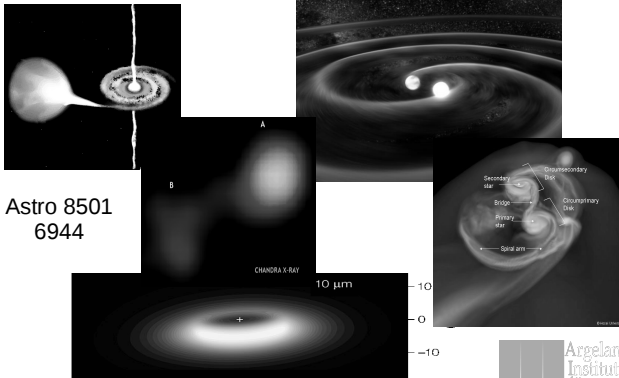


Binary Stars - Lecture 11

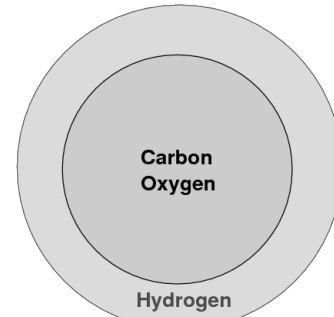


Astro 8501
6944

CHANDRA X-RAY
10 μm

Binary stars - Robert Izzard Lecture 11 (AU) -10 -20 -30 Argelander Institut für Astronomie

Classical Nova I



Carbon
Oxygen

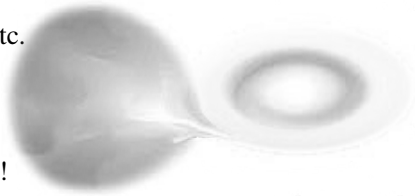
Hydrogen

Michael Richmond

Binary stars - Robert Izzard Lecture 11 http://spiff.rit.edu/richmond/asras/sn_bh/sn_bh.html Argelander Institut für Astronomie

Cataclysmic Variables

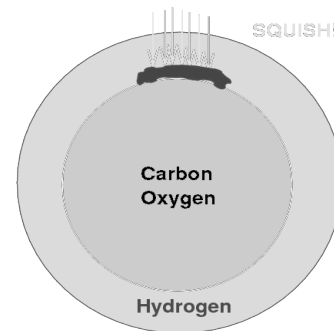
- White Dwarf +
- Low mass star
- WD accreting:
- Disc, outbursts etc.
- WD $M \uparrow$
- Sometimes...
... Explosions!



Binary stars - Robert Izzard Lecture 11

Argelander Institut für Astronomie

Classical Nova II



Carbon
Oxygen

Hydrogen

Michael Richmond

Binary stars - Robert Izzard Lecture 11 http://spiff.rit.edu/richmond/asras/sn_bh/sn_bh.html Argelander Institut für Astronomie

Accretion Rates onto a WD

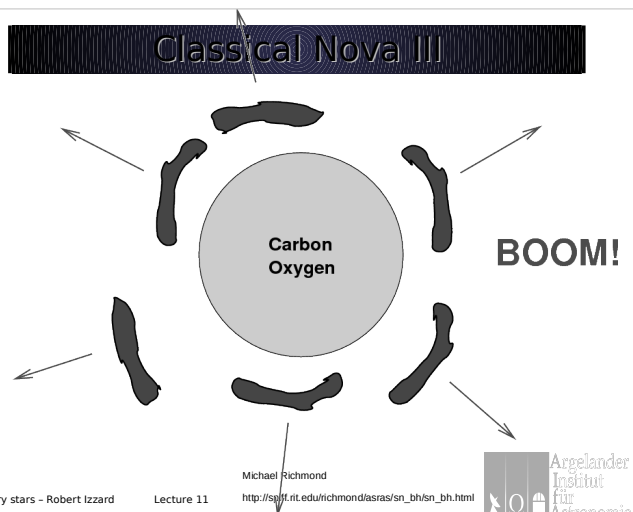
$\dot{M} < 10^{i7} M_{\odot} \text{ yr}^{-i1}$	Thermonuclear Novae
$1.03 < 10^7 \dot{M} < 2.71$	Steady burning
$\dot{M} > 2.7 \times 10^{i7} M_{\odot} \text{ yr}^{-i1}$	Giant envelope

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

Binary stars - Robert Izzard Lecture 11

Argelander Institut für Astronomie

Classical Nova III



Carbon
Oxygen

BOOM!

