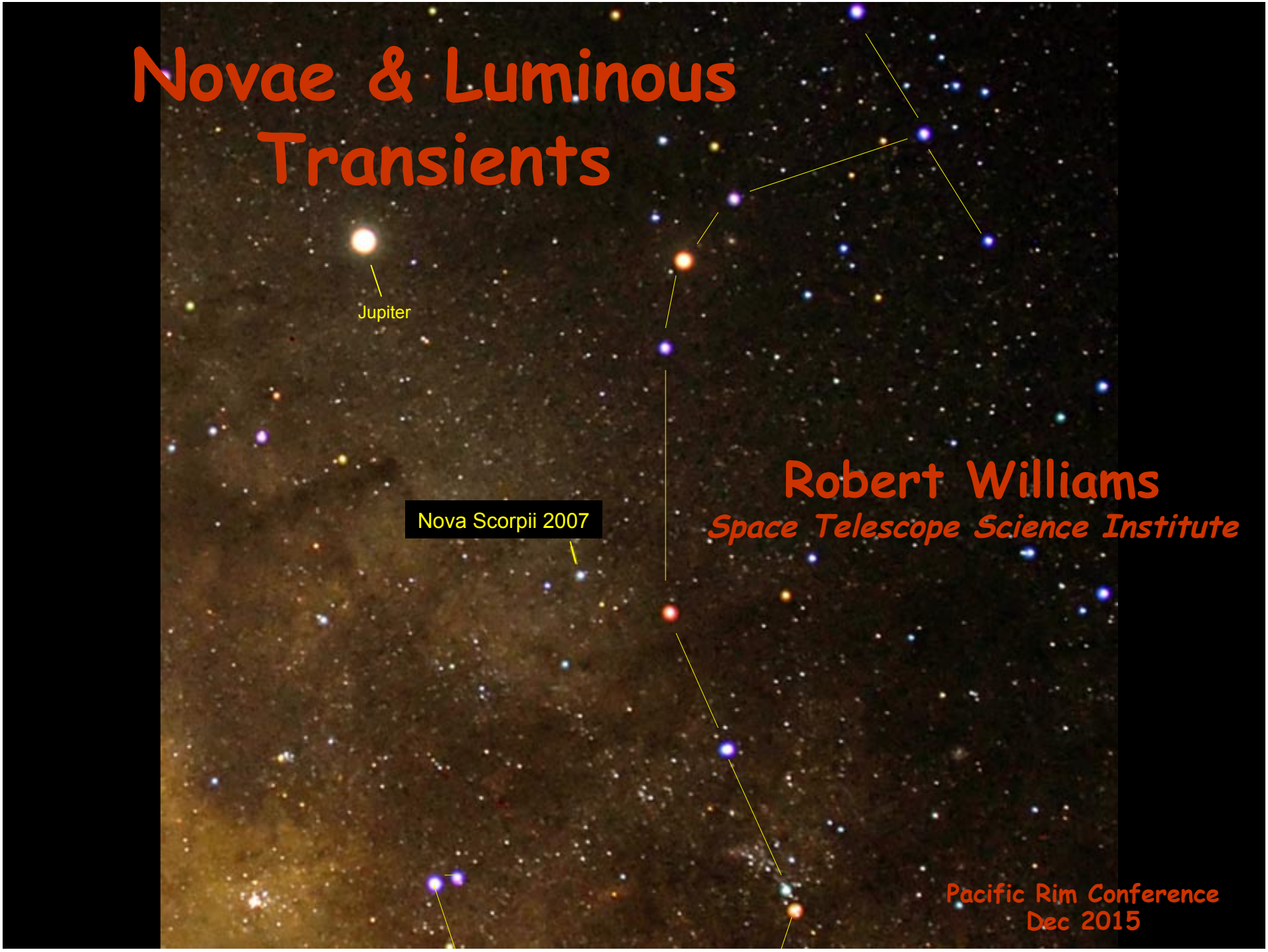
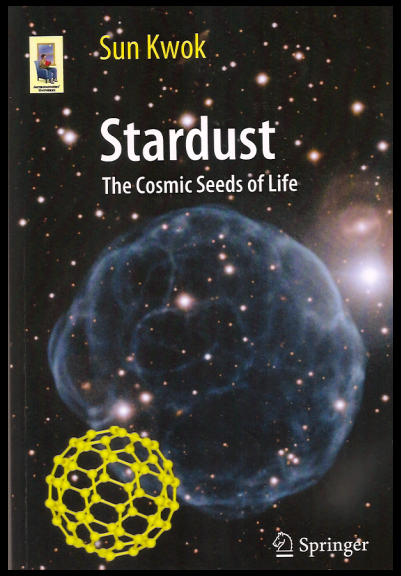
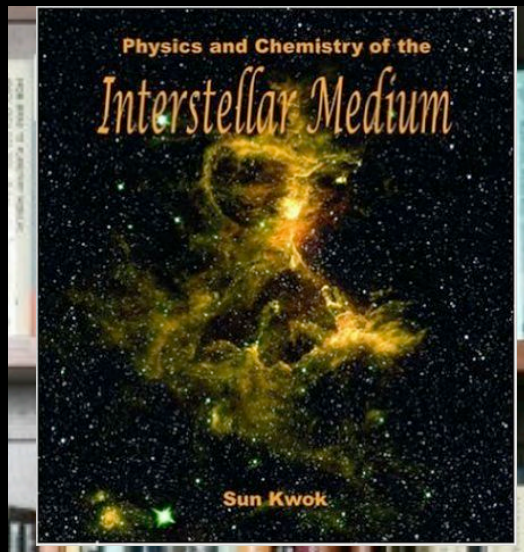
Novae & Luminous Transients

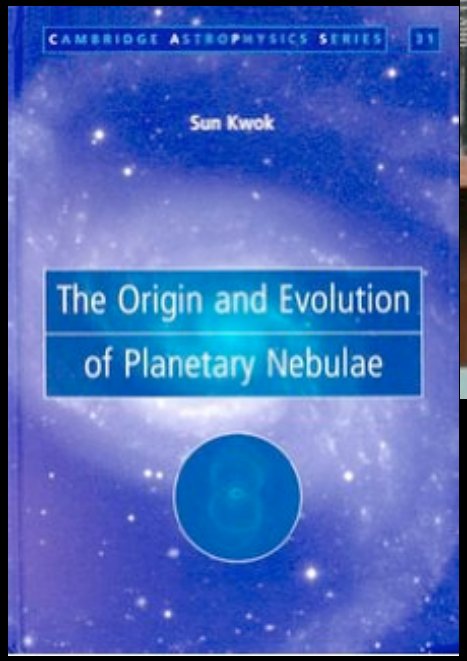


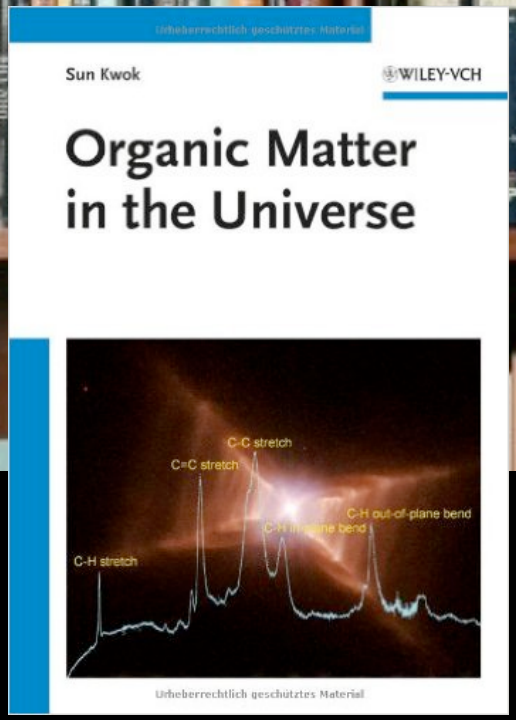
Robert Williams
Space Telescope Science Institute

