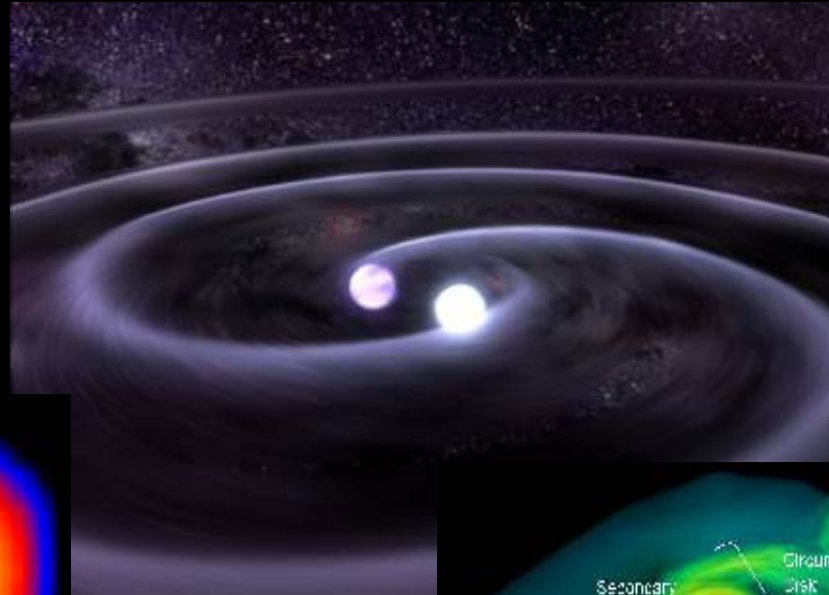
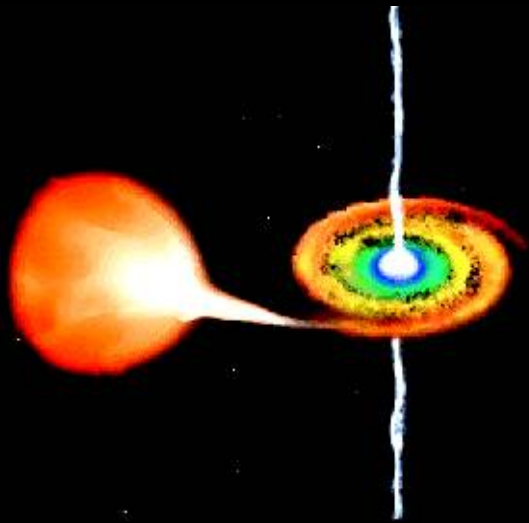
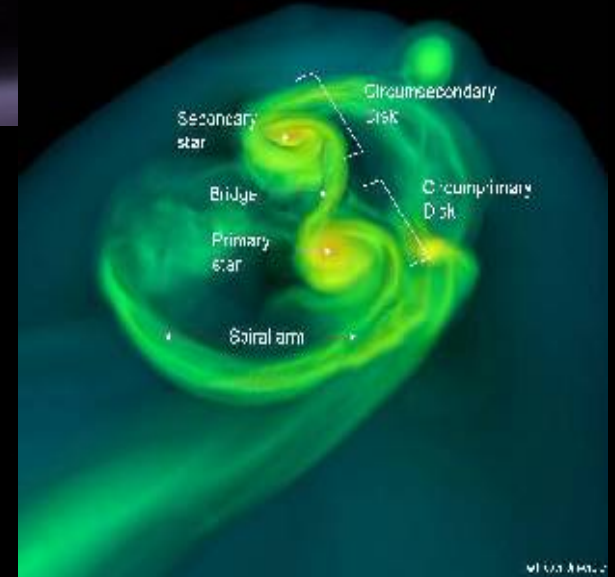
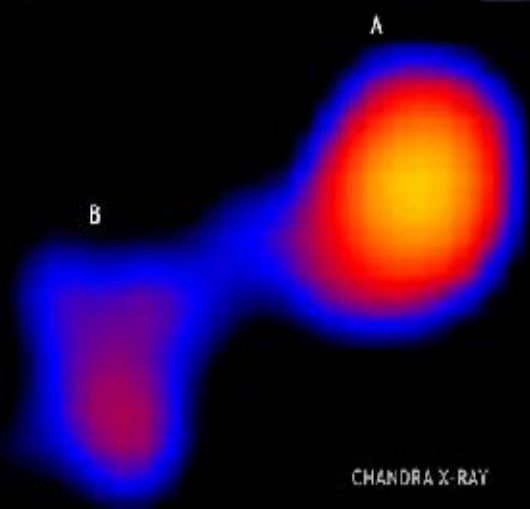


Binary Stars – Lecture 11

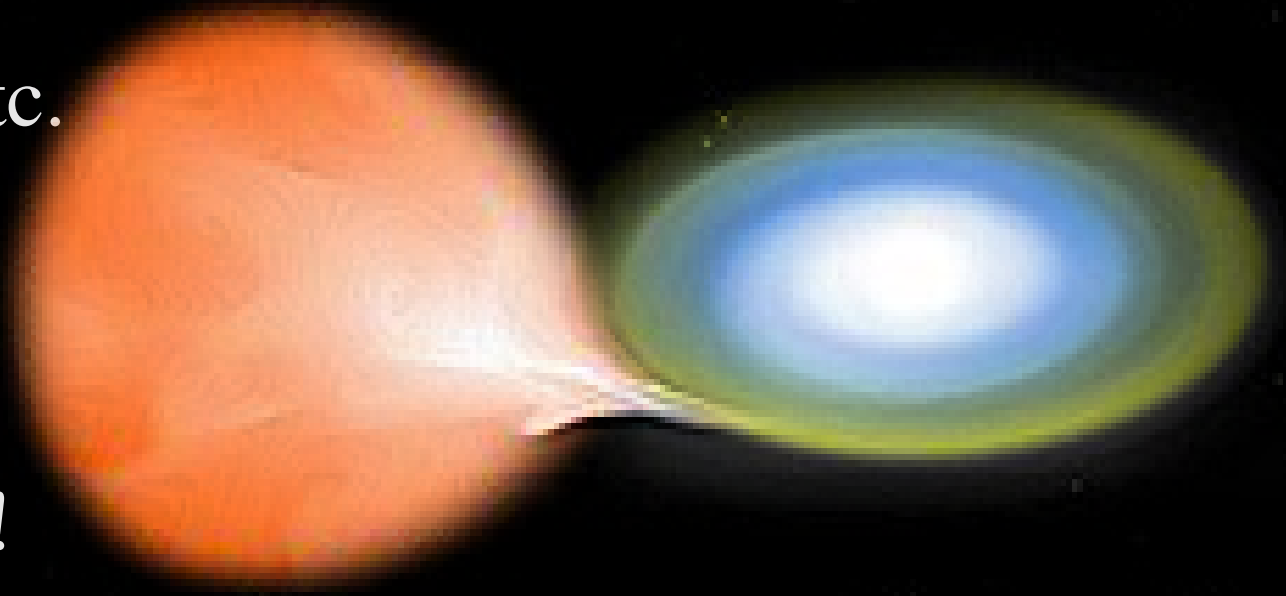


Astro 8501
6944



Cataclysmic Variables

- White Dwarf +
- Low mass star
- WD accreting:
- Disc, outbursts etc.
- WD $M \uparrow$
- Sometimes...
... Explosions!