Michael Richmond

Binary stars - Robert Izzard Lecture 11 http://spiff.rit.edu/richmond/asras/sn_bh/sn_bh.html Argelander Institut für Astronomie

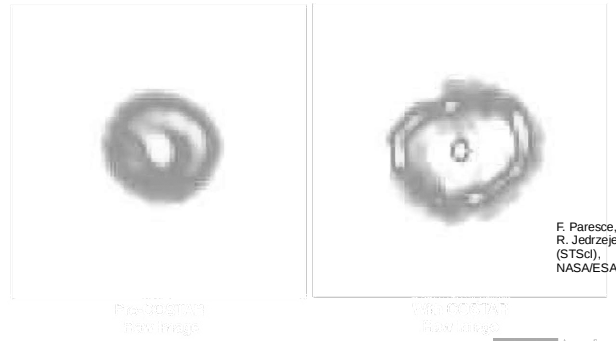
Thermonuclear Nova Properties

- Galactic rate $\sim 35 \pm 11 \text{ yr}^{-1}$ (~ 5 observed)
- Mass return $\sim 4 \times 10^4 M_{\oplus}$ in 100 – 1000 s
- Energy $E \sim 10^{45}$ erg
- Luminosity $L \sim 10^{41.5} L_{\odot}$ (c.f. $10^{10} L_{\odot}$ for SNe)
- Peak $T \sim 0.1 - 0.4$ 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



Nova Cygni 1992

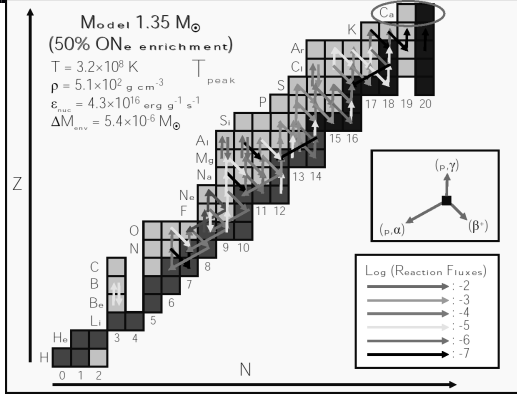
Hubble Space Telescope
Right Object Camera