Pacific Rim Conference
Dec 2015



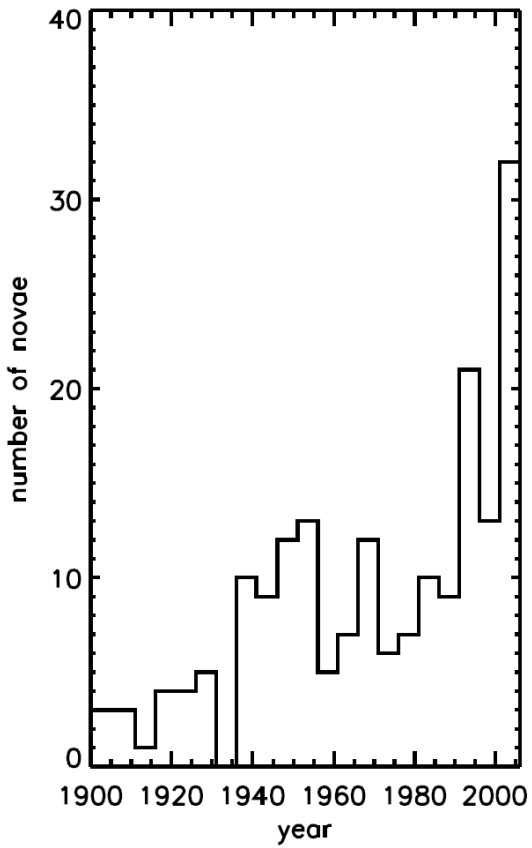


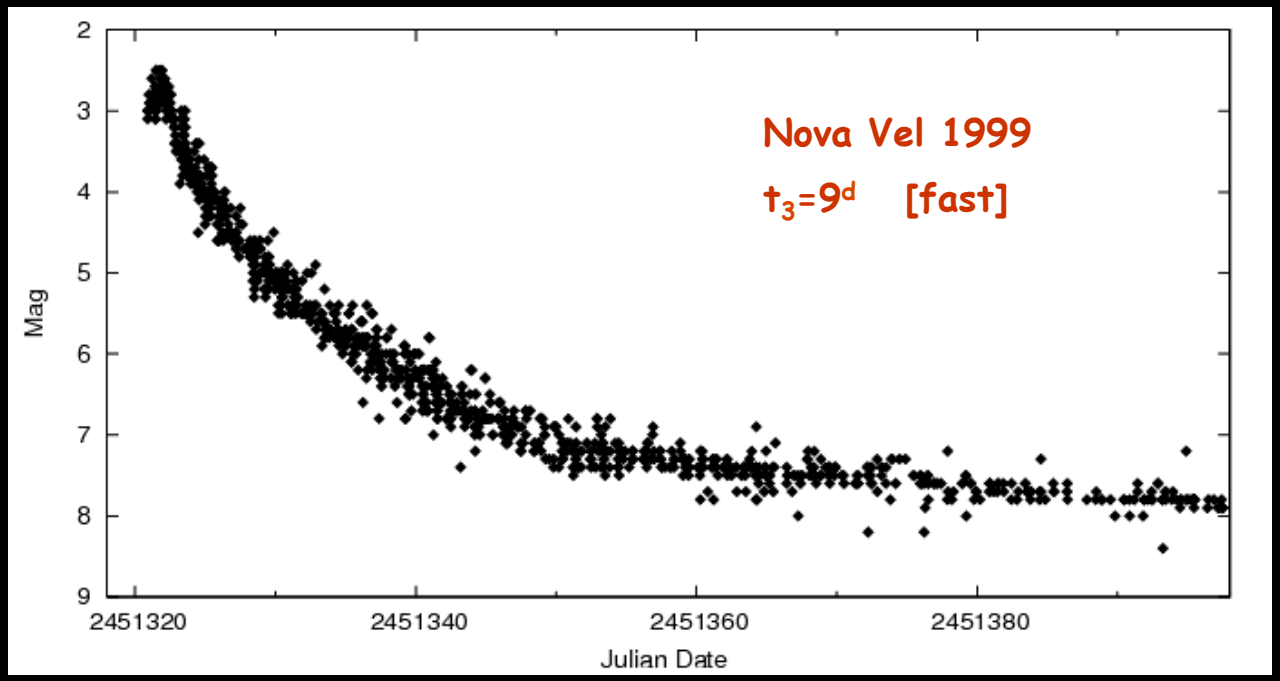


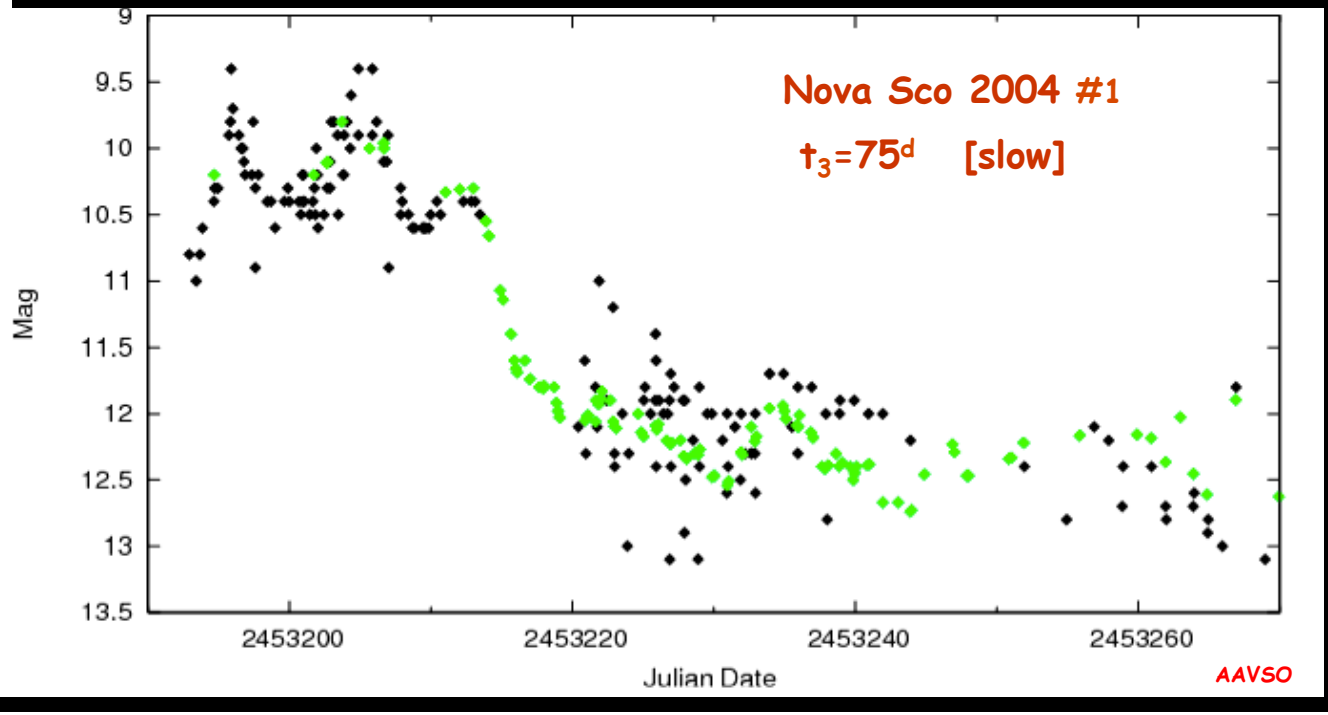


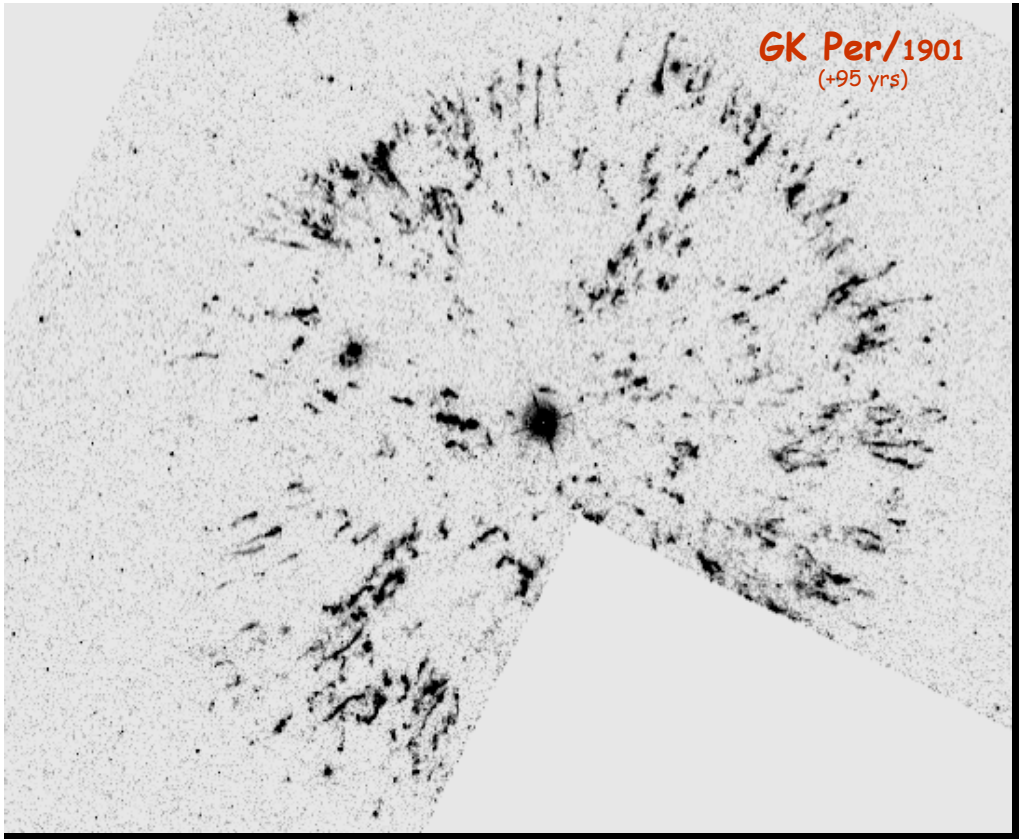
Thanks and best wishes to Sun KWOK

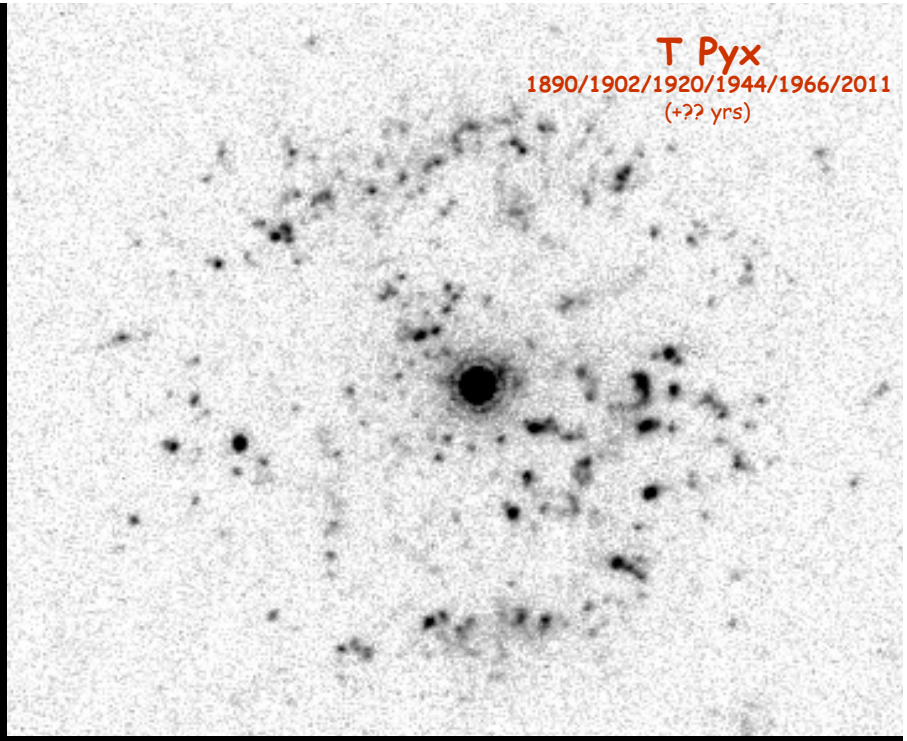
Novae: Discovery & Light Curves



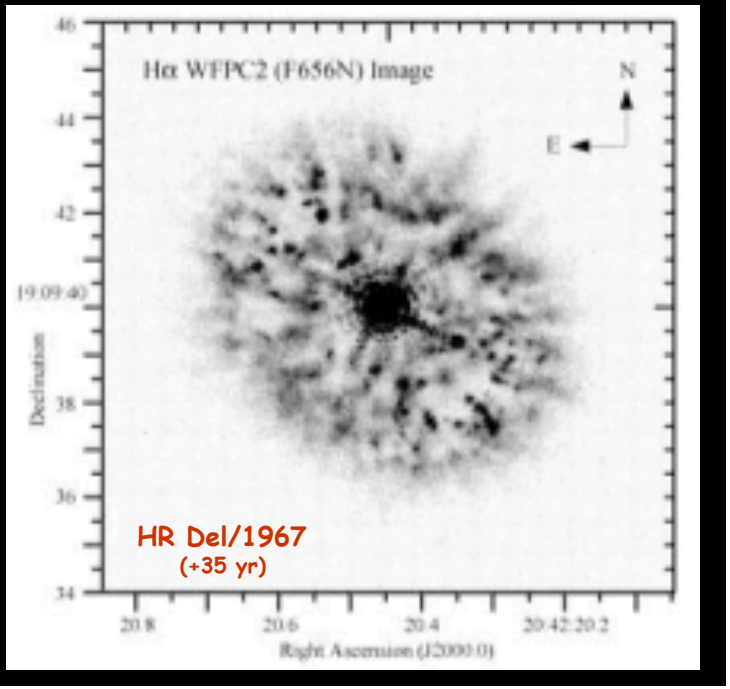


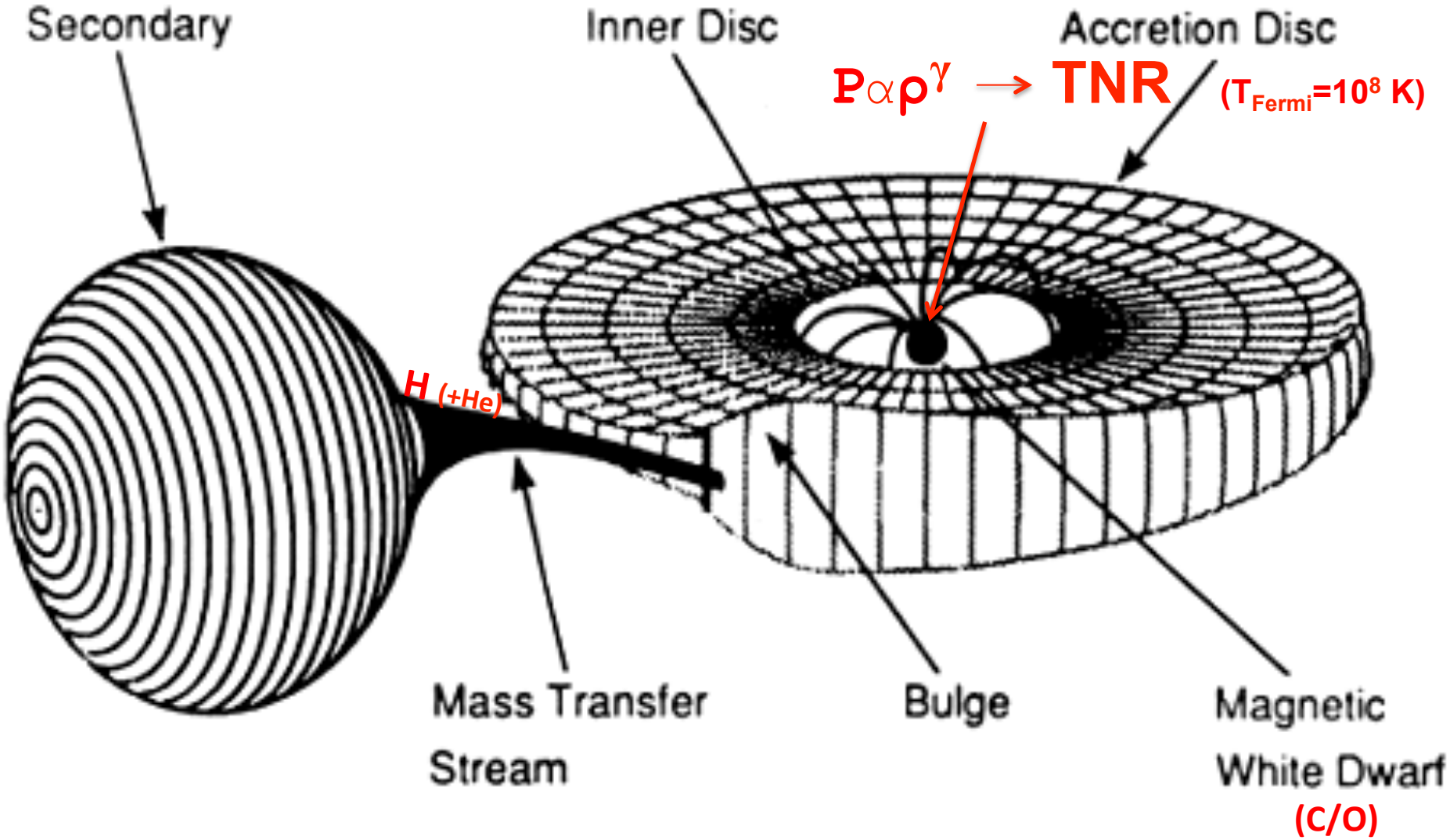



