BRIEF

STARS

Difference Between Nova and Supernova

Overview

The terms Nova and Supernova are sometimes used interchangeably.

However, there is a distinct difference. This is important to understand when performing Photometry work on these types of events.

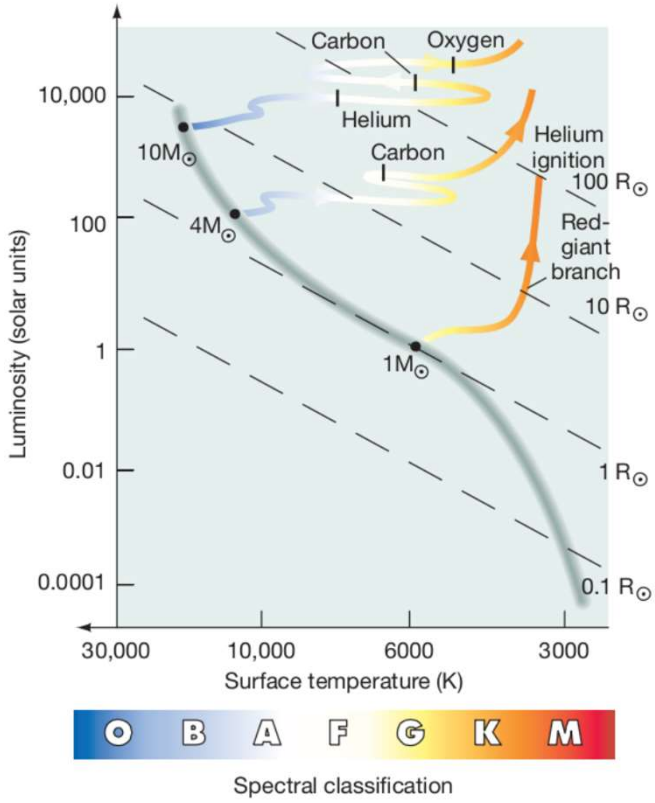
Nova and Supernova

Nova:

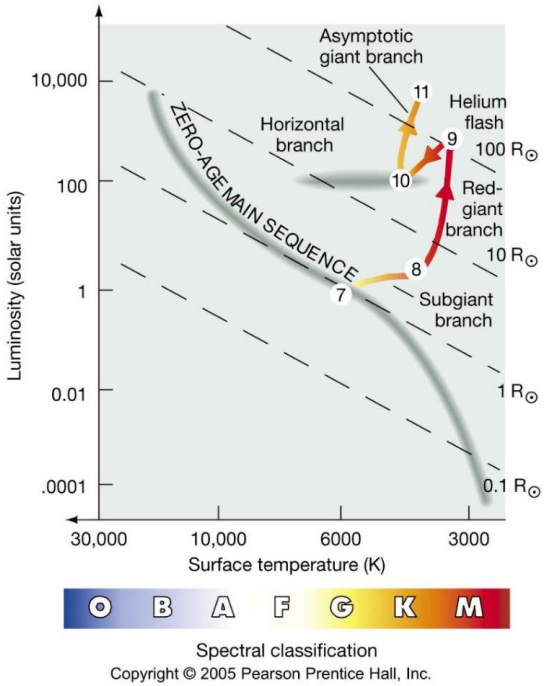
- A single star (White Dwarf) can go Nova multiple times
- Is an accretion-explosion cycle

Supernova:

- High mass star core collapse
- The energy output in a Supernova in the first few months after explosion is greater than what our Sun will produce in its entire lifetime.
- Only occurs once. Explodes and it is done.
- Supernova is 1,000,000 times brighter than a Nova