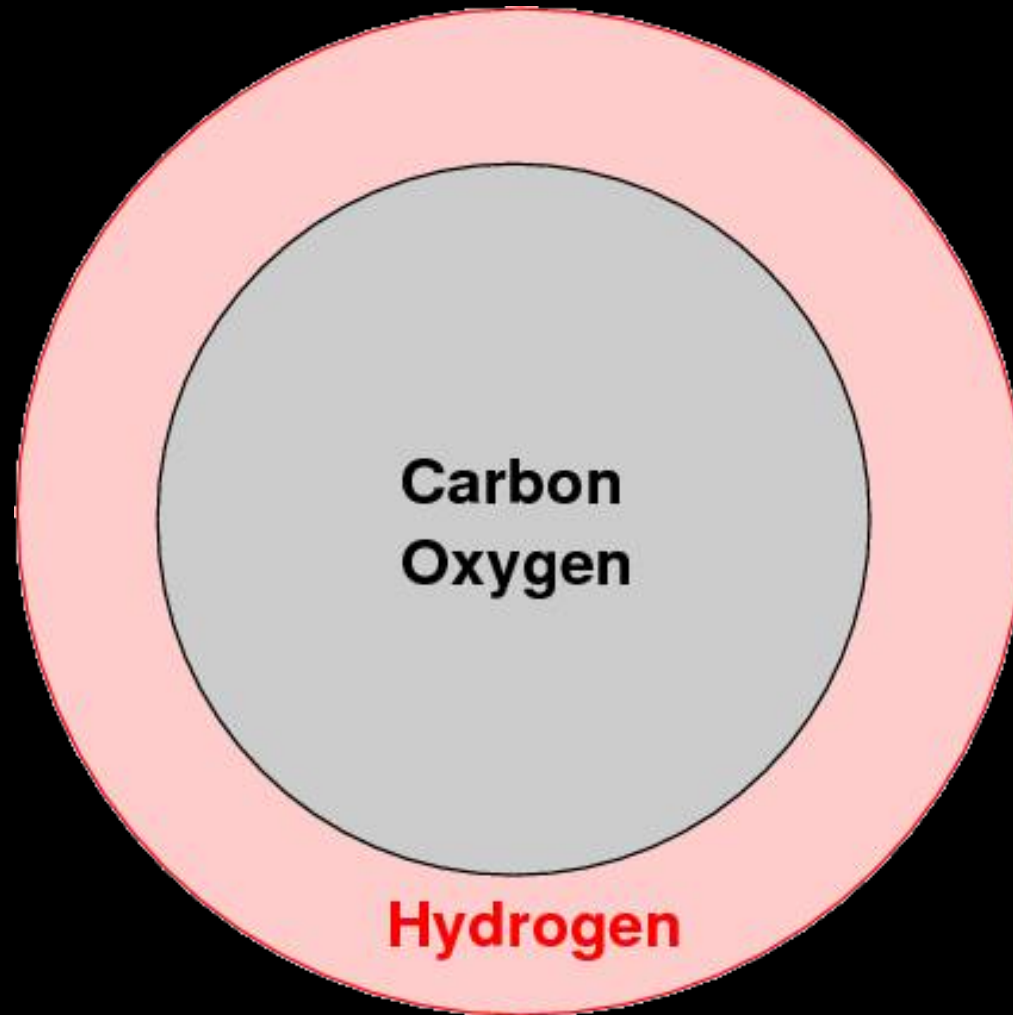


Accretion Rates onto a WD

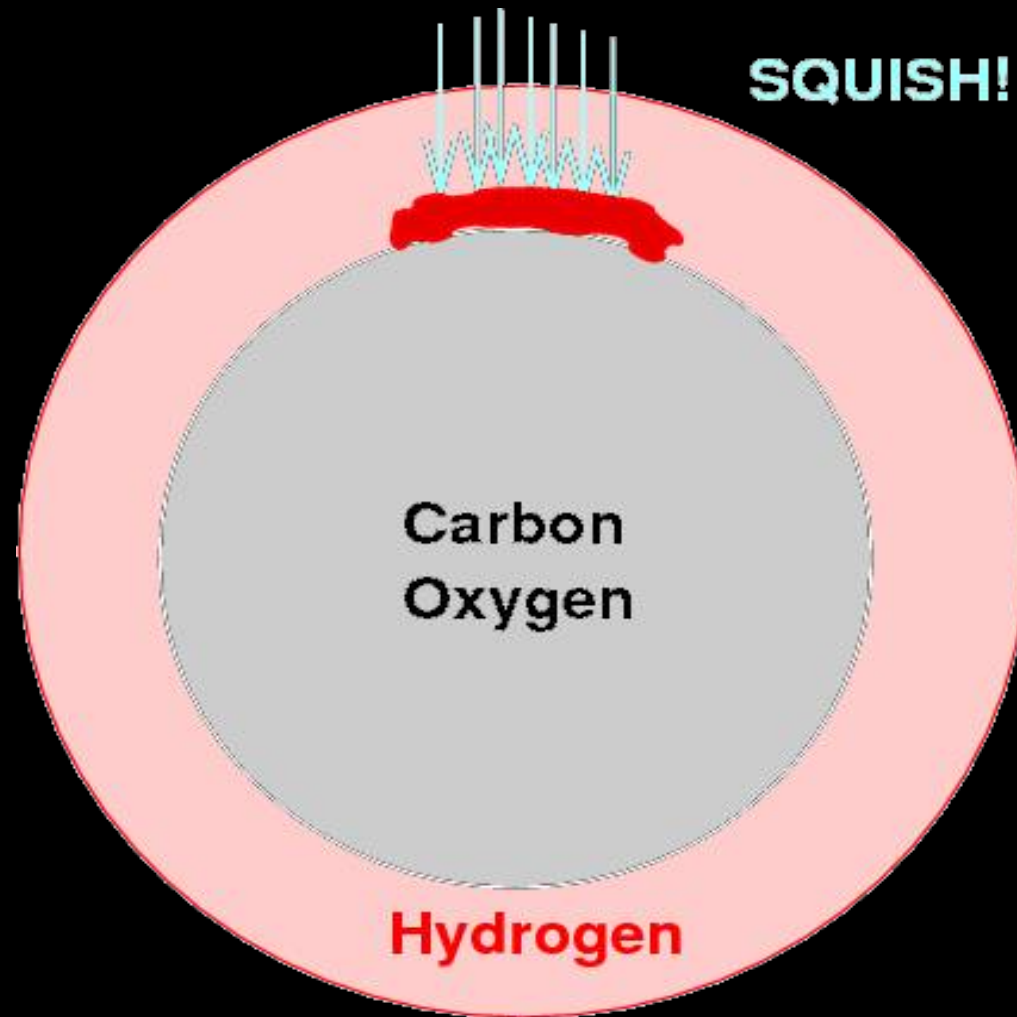
$\dot{M} < 10^{-7} M_{\odot} \text{ yr}^{-1}$	Thermonuclear Novae
$1.03 < 10^7 \dot{M} < 2.71$	Steady burning
$\dot{M} > 2.7 \times 10^{-7} M_{\odot} \text{ yr}^{-1}$	Giant envelope

See e.g. Warner's book (1995)
Remember the Eddington limit!

