Birth of Stars and Planets

**Birth of Stars**

- Pleiades Star Cluster

**and Planets**

- Protoplanetary Disks in Orion

**Star and Planet Birth**

- Look at how stars are formed out of big and cold molecular clouds
- Explore how young stars interact with their environments
- Consider the formation of planets in new solar systems

**STAR BIRTH within big cold clouds**

- Start with clouds of cold, interstellar gas
- Molecular clouds -- cold enough to form molecules $T=10-30K$
- Often dusty
- Collapses under its own gravity

**Recurring theme in forming stars:**

Conservation of energy and angular momentum

- 1. Collapse due to gravity increases the temperature. If thermal energy can escape via radiation (glowing gas), collapse continues
- 2. If thermal energy is trapped, or more energy is generated due to fusion, collapse is slowed

**Collapse from Cloud to Protostar**

- First collapse from very large, cold cloud -- cold enough to contain molecules (molecular clouds)
- The cloud fragments into star-sized masses
- Temperature increases in each fragment as it continues to collapse
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**Dusty, dark molecular cloud regions**

**Stellar nurseries start as cold places**

**Gravity, Spin, Magnetic Fields**

**Collapse from large, cold cloud**

Conservation of Angular Momentum: material spins faster

Disks and Jets form around protostar

**Collapsing cloud spins up, forms star, disk and jet**

**Jets from young stellar objects (YSOs)**

HST: actual edge-on disk, jet
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3 → 4: As core temperatures reach millions of degrees, fusion begins and stabilizes – star joins main sequence

Galaxy color

- 1 blue O → 100 red M
- Lum O = 10,000 solar luminosities
- Lum M = 0.001 solar luminosities
- What color is the starlight from the star forming spiral arms in our galaxy?
  - A. Blue
  - B. Orange
  - C. Red

Stellar nurseries yield lovely sights

- Hot new blue main sequence stars
- Pink hydrogen gas
- Black sooty dust
- Blue nebulae are reflections of starlight from massive blue stars

The Orion Star Forming Complex

- A. Blue
  - 100 times more M stars, but each is 10,000,000 times fainter than an O star
  - Massive blue stars dominate the light
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Infrared view of winter sky (10 - 120 µm)

IRIR

Carbon Monoxide measurements

Orion Molecular Clouds

Orion Nebula

HST 16

Irradiated proto-planetary disks in Orion

HST 10

HST 17

Eagle Nebula: cold dark clouds are eroded by intense starlight

HST icon

Images from:

Hubble Space Telescope
Spitzer Space Telescope
ESO Very Large Telescope

The Cosmic Perspective Textbook
The Birth of Stars and Planets

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