The Path to Stellar Death

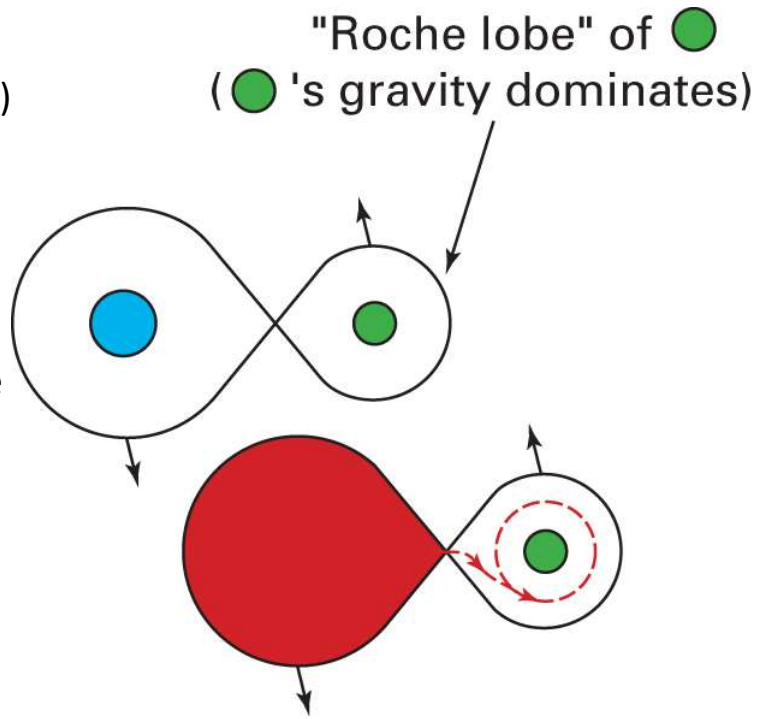


Stellar Death

STARS - Difference Between Nova and Supernova

Nova (Novae is plural)

- Occurs as part of a binary star system. Remember: Most stars are in binary systems and these can, and sometimes do, exchange matter.
  - One star (recipient) is a white dwarf (planetary nebula remnant)
  - Other star (donor) is a non-white dwarf
- Surrounding each star is a region known as the Roche Lobe:
  - The Roche lobe is a tear-drop shaped region around a star in a binary system within which orbiting material is gravitationally bound to that star.
  - The region where a star's (recipient) gravity dominates over the other star (donor).
  - Accretion disk is formed
    - Matter from Accretion disk falls on surface of White Dwarf
    - Temp rises, fusion starts again on White Dwarf surface
    - Reaches a maximum density and explodes into Nova
    - Chandrasekhar Limit 1.4 Solar Masses
    - During fusion carbon and O2 are created
    - Known as Type Ia supernovae
    - Have common peak brightness



Stellar Death

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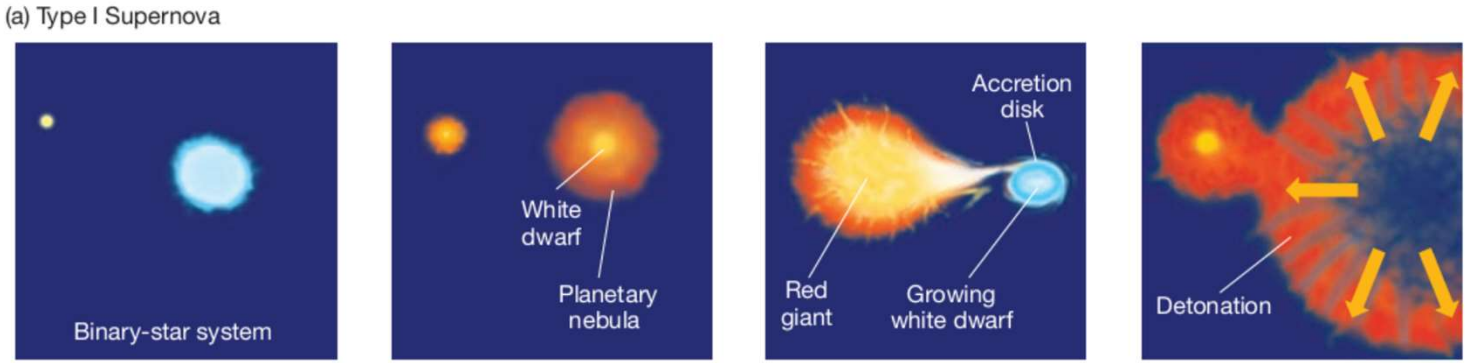
Nova (Novae is plural)

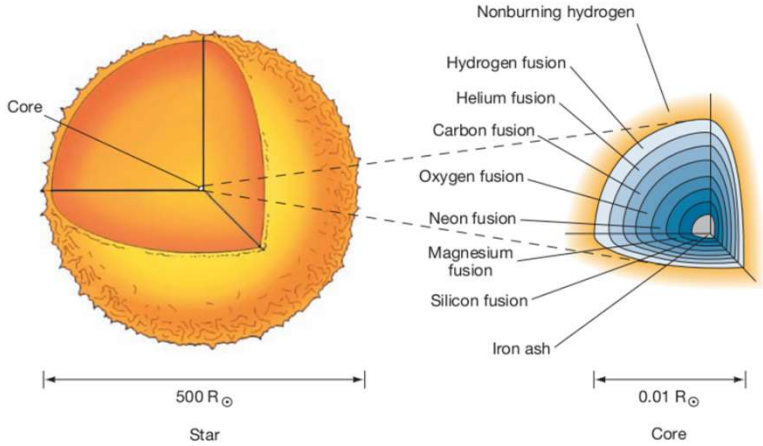
- Another view:



Supernova - High Mass Stars

Due to mass, high mass stars have more stable evolution from one fusion process to the next.