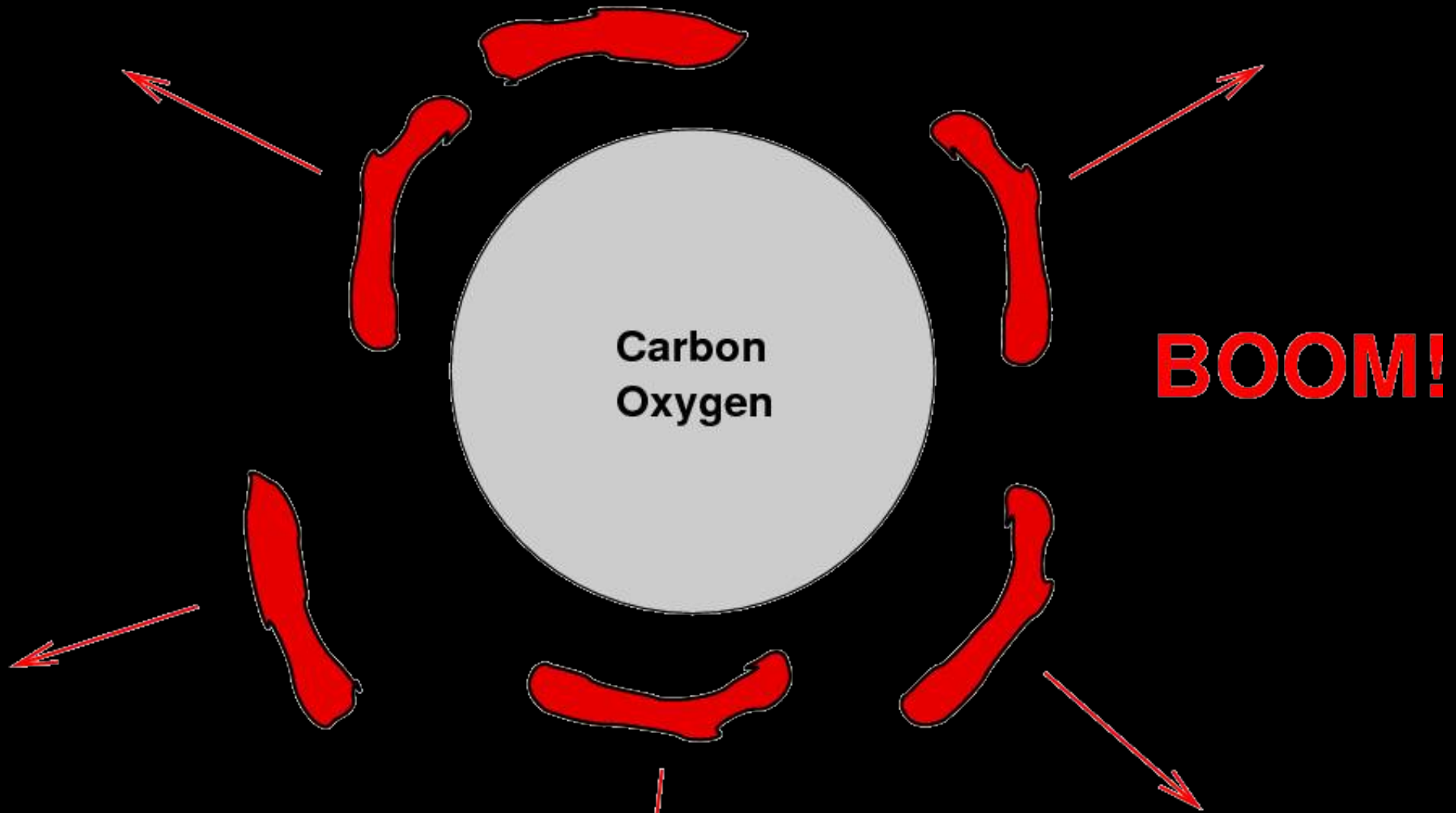
Classical Nova I



Classical Nova II



Classical Nova III

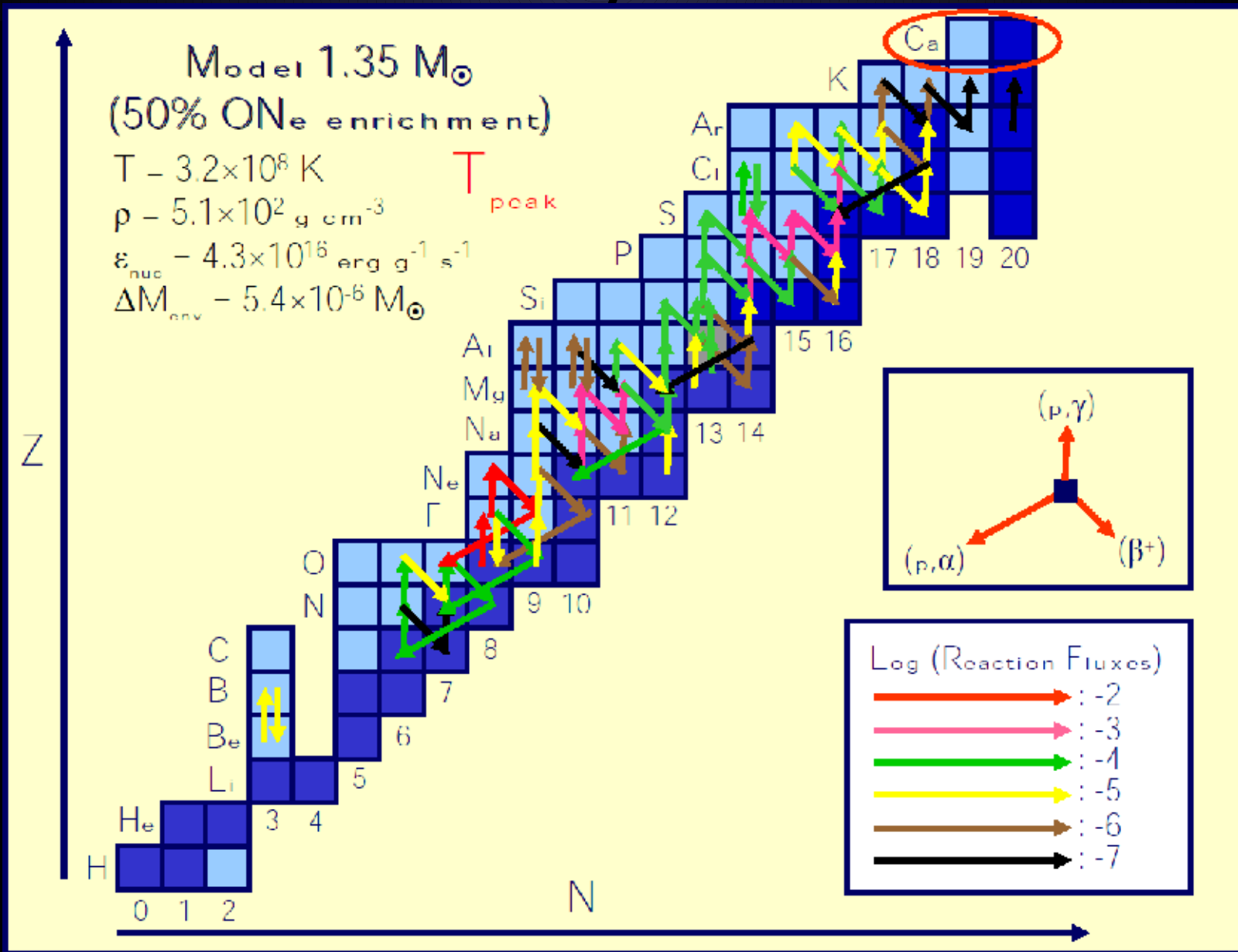


Thermonuclear Nova Properties

- Galactic rate $\sim 35 \pm 11 \text{ yr}^{-1}$ (~ 5 observed)
- Mass return $\sim 4 \times 10^{-4} M_{\odot}$ in 100 – 1000 s
- Energy $E \sim 10^{45}$ erg
- Luminosity $L \sim 10^{4-5} L_{\odot}$ (c.f. $10^{10} L_{\odot}$ for SNe)
- Peak $T \sim 0.1 - 0.4 \text{ GK}$
- Ejection velocity $\sim 10^3 \text{ km s}^{-1}$ (c.f. $\sim 10^4$ for SNe)
- Binary progenitors $P \sim 1 - 12$ hours
CVs!
- Periodic: typically $10^4 - 10^5$ years
- Rise time $\sim 1 - 2$ days