GK Per/1901
(+95 yrs)


T Pyx
1890/1902/1920/1944/1966/2011
(+?? yrs)


DQ Herculis/1934
(+45 yrs)


Hα WFPC2 (F656N) Image
N
E
HR Del/1967
(+35 yr)
Declination
Right Ascension (J2000.0)



Prototype Nova System
(with magnetic field)

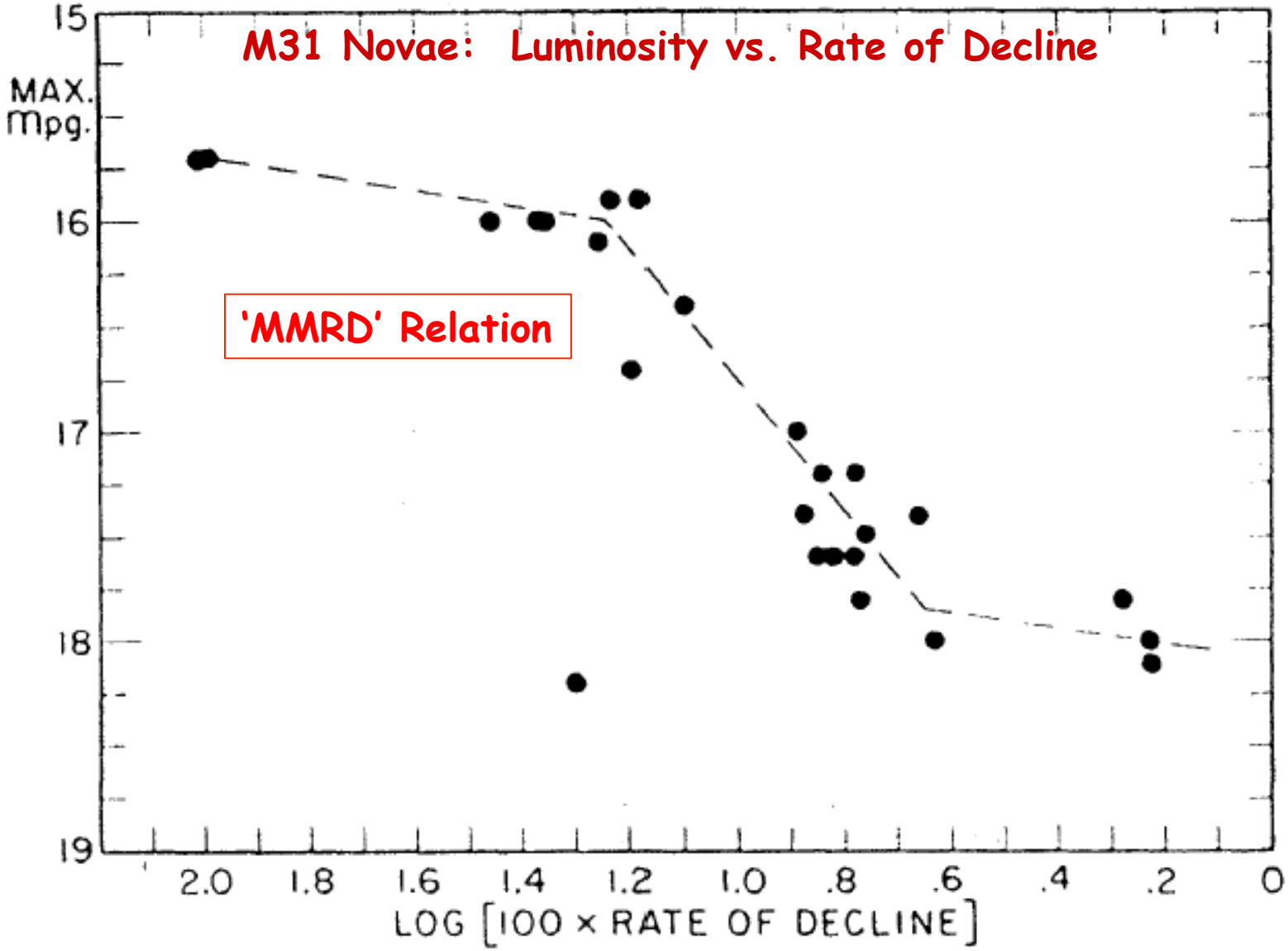


Figure 32. Relation between maximum magnitude and rate of decline through brightest 2 magnitudes. Point at lower left is No. 4.

