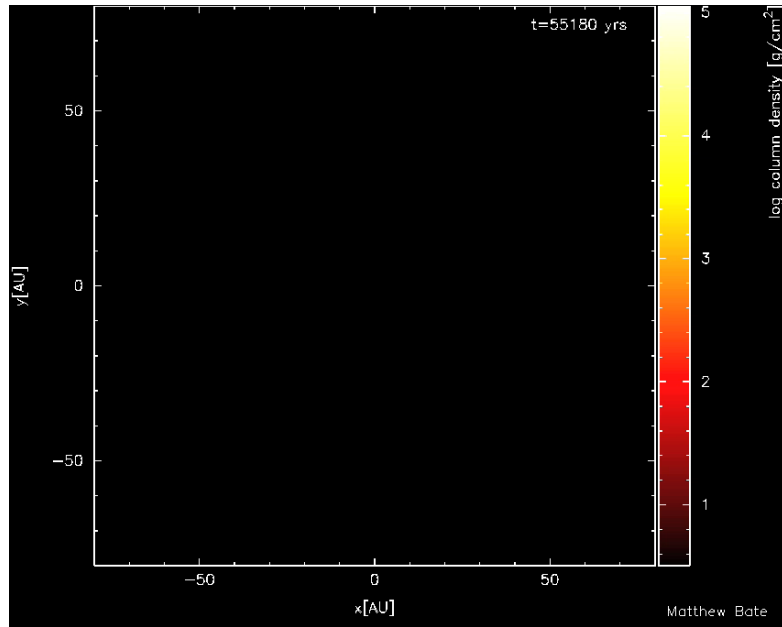


Heating Up

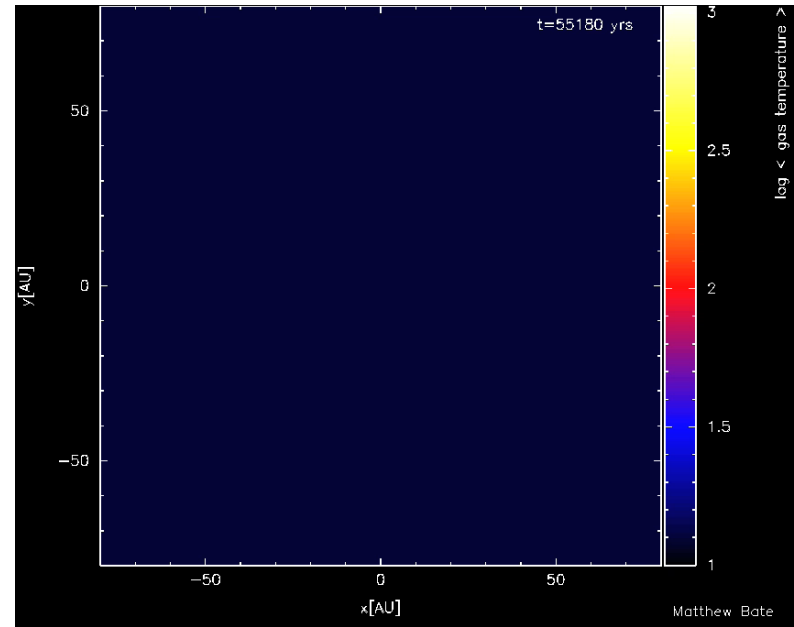
- Friction converts gravitational potential energy into heat (Kelvin-Helmholtz)
- Temperature and density highest in center
- Protosun surface temperature 2000 K
- Disk contains Hydrogen, Helium, trace metals in molecular form
- In 10My T-Tauri wind blows away gas and dust

Making a Star

Column Density



Temperature



Credits

- Astronomy Animations: University of Nebraska-Lincoln Astronomy Education Group <http://astro.unl.edu/>
- Concordia diagram, as used in U-Pb dating, with data from the Pfunze Belt, Zimbabwe. Diagram own work using data points from: Vinyu, M.L., Hanson, R.E., Martin, M.W., Bowring, S.A., Jelsma, H.A. and Dirks, P.H.G.M. 2001. U-Pb zircon ages from a craton-margin Archaean orogenic belt in northern Zimbabwe. Journal of African Earth Sciences, 32, 103-114.
http://en.wikipedia.org/wiki/File:Pfunze_belt_concordia.png
- HH-30 Image: NASA/STScI
<http://hubblesite.org/newscenter/archive/releases/1995/24/image/e/>
- Cluster and Protostellar Disk Animation: Professor Matthew Bate, University of Exeter, UK <http://www.astro.ex.ac.uk/people/mbate/Animations/>
- Demonstration Video: Duke Media Services