- For a $20M_{\odot}$ star, roughly, it burns:
  - Hydrogen for 10M years
  - Helium from 1M years
  - Carbon a few thousand
  - Oxygen 1 year
  - Silicon for a week
  - Iron for less than a day



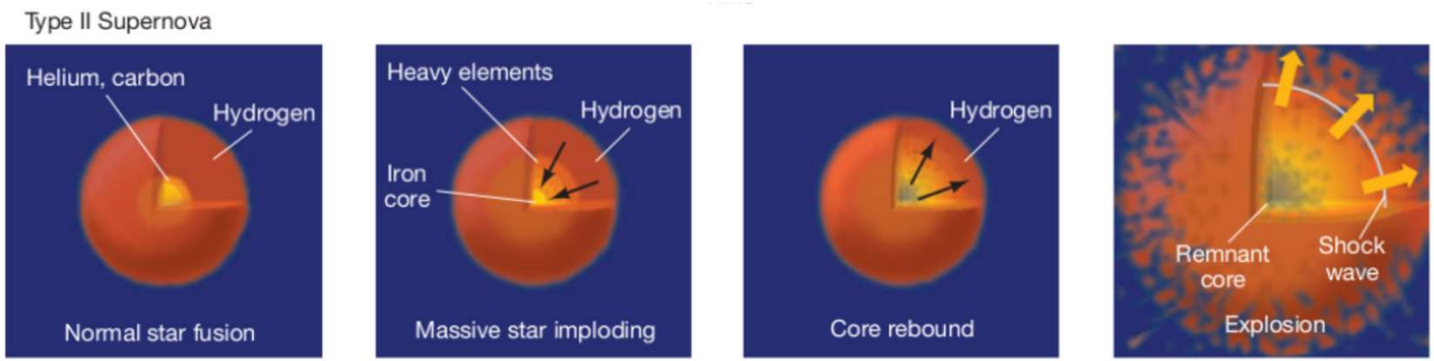
- Iron is the most stable atom
- Its the point at which energy can no longer be extracted either by Fusion or Fission (the opposite of Fusion)
- Iron thus acts as a “fire extinguisher” dampening the fusion in the core
- With the “fire” out a star can no longer reach an equilibrium
- Despite temps around a few billion K, Gravity will win the tug-o-war
- The star will begin to implode

Supernova - High Mass Stars

Core collapse raises the internal temp in excess of 10B K

- This breaks Iron nuclei apart in a process called Photo Disintegration which cools the core thus reducing pressure making it even more unable to oppose gravity

Gravitational pressure compresses the core to a point where individual elements of the atom touch each other creating very high pressures.



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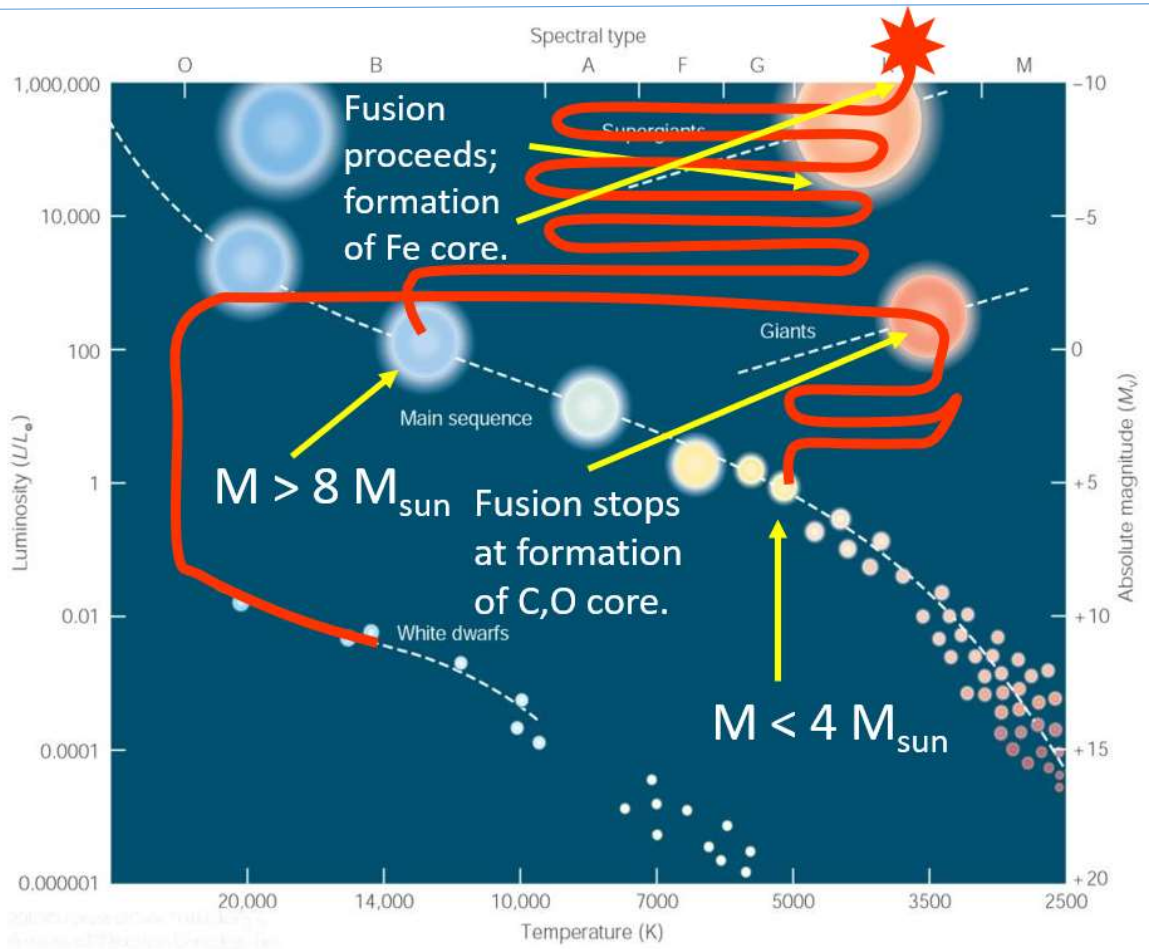


