BRIEF

HR DIAGRAM

Stellar Life Interstellar Medium to the Main Sequence

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Overview:

This lesson will cover an overview of the stellar life cycle from the Interstellar Medium (ISM) to Zero Age Main Sequence (ZAMS).

It’s important to understand the stellar life cycle for any astronomical research project.

For example, a T Tauri Variable Star is associated with the birth process before the Main Sequence. RR Lyrae stars are in the Instability strip after a star has departed the Main Sequence.

Understanding of the stellar life cycles will help in your understanding of stars overall.

NOTE: Many of today’s images will come from the outstanding book *Astronomy Today* by Chaisson and McMillan (Pearson Prentice Hall, Inc).

Credit: NASA

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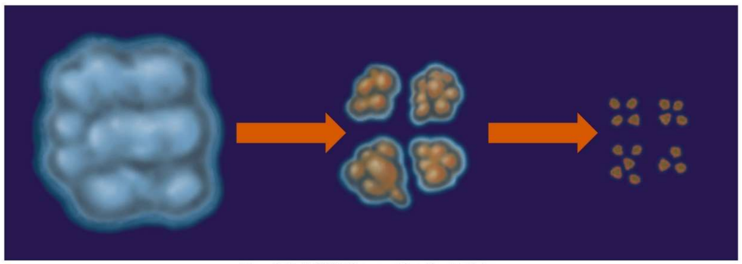
Stage 1: Interstellar Cloud Starts to Contract

- Interstellar cloud starts to contract, triggered by shock or pressure wave from nearby star, supernova, galaxy collision, or density wave. As it contracts, the cloud fragments into smaller pieces.



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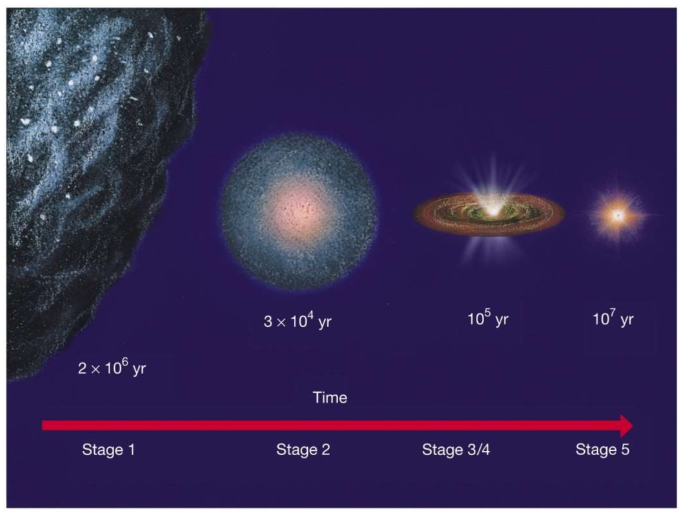
Stage 2: Collapsing Cloud

- Once the cloud density is high enough, there is no further fragmentation.
- 1-2 Solar Mass, cool temperatures, and size ~100x Solar System

Stage 3: Fragmentation Ceases. Begins to resemble a star – Protostar w/ Photosphere

- The interior of the fragment has begun heating
- Interior Temp: 10,000 K.
- Size: Solar System

- **Stage 4:**
  - ~100,000 years later
  - Makes its first appearance on the H–R diagram.
  - Interior Temp: ~1,000,000 K
  - Size: ~ Mercury's Orbit
  - Planetary formation has begun
  - Not in hydrostatic equilibrium
  - Heating from the gravitational collapse not Hydrogen Fusion.



