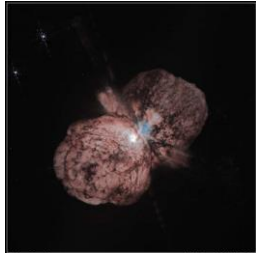
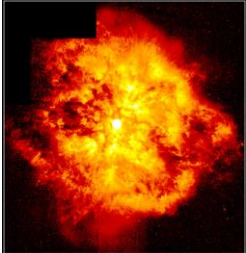


# Large Mass Death

Before the End - Large Scale Mass Loss



**Nebula M1-67 around Star WR124**  
 HST - WFPC2  
 PR126-33 - ST ScI OPO - November 5, 1993  
 © Ossipenko and A. Woral (University of Warwick) and H&A

**Eta Carinae**  
 HST - WFPC2  
 PR126-23a - ST ScI OPO - June 10, 1996  
 © Morley EC, COY K, Davidson, © MML, NASA

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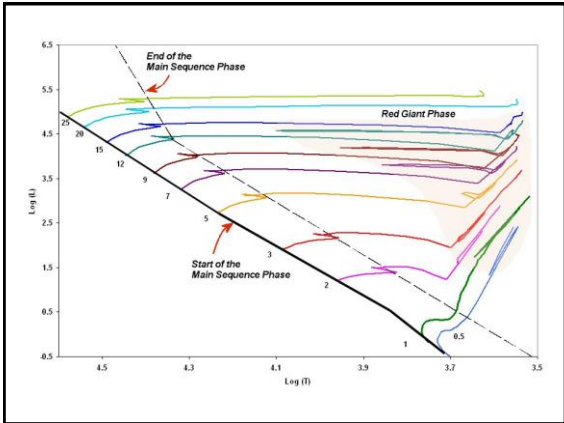
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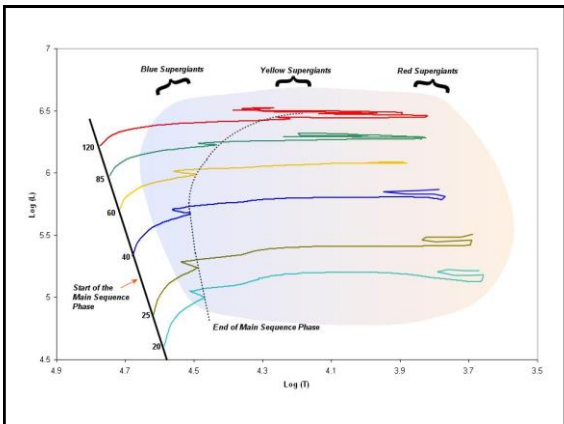
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Fusing	Main Fusion Products	Time
H	_____	__ million years
He	_____	_____ years
C	_____	_____ years
Ne	_____	_____
O	_____	_____
Si	_____	_____

Why so short?  
What is the rest of the star like?

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**Atmosphere of Betelgeuse**  
PRC96-04 - ST Sci OPO - January 15, 1995 - A. Dupree (CIA), NASA HST - FOC

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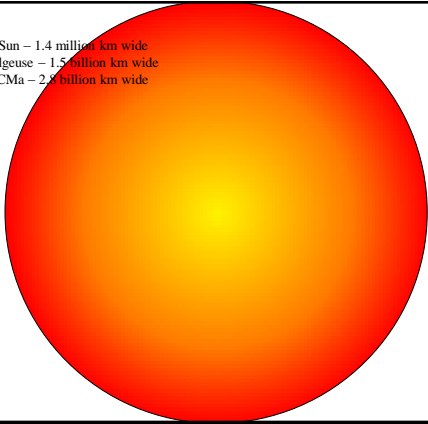
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The Sun - 1.4 million km wide  
Betelgeuse - 1.5 billion km wide  
VY CMa - 2.8 billion km wide



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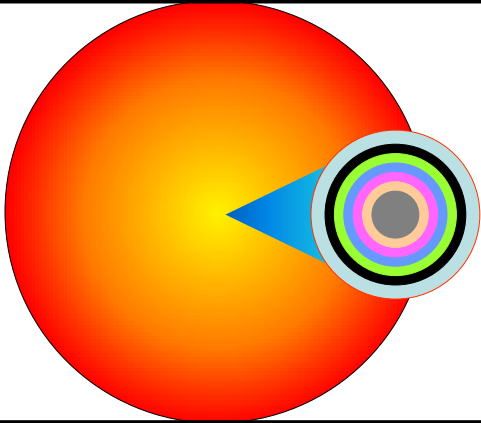
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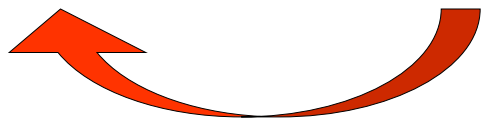
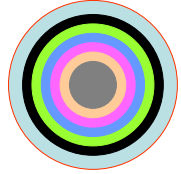
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What's next?  
\_\_\_\_\_ Fusion.