Stellar Death

STARS - Difference Between Nova and Supernova

Types of Supernova

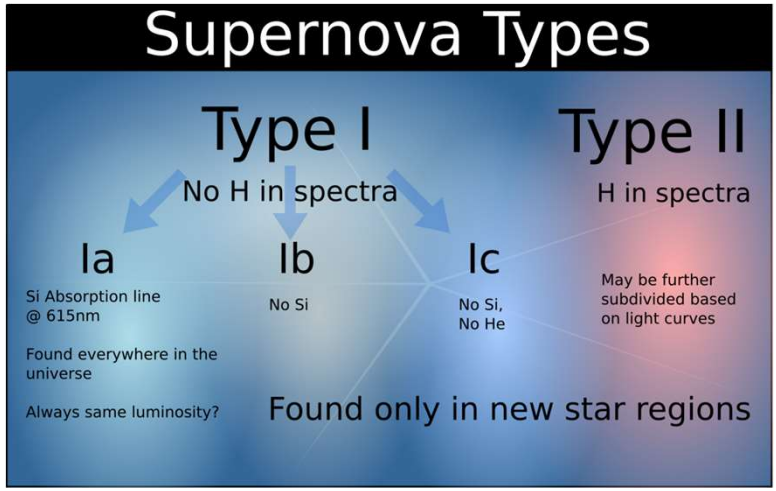
Supernovae, are classified according to their spectra.

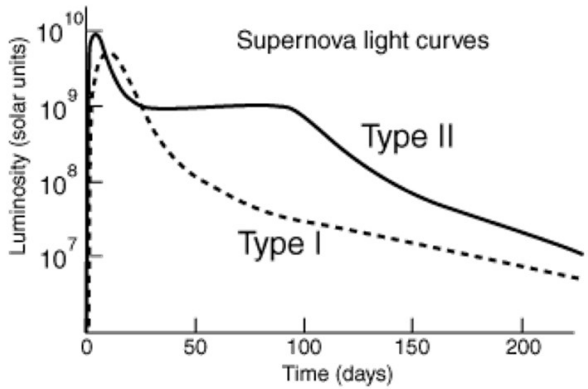
Two basic types of supernova: Type I and Type II. Hydrogen in the spectra is the differentiator.

Type I supernovae are subdivided into three subclasses:

- Type Ia: no hydrogen lines, no helium lines, strong silicon lines
- Type Ib: no hydrogen lines, strong helium lines
- Type Ic: no hydrogen lines, no helium lines, no silicon lines

Type II supernovae are massive stars whose iron cores collapse and then rebound, shock heating the outer layers of the star, which then explode outward.





Summary

The death of a star, and its process to this moment, is defined by mass.

Lower mass stars end up as White Dwarfs. Novae are White Dwarfs pulling stellar material from a less massive companion star.

Higher mass stars end up in supernova explosions where material is distributed to form new stars and the cores are left as neutron stars, or black holes.

Questions?