Arp, H. 1956, AJ, 61, 15

M31 Novae: Luminosity vs. Rate of Decline

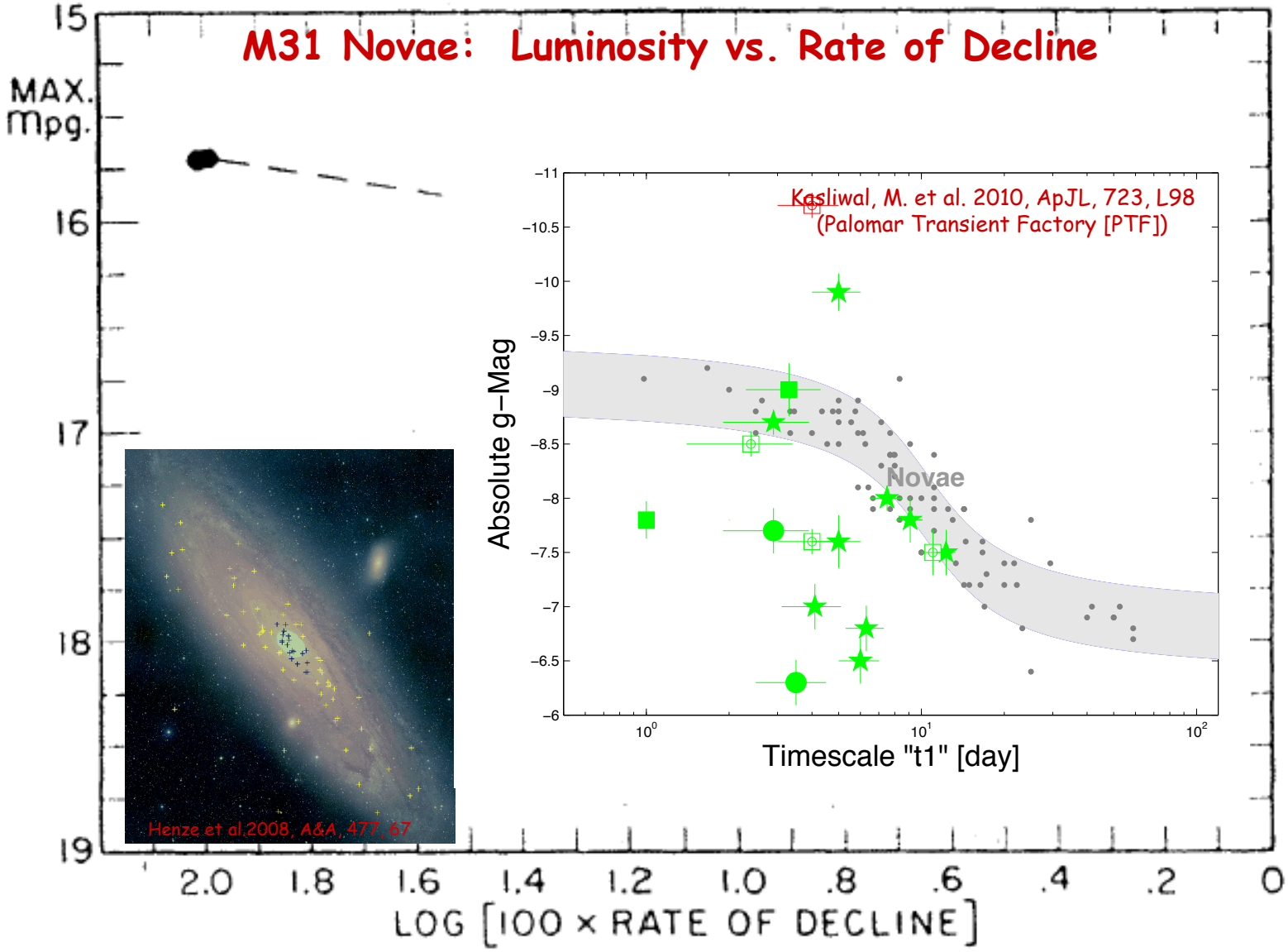
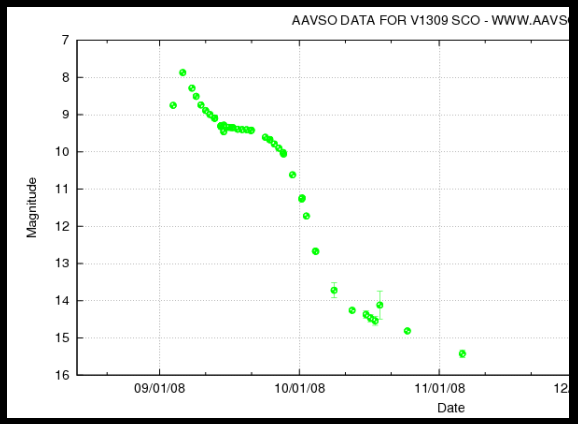
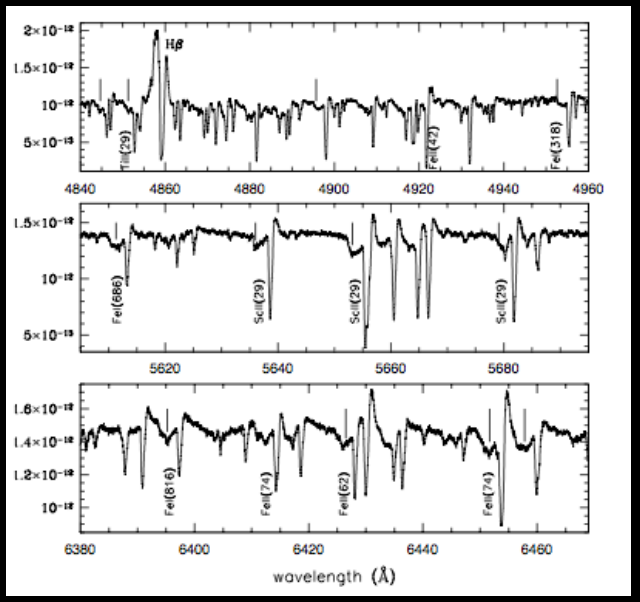


Figure 32. Relation between maximum magnitude and rate of decline through brightest 2 magnitudes. Point at lower left is No. 4.

'Nova' V1309 Sco/08





?

V838 Mon

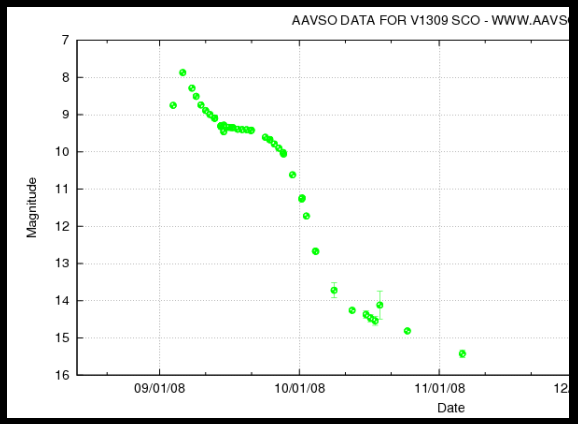
ABSTRACT

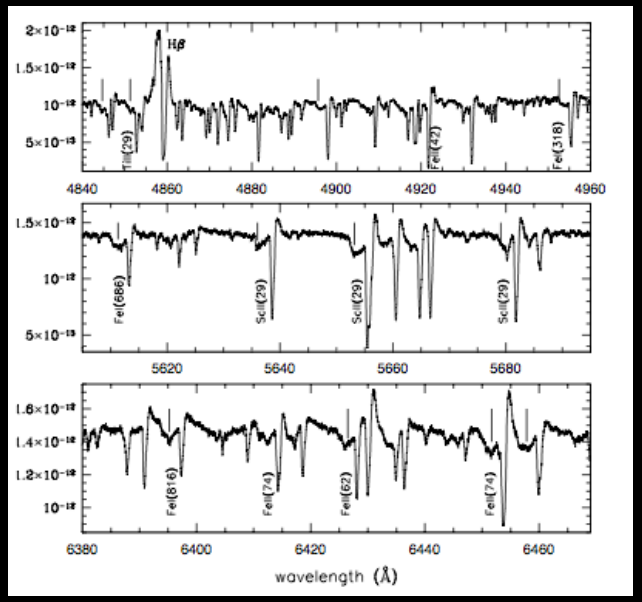
Aims. Nova Scorpii 2008 was the target of our Director Discretionary Time proposal at VLT+UVES in order to study the evolution, origin and abundances of the heavy-element absorption system recently discovered in 80% of classical novae in outburst.
Methods. The early decline of nova Scorpii 2008 was monitored with high resolution echelle spectroscopy at 5 different epochs. The analysis of the absorption and the emission lines show many unusual characteristics.
Results. Nova Scorpii 2008 is confirmed to differ from a common classical nova as well as a symbiotic recurrent nova, and it shows characteristics which are common to the so called, yet debated, red-novae. The origin of this new nova remains uncertain.

Key words. stars: individual: V1309 Sco – novae, cataclysmic variables – binaries: symbiotic

Mason+ 2010, A&A, 516, 108

'Nova' V1309 Sco/08

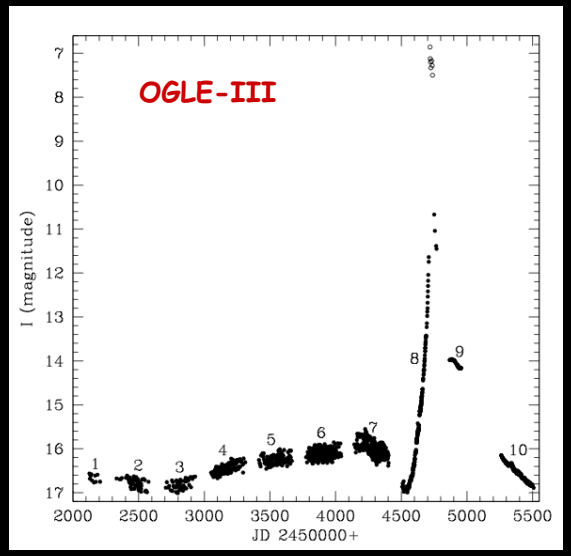


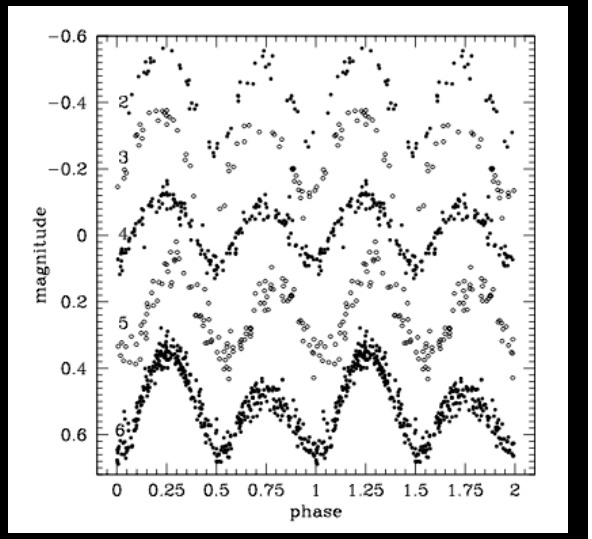


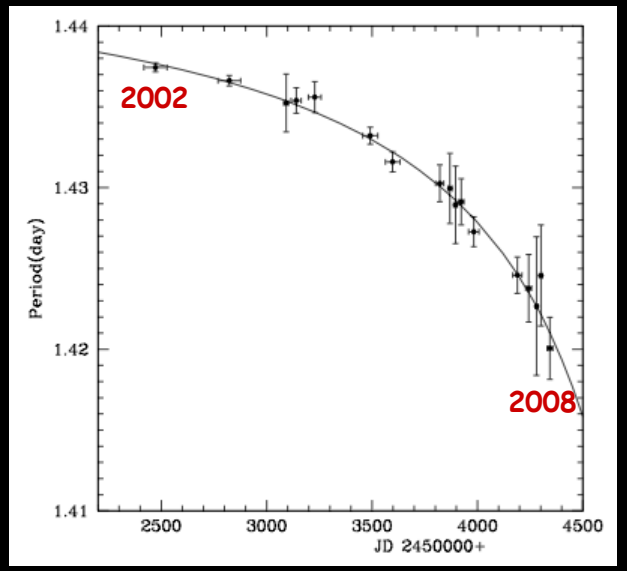
?