Good?  
BAD!

Iron fusion \_\_\_\_\_ energy!  
Iron fuses, core collapses, core gets hotter, fuses iron faster



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End result –

Core collapses in \_\_\_\_\_

$p + e \Rightarrow n + \nu$

Core  $\Rightarrow$  ball of neutrons - \_\_\_\_\_ **Star**

What about the rest of the star?

“Wiley E. Coyote effect”

Delayed collapses on to tiny core

Huge energy generation

Expels layers out - “big star go BOOM!”



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## Supernova!

Very important event because...

Very \_\_\_\_\_

Material spread out

Trigger \_\_\_\_\_

Produces \_\_\_\_\_

\_\_\_\_\_

Remnant - neutron star (smaller mass) or black hole (higher mass)

Rare event - 1 supernova/galaxy/century

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Where is the Supernova?



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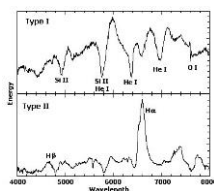
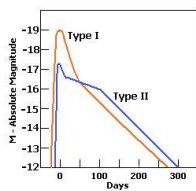
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Two types of supernova

Type \_\_\_\_ - Massive star dying

Type \_\_\_\_ - White dwarf going over Chandrasekhar limit

Type I - brighter, no \_\_\_\_ in spectra



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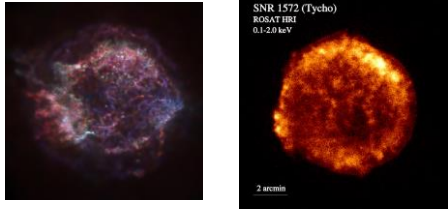
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Supernova Remnants

Hot for a long time

Give off x-rays, visible, radio light

Age of explosion



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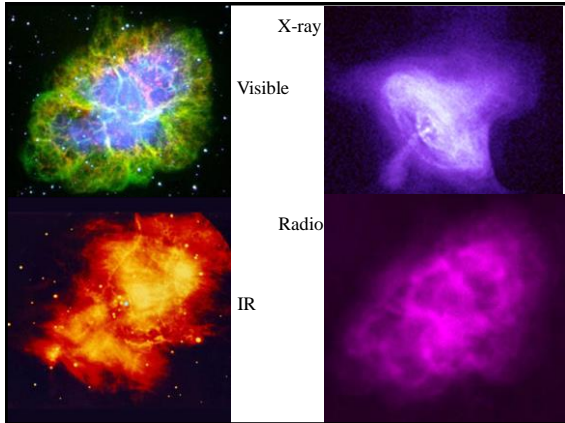
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Then one day in 1987 (February 23, 1987 to be exact)



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## Supernova 1987A (SN87A)

The best observed supernova of all time!  
Visible to the naked eye - first since 1604!  
Sanduleak -69 202 identified as source  
Neutrinos observed!  
Nucleosynthesis (production of heavy elements) observed  
And today we see.....

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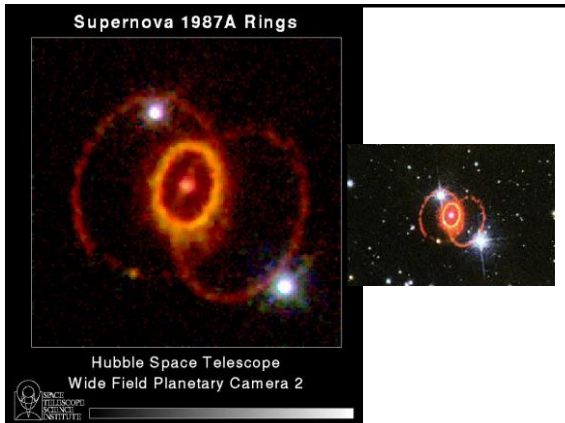
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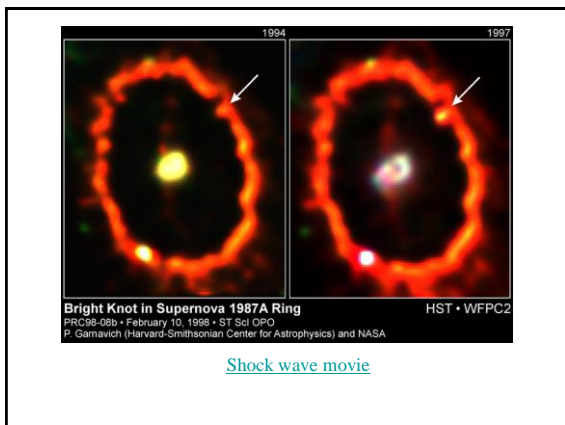
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