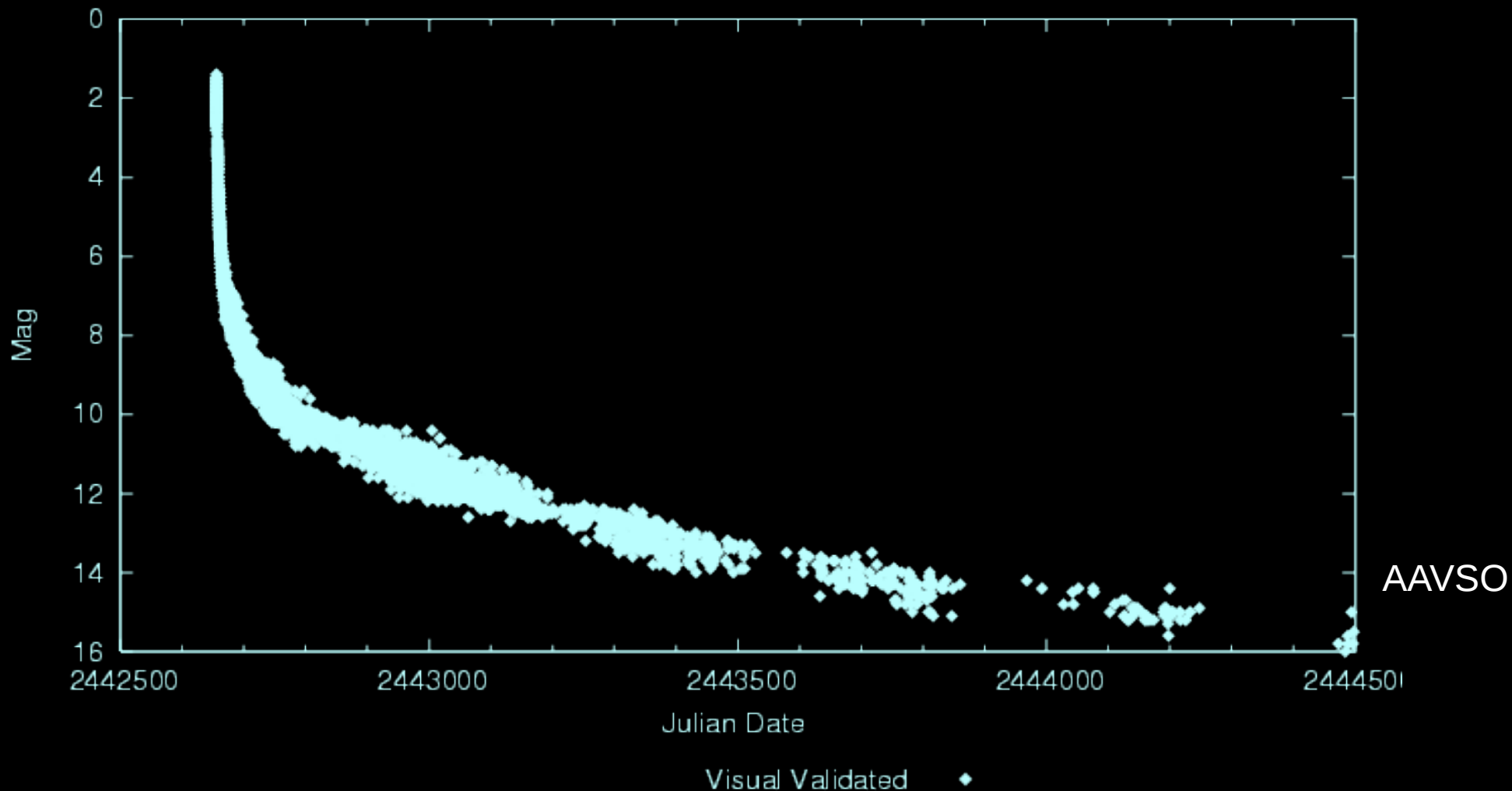
Nucleosynthesis



Stolen from Jordi Jose

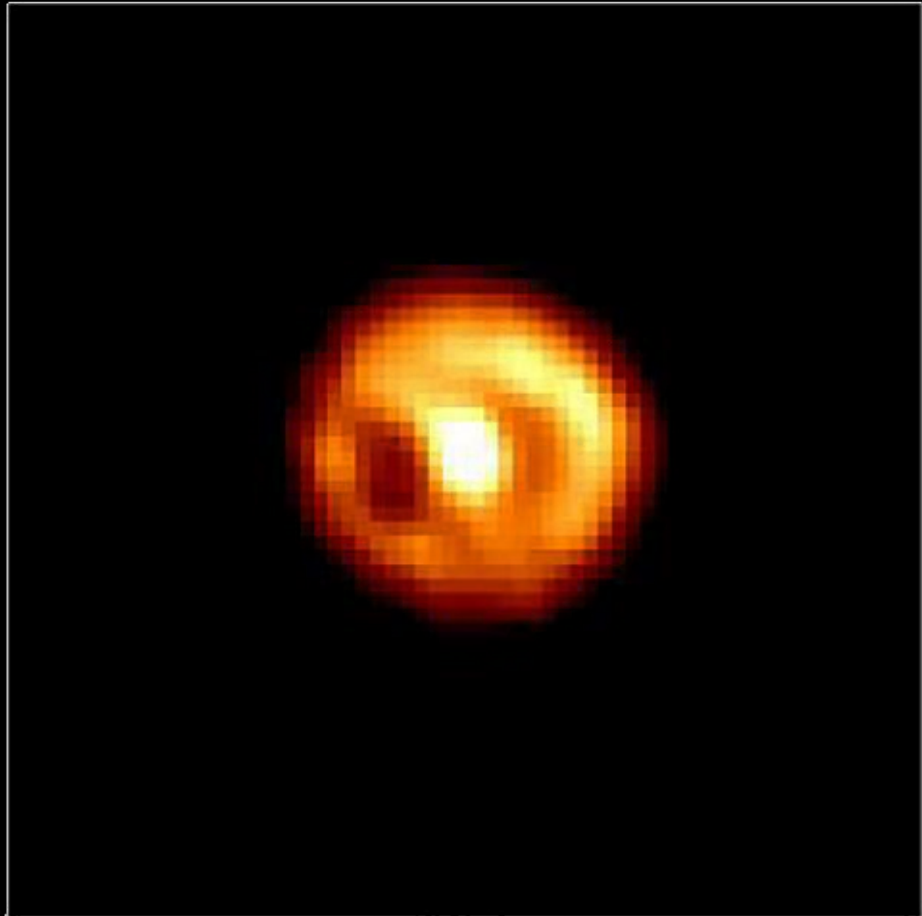
V1500 Cygni

AAVSO DATA FOR V1500 CYG - WWW.AAVSO.ORG