V838 Mon

Mason+ 2010, A&A, 516, 108

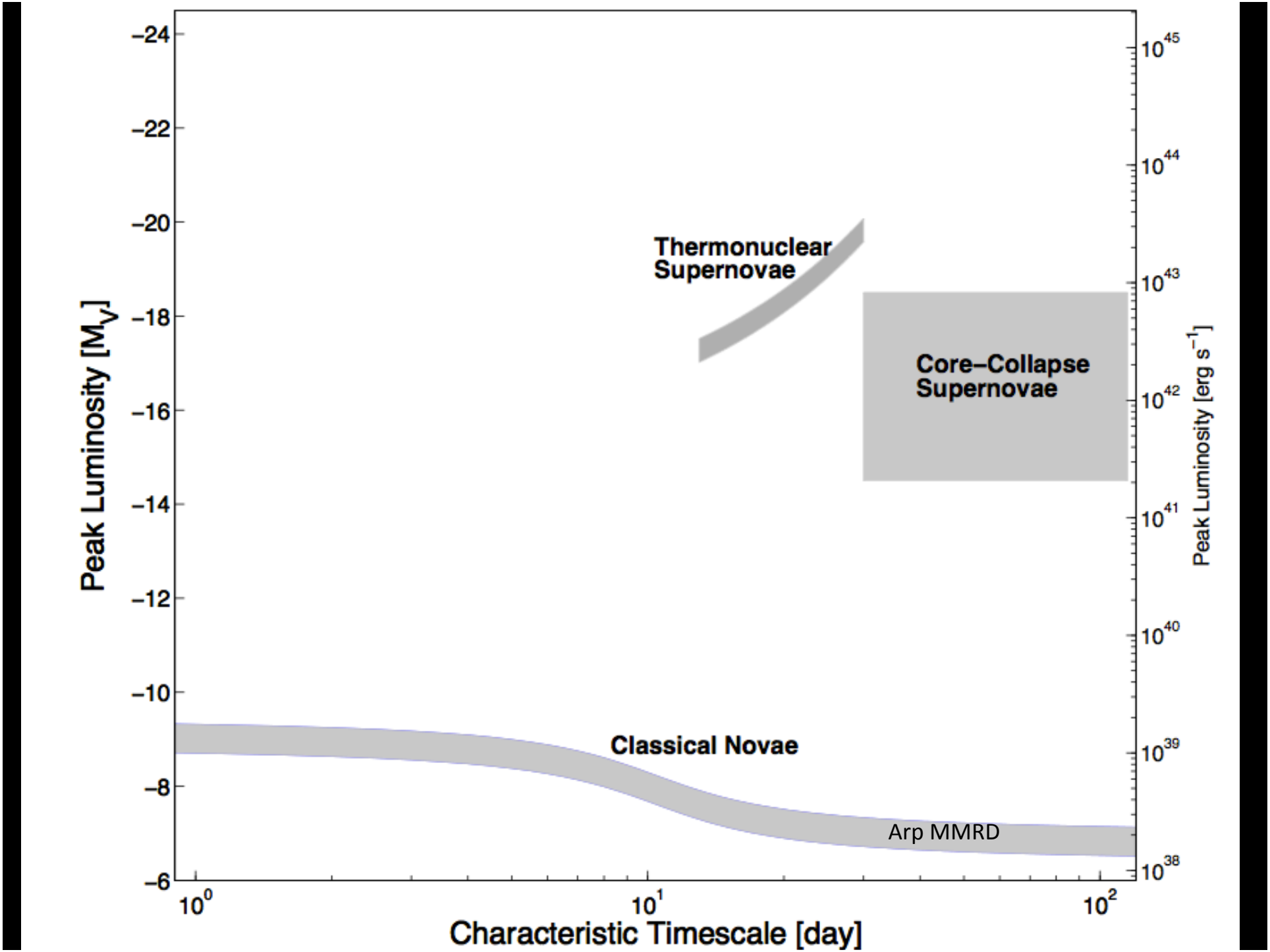


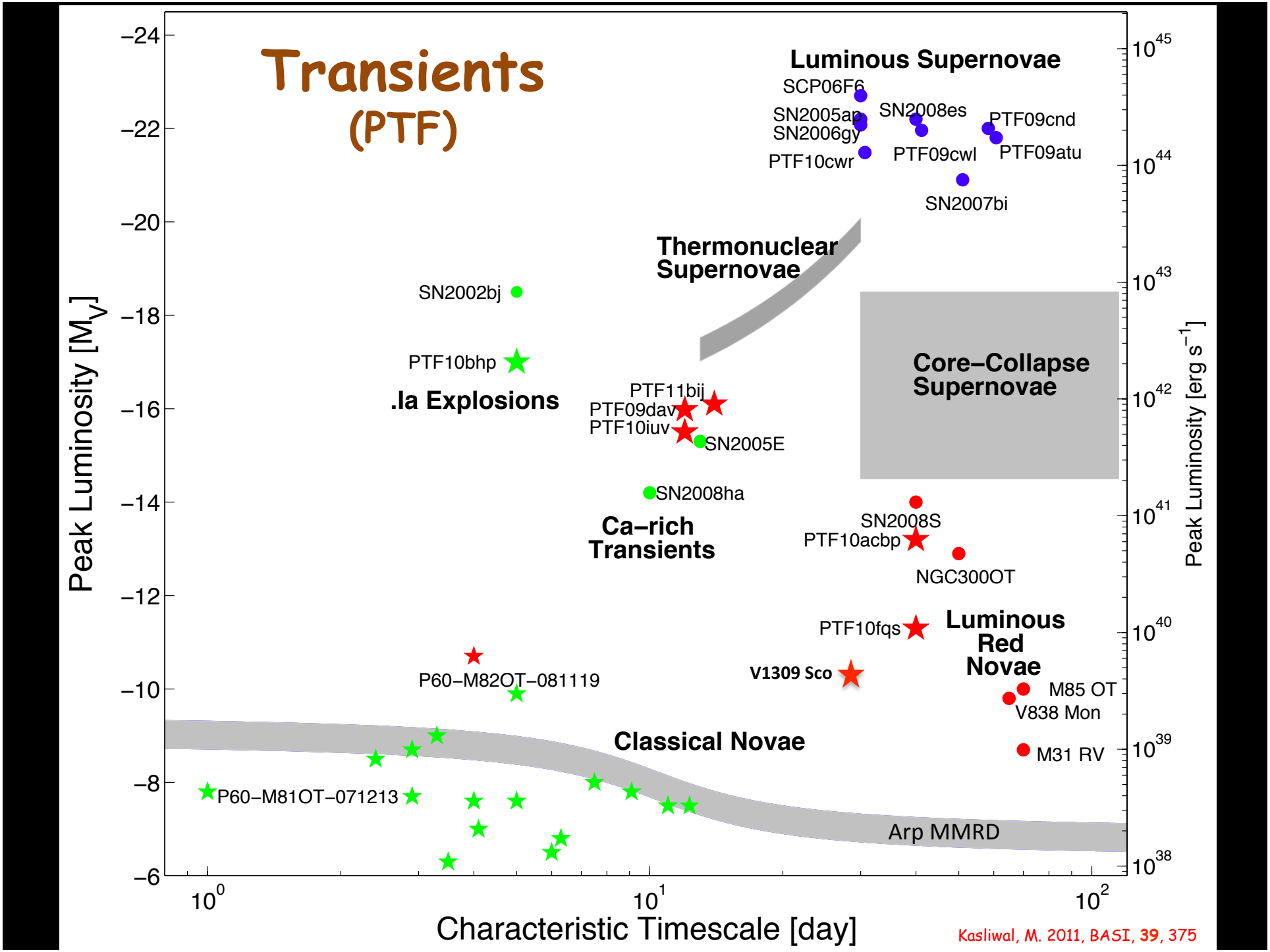




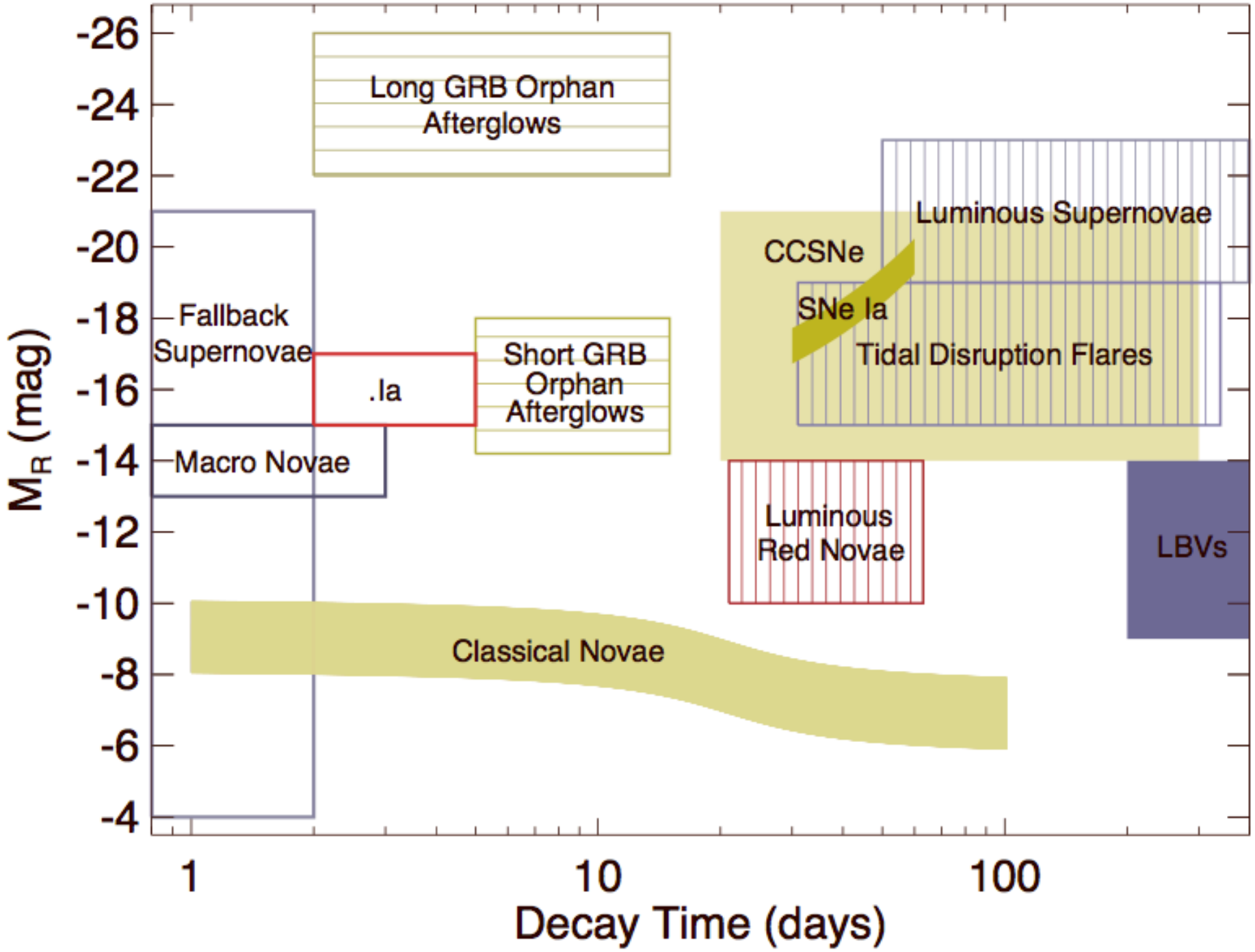
Tylenda+ 2011, A&A, 528, 114

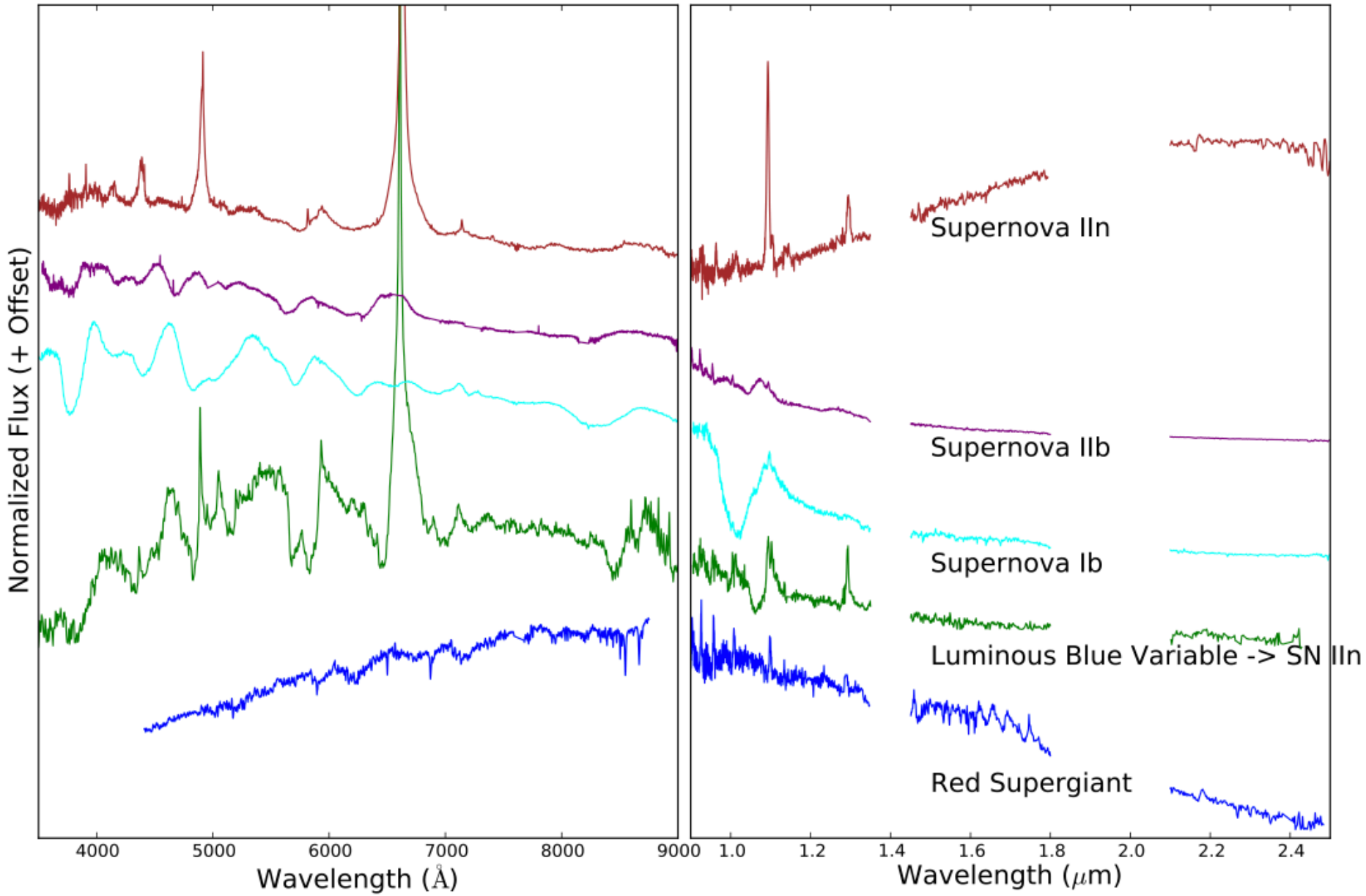
..... Merger of contact binary!

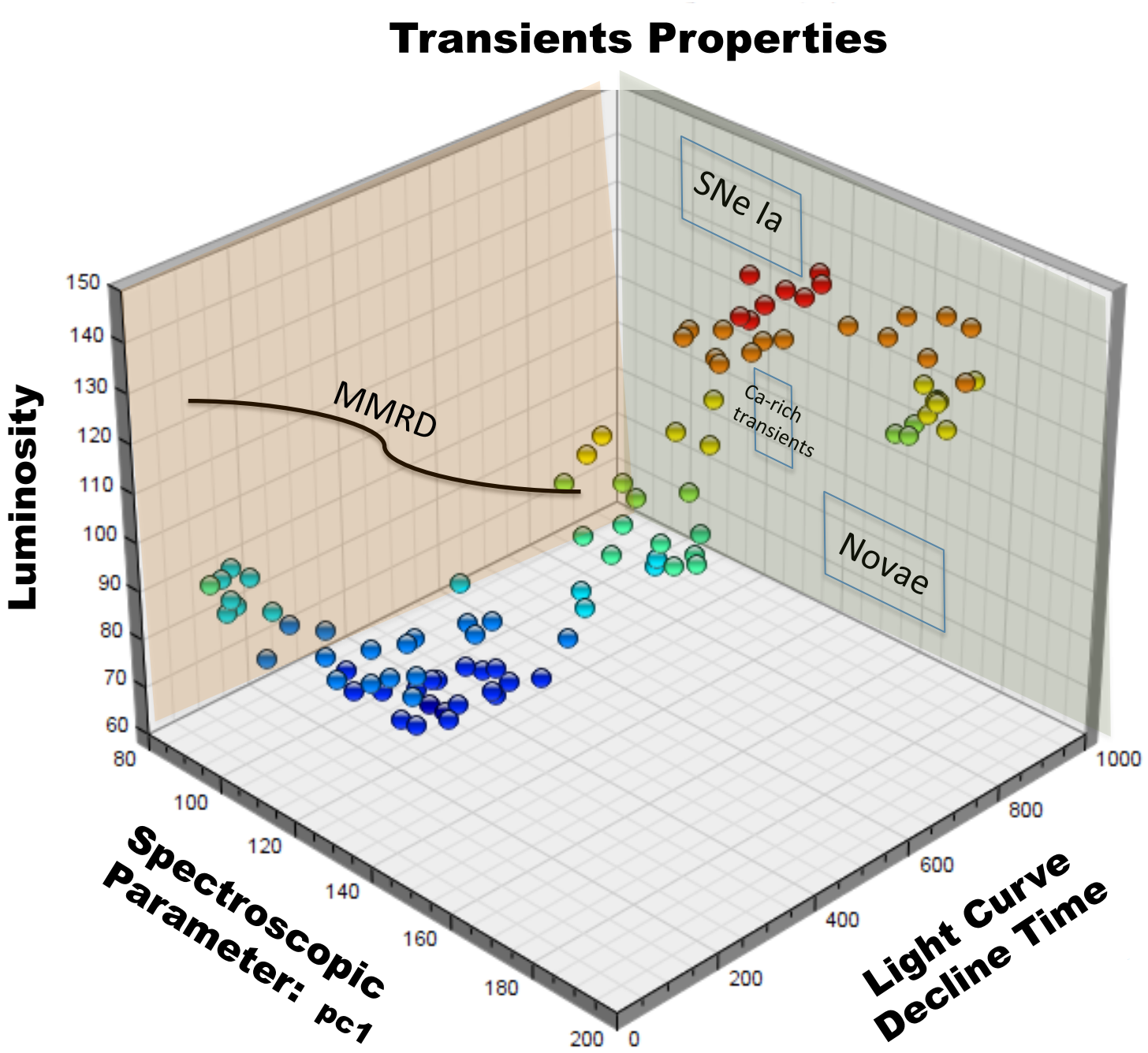

Thermonuclear Supernovae
Core–Collapse Supernovae
Classical Novae
Arp MMRD
Peak Luminosity [M_V]
Peak Luminosity [erg s^{-1}]
Characteristic Timescale [day]
−24
−22
−20
−18
−16
−14
−12
−10
−8
−6
10^{45}
10^{44}
10^{43}
10^{42}
10^{41}
10^{40}
10^{39}
10^{38}
10^{0}
10^{1}
10^{2}