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

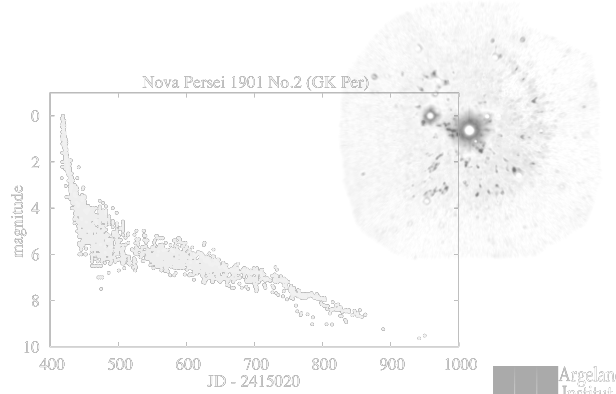
Note the "bar" in the orbital plane

Nucleosynthesis

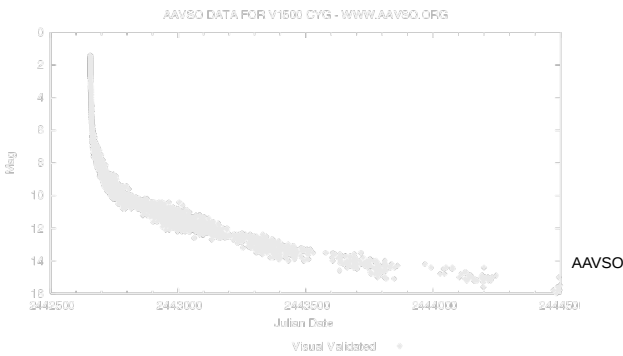


Stolen from Jordi Jose

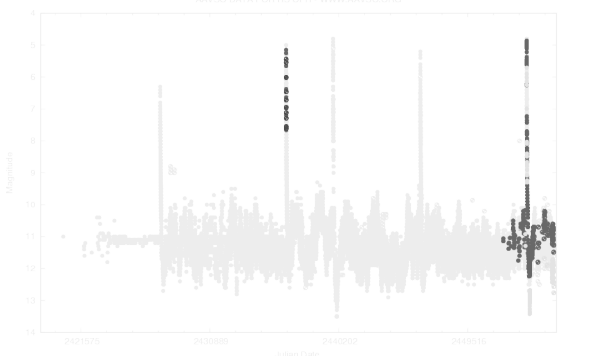
GK Per



V1500 Cygni



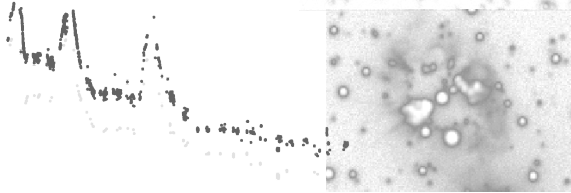
RS Ophiuchi



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

V458 Vul

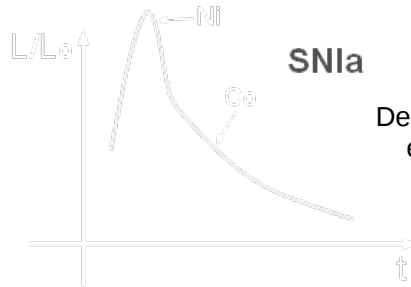
Nova inside a planetary nebula!
 PN Estimated 14000 years old
 Post common envelope
 SNIa progenitor???



Wesson et al 2008

AAVSO

SNIa lightcurve

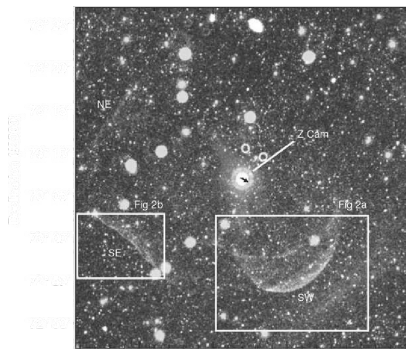


SNIa

Decay of radioactive elements :
 Nickel
 Cobalt

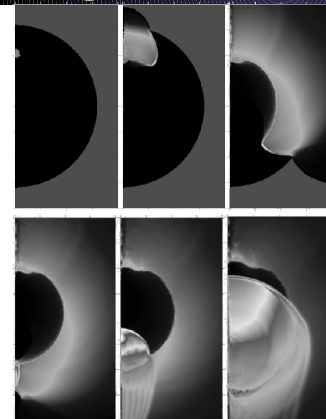
Image from Wikipedia

Classical - Dwarf Connection



Shara et al 2007
 Nature 446,159

Edge-Lit Detonation ($M < 1.4$)



colour=temperature

white = 6×10^9 K

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

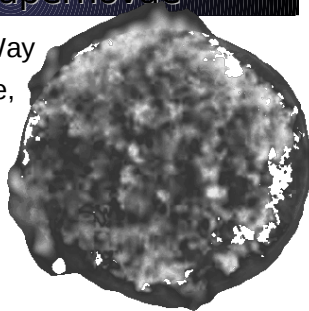
$M_{\text{He}} = 0.2 M_{\odot}$

Total time < 2 seconds!

Forcada, Garcia-Senz, Jose 2007

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:



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

Fe, Ni, Co, Ti ...