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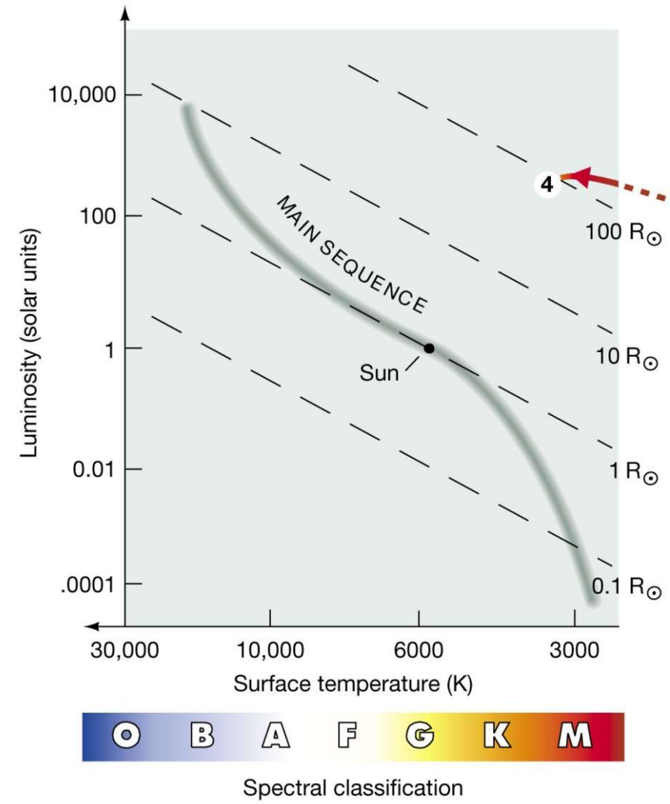

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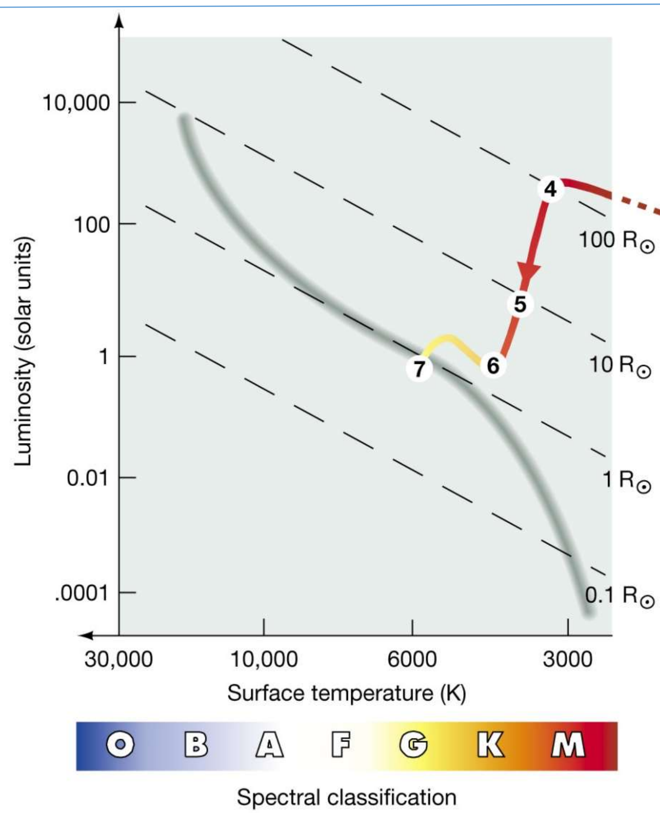
- **Stage 5: Protostellar Evolution**
    - Size: ~10x the Sun
    - Interior Temp: 5,000,000 K
    - Evolution slows due to slowing ability to radiate heat into space
- **Stage 6: Newborn Star**
    - Time: ~10M yr
    - Size: 1,000,000 km
    - Interior Temp: 10,000,000 K
    - Hydrogen to Helium Fusion can begin
- **Stage 7: Main Sequence:**
    - Interior Temp: 15M K
    - Will stay on the Main Sequence as long as there is Hydrogen Fusion in the core.

- **IMPORTANT:** The place that a star arrives on the Main Sequence, is where it will stay as long as it is there.
    - It **cannot** travel up and down the Main Sequence.
    - It is where it is.