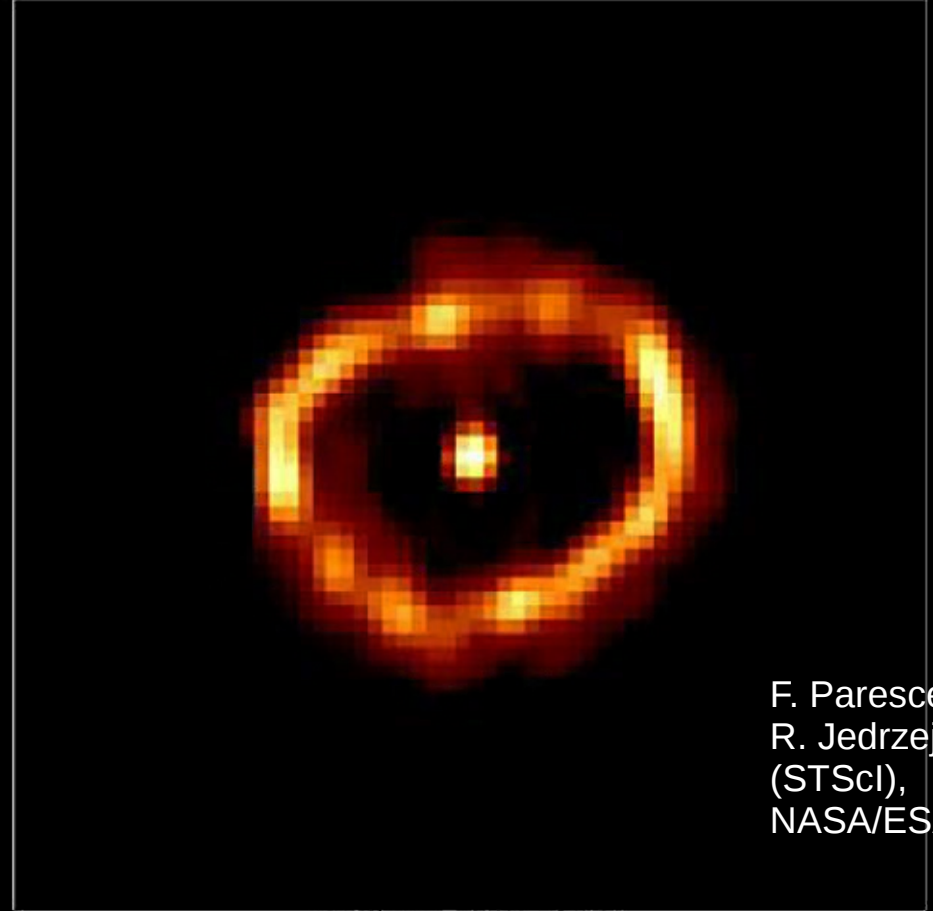


Nova Cygni 1992

Hubble Space Telescope
Faint Object Camera



Pre-COSTAR
Raw Image

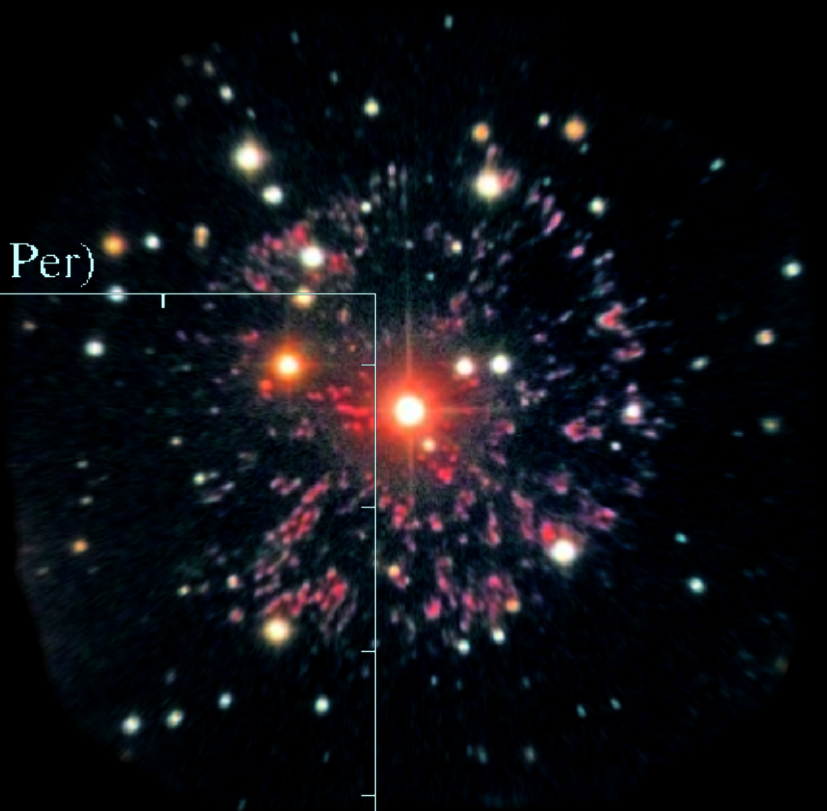
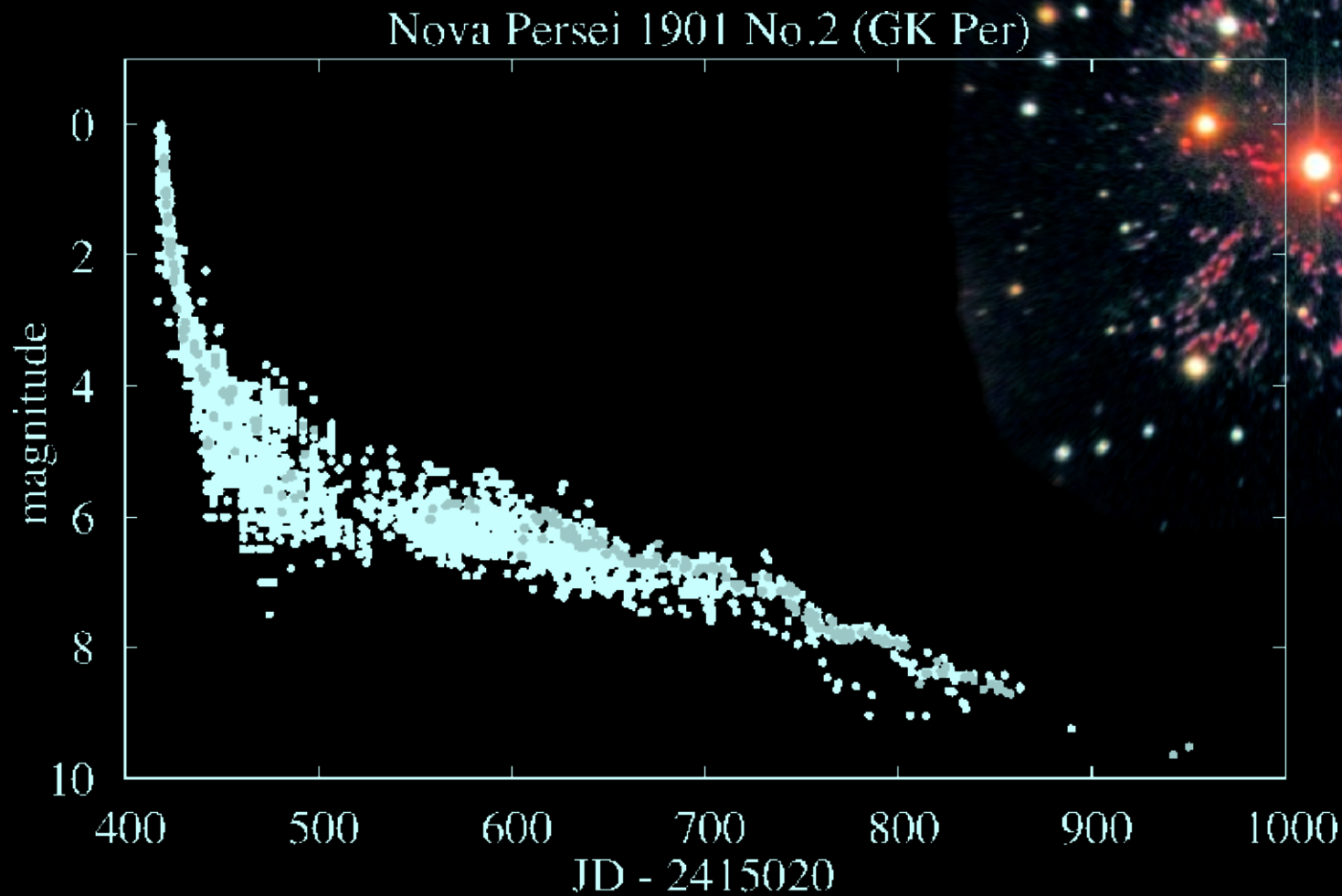