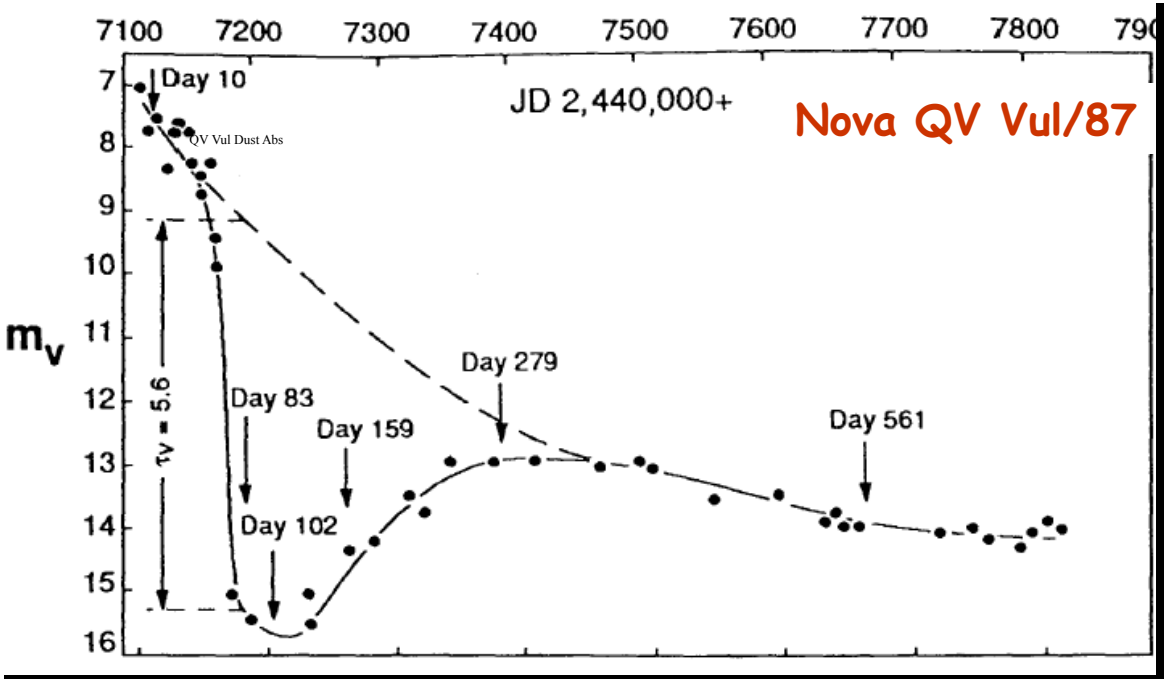
Kasliwal, M. 2011, BASI, **39**, 375

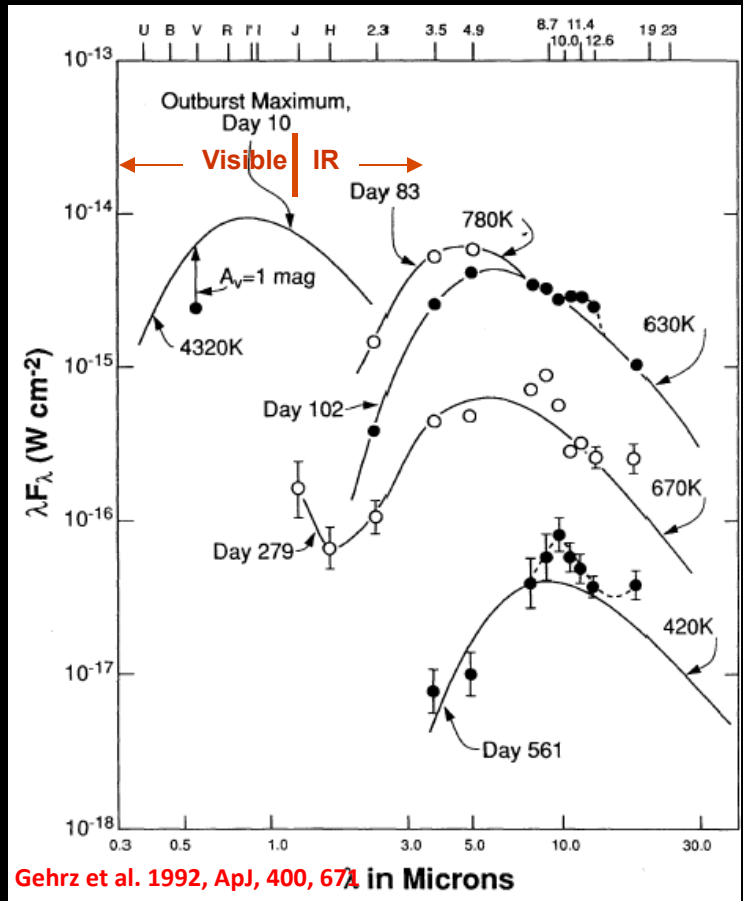

-26
-24
-22
-20
-18
-16
-14
-12
-10
-8
-6
-4
M_R (mag)
Long GRB Orphan Afterglows
Luminous Supernovae
CCSNe
SNe Ia
Tidal Disruption Flares
Fallback Supernovae
.Ia
Short GRB Orphan Afterglows
Macro Novae
Luminous Red Novae
LBVs
Classical Novae
1
10
100
Decay Time (days)


Normalized Flux (+ Offset)
4000
5000
6000
7000
8000
9000
Wavelength (Å)
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
Wavelength (μm)
Supernova IIn
Supernova IIb
Supernova Ib
Luminous Blue Variable -> SN IIn
Red Supergiant


Transients Properties
Luminosity
150
140
130
120
110
100
90
80
70
60
MMRD
SNe Ia
Ca-rich transients
Novae
80
100
120
140
160
180
200
Spectroscopic Parameter: pc1
0
200
400
600
800
1000
Light Curve Decline Time

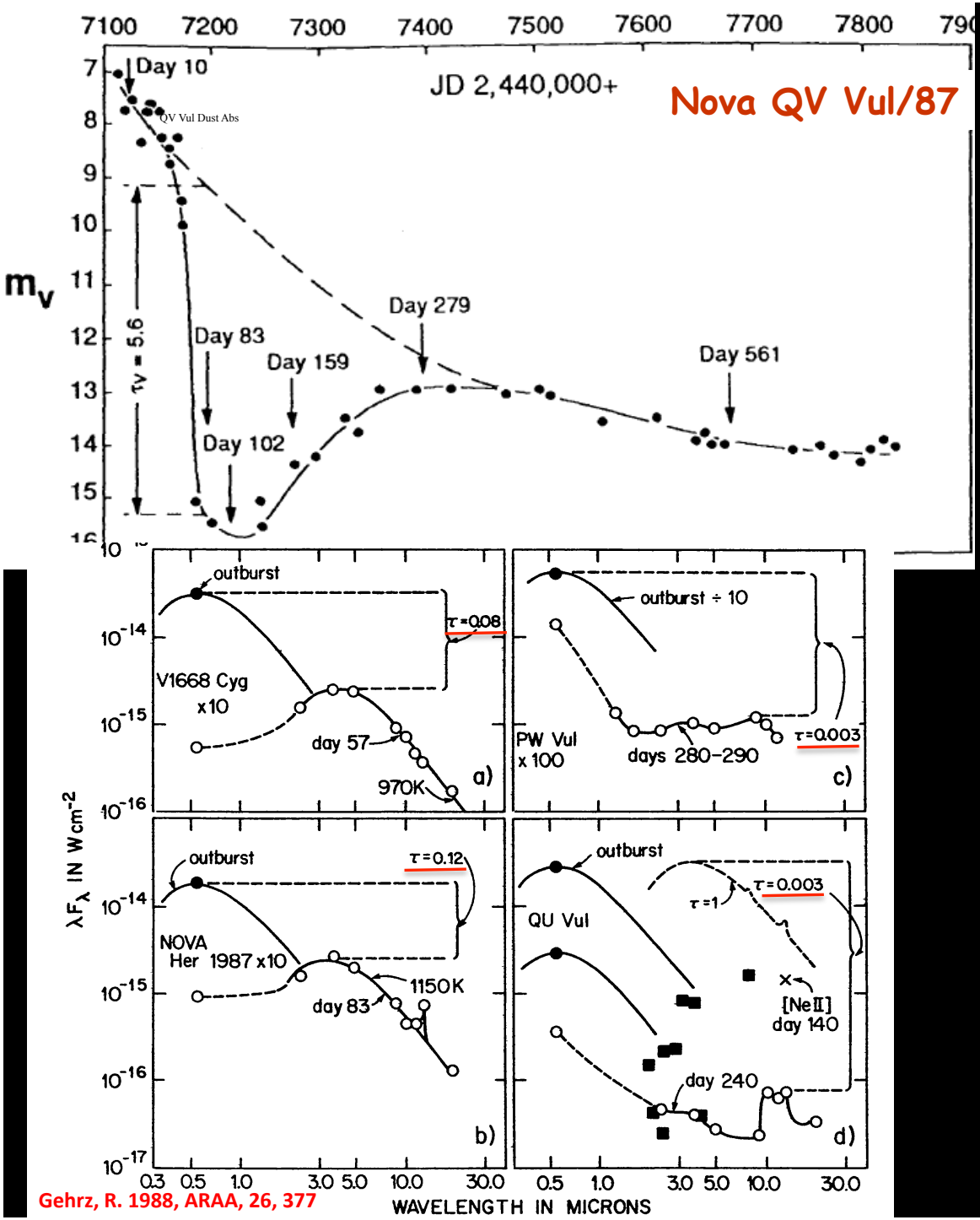
Optical Extinction & IR Emission: Dust Formation