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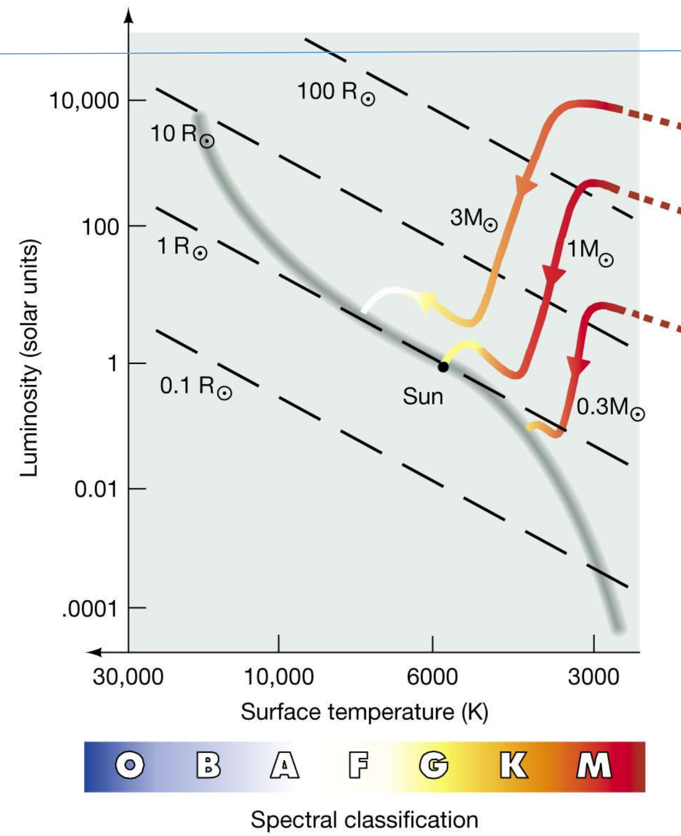
How Mass impacts HR position

Higher & Lower Mass Stars?

- They travel similar paths, but they wind up in different places on the main sequence.

Can stellar clouds be too small?

- A protostar must have 0.08 the mass of the Sun (which is 80 times the mass of Jupiter) in order to become dense and hot enough that fusion can begin.
- Brown Dwarfs



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Summary

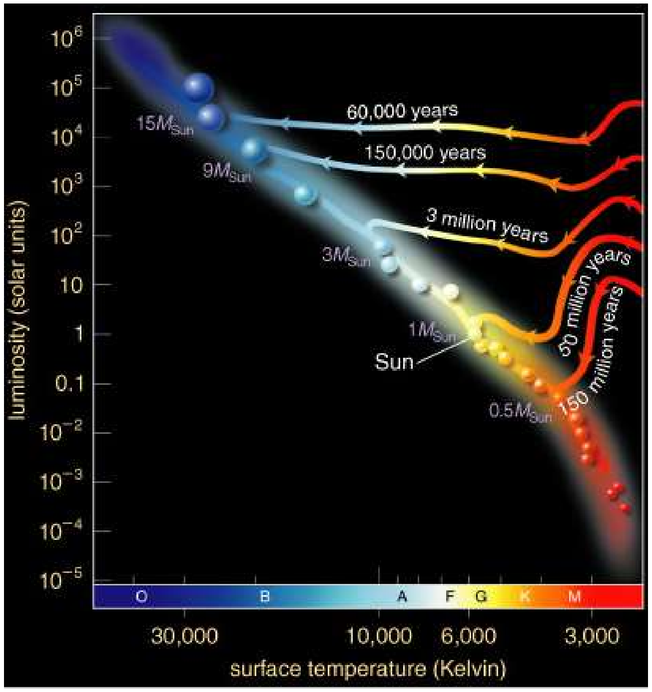
The process from the ISM to the ZAMS is how a star forms.

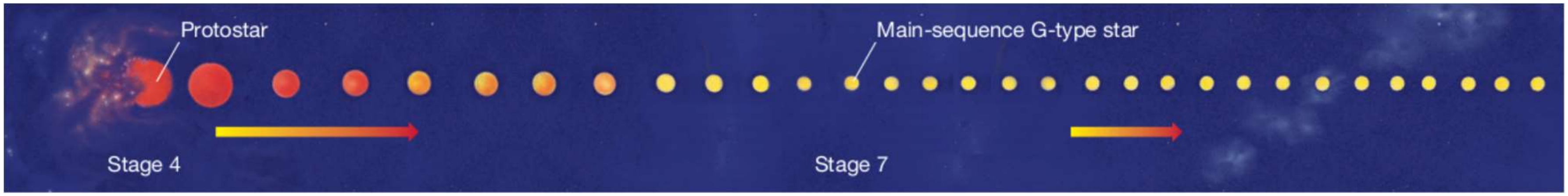
These theories are, currently, the best known idea of how stars form.

Some variable stars, T Tauri, study protostars in this ISM – ZAMS environment.

Studies like these are important to refine stellar birth theories.

The next video will cover ZAMS through Stellar Death.





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Questions?

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