F. Paresce,
R. Jedrzejewski
(STScI),
NASA/ESA

With COSTAR
Raw Image

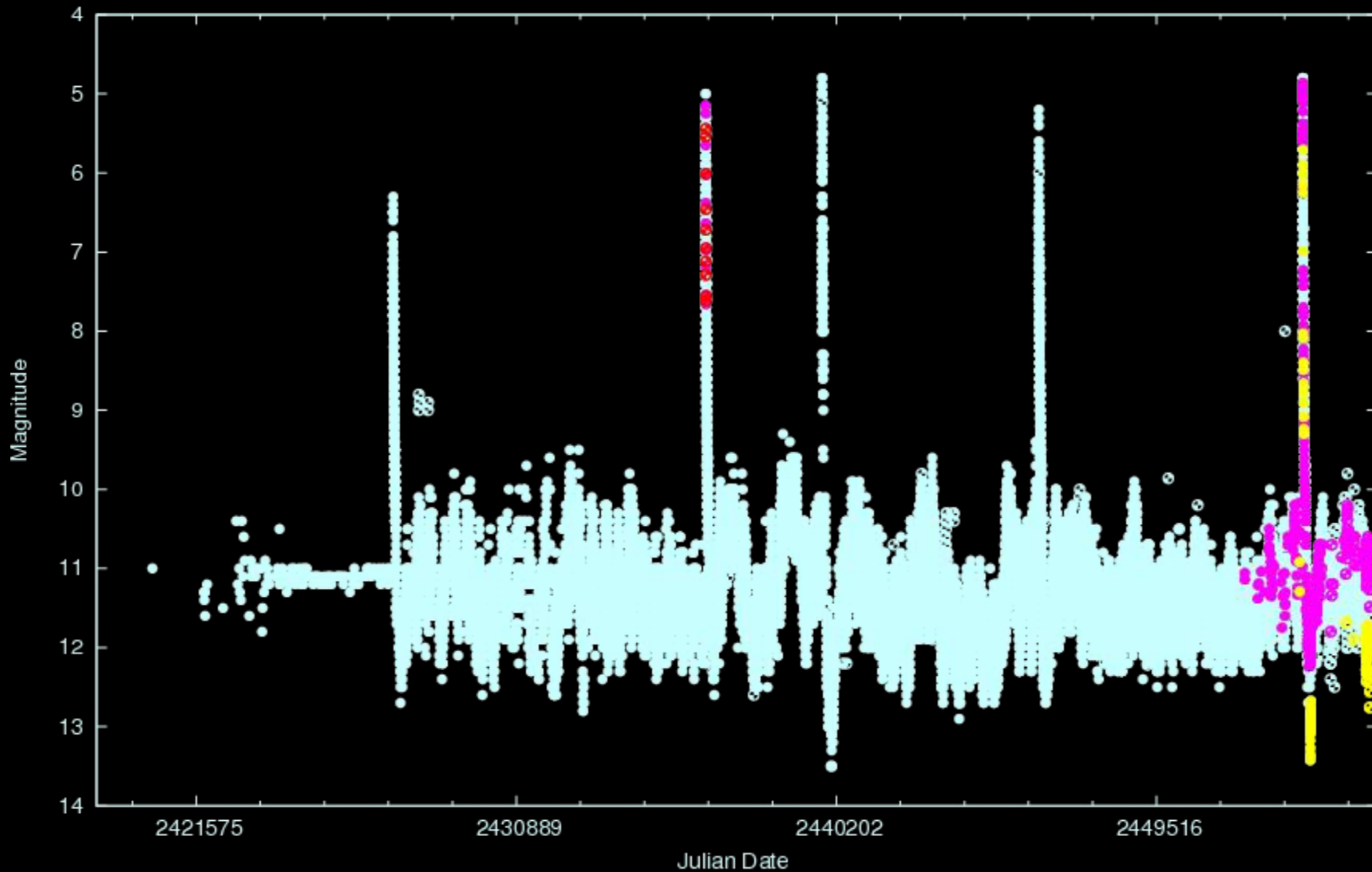
Note the “bar” in the orbital plane

GK Per



RS Ophiuchi

AAVSO DATA FOR RS OPH - WWW.AAVSO.ORG



Visual Validated ●
Visual Prevalidated ○

V Validated ●
V Prevalidated ○

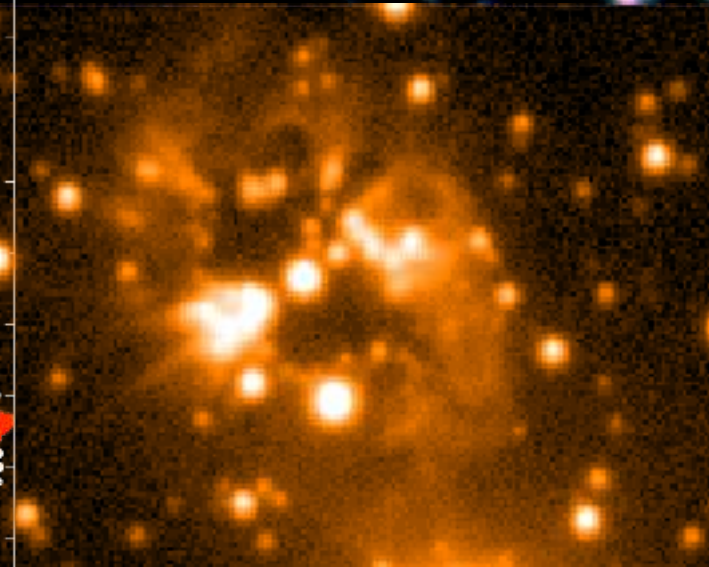
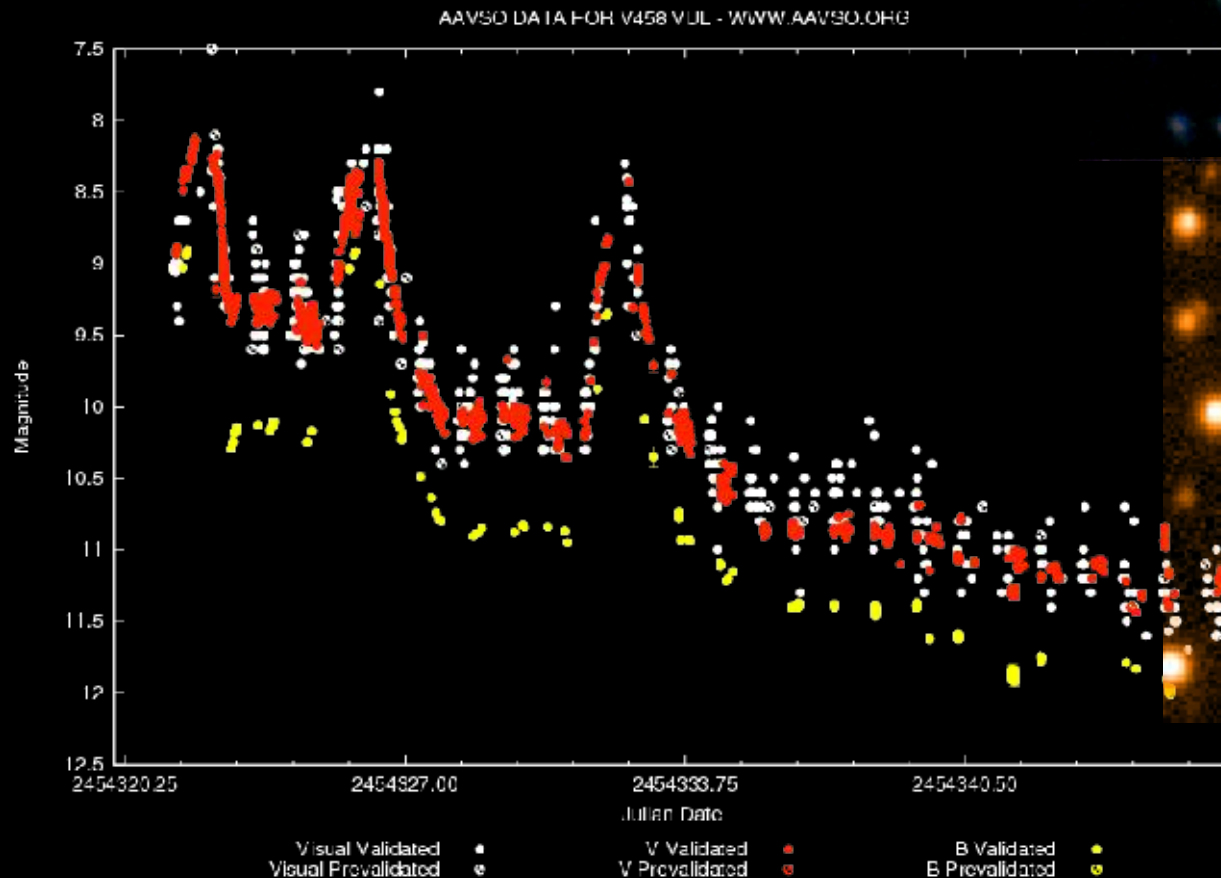
B Validated ●
B Prevalidated ○