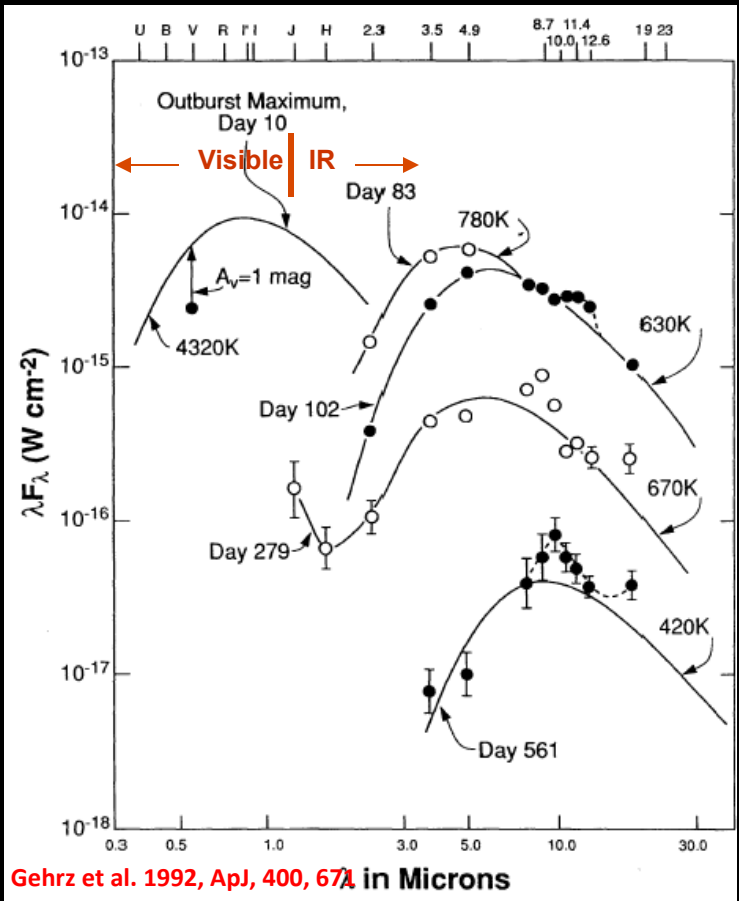


Gehrz et al. 1992, ApJ, 400, 671

Optical Extinction & IR Emission: Dust Formation



Gehrz, R. 1988, ARAA, 26, 377

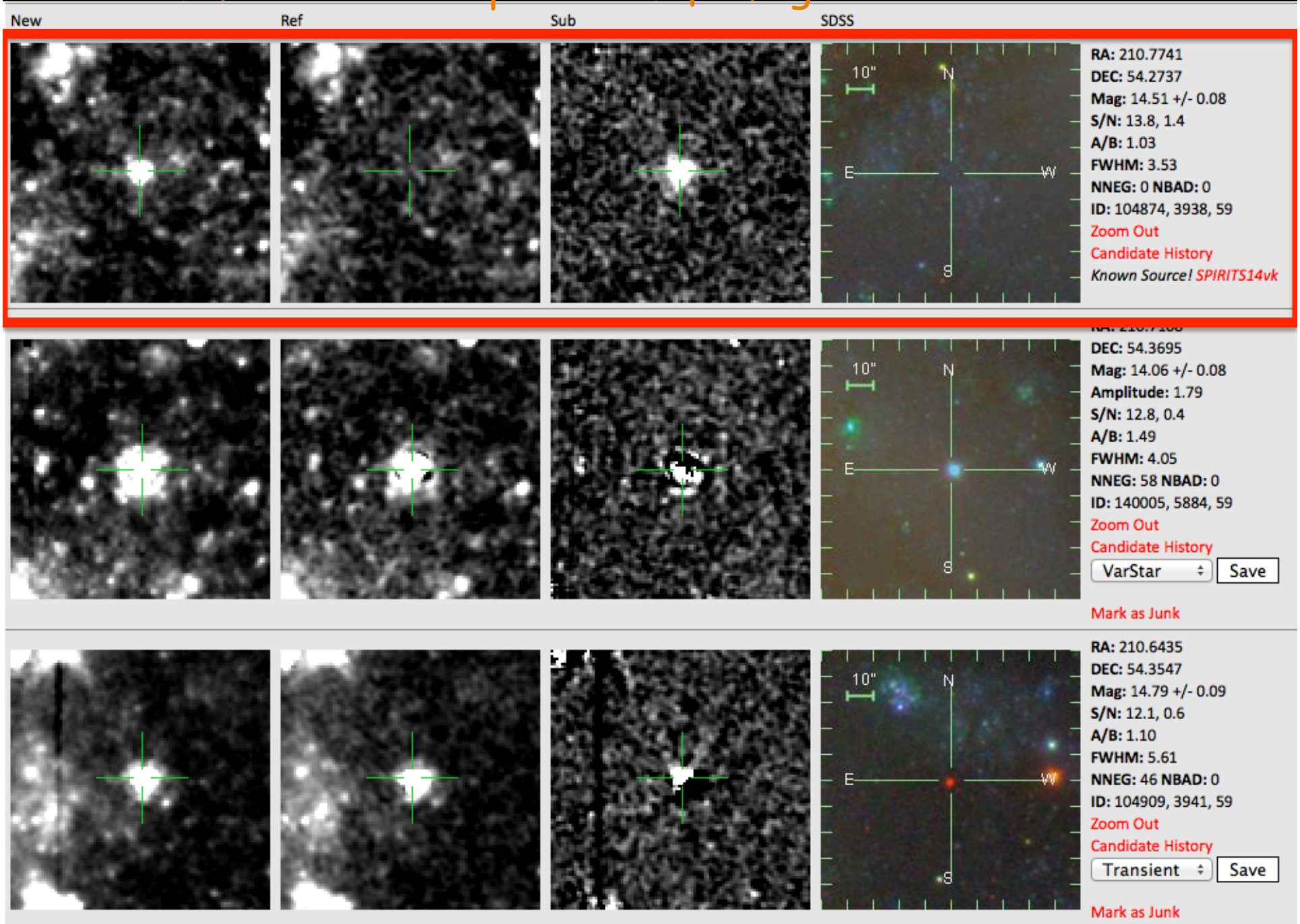


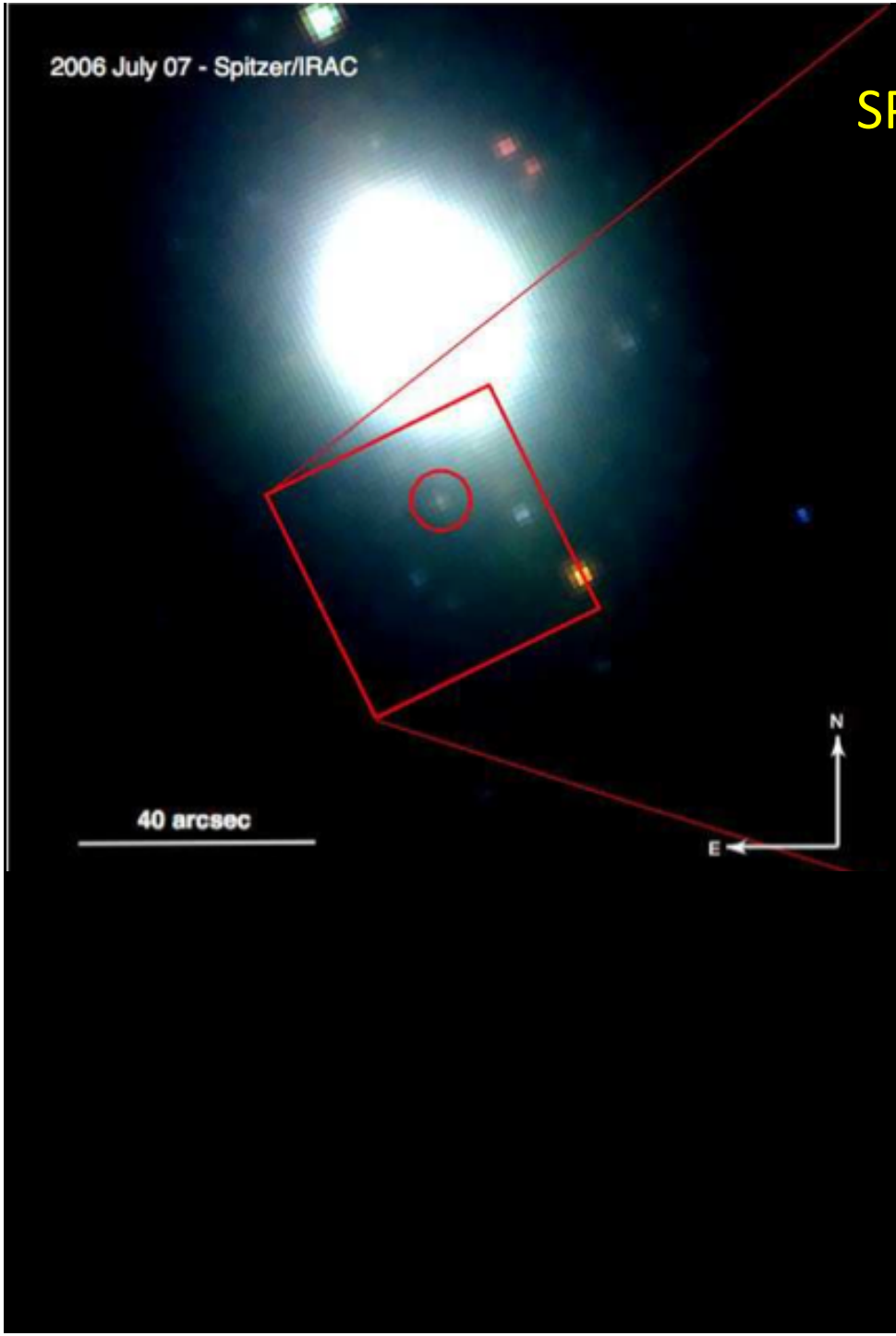
Gehrz et al. 1992, ApJ, 400, 671

SPIRITS Program (M. Kasliwal, PI)

- Spitzer-warm Cycles 10 & 11: 338 + 790 hrs
- L & M bands (3.6μ & 4.5μ)
- ~200 galaxies d < 20 Mpc
- Observing Cadence: 1,2,3 week/month/3-6 months
- Limiting IR detection: ($m_{3.6}$<20 ; $m_{4.5}$< 19)
  - d< 5 Mpc: M_{IR} < -8.5 (novae)
  - d< 20 Mpc: M_{IR} < -11.5 (explosive transients)
- Follow-up photometry