U Prevalidated ○

20 year period (1898, 1933, 1958, 1967, 1985, 2006)

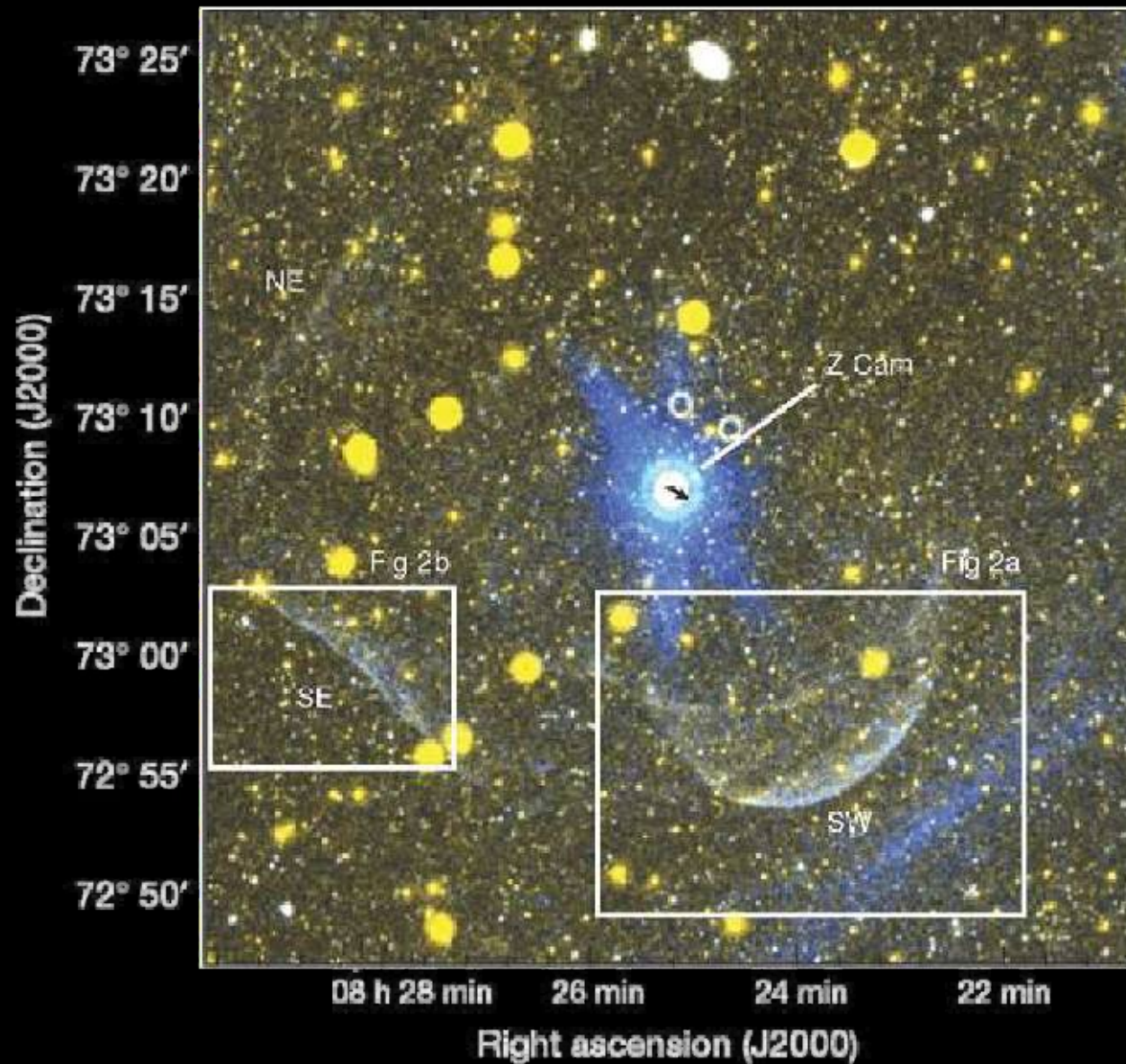
V458 Vul

Nova inside a planetary nebula!
PN Estimated 14000 years old
Post common envelope
SNIa progenitor???



Wesson et al 2008

Classical - Dwarf Connection

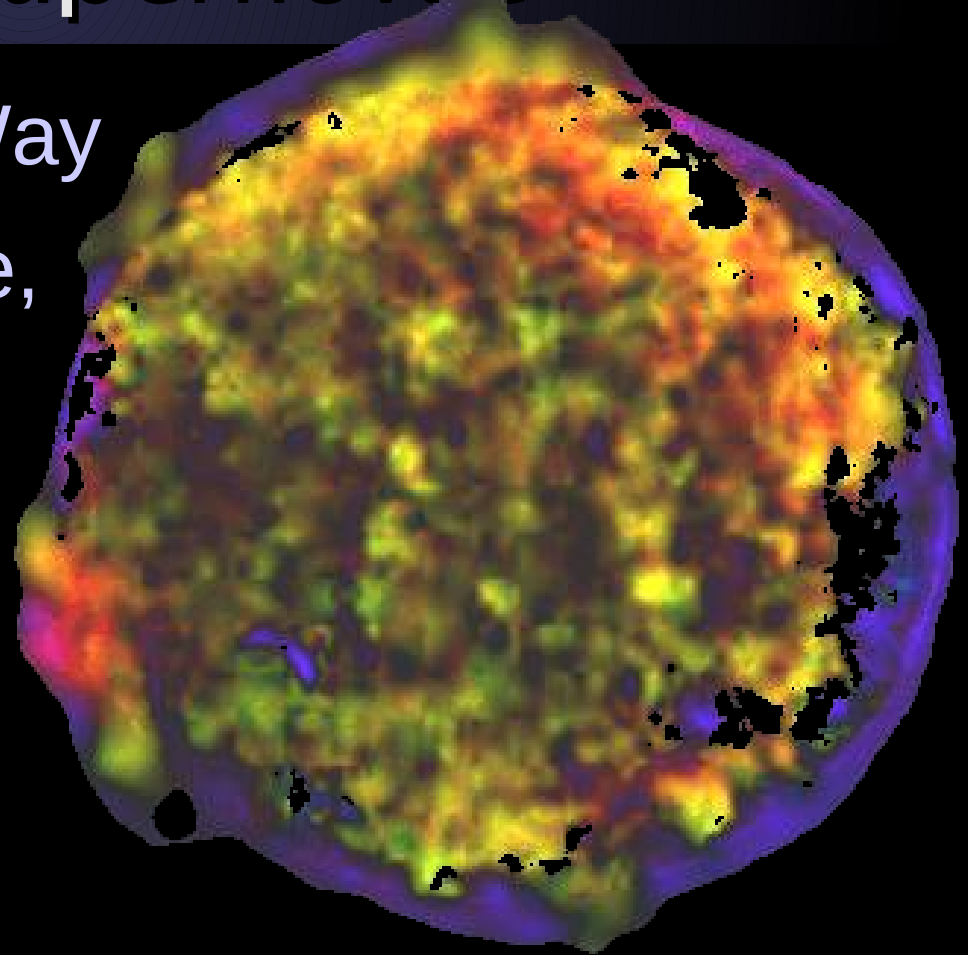


Shara et al 2007
Nature 446,159

Type Ia supernovae

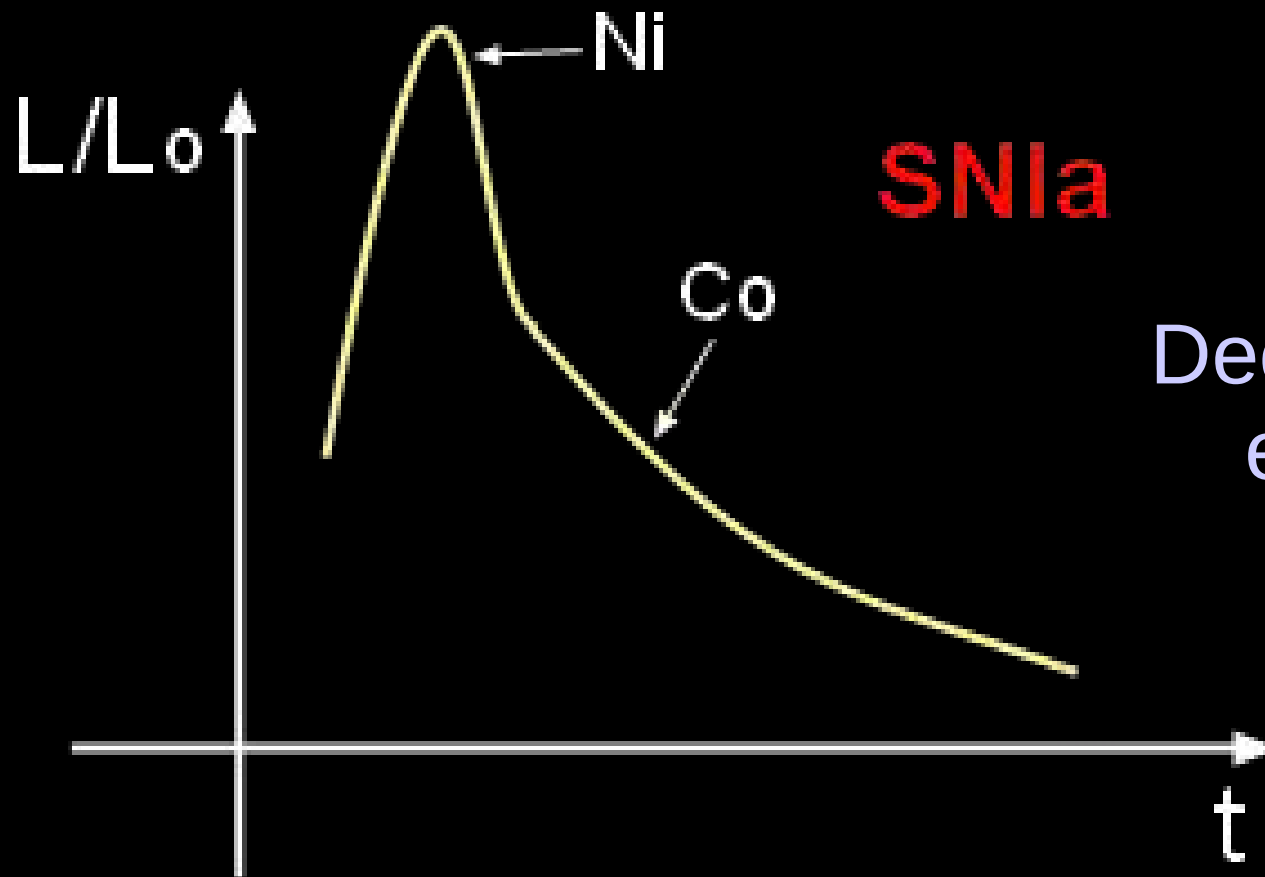
- 1/250 years in Milky Way
- Spectrum: Si; No H, He,
- White dwarf explosion
- Sub-MCh/MCh/>MCh
- Mag $M_v = -19$
- “Standard Candles”
- Useful for *cosmology*
- Iron-peak nucleosynthesis:

Fe, Ni, Co, Ti ...



Tycho's SN remnant
NASA/MPIA/Calar Alto Observatory,
Oliver Krause et al.

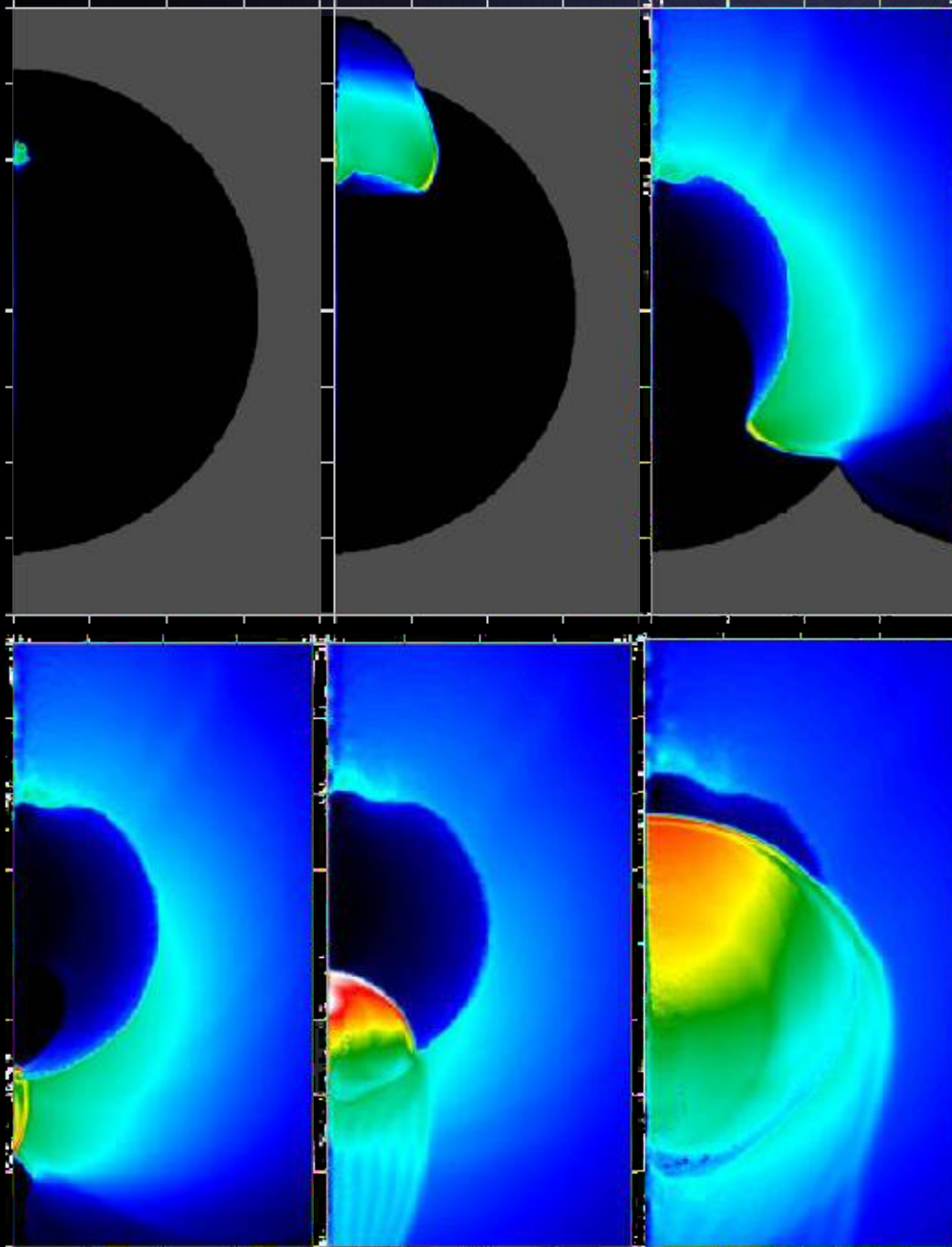
SN Ia lightcurve



Decay of radioactive elements :
Nickel
Cobalt

Image from Wikipedia

Edge-Lit Detonation ($M < 1.4$)



colour=temperature

white = 6×10^9 K

$M_{\text{CO}} = 0.7 M_{\odot}$

$M_{\text{He}} = 0.2 M_{\odot}$

Total time < 2 seconds!

Forcada, Garcia-Senz,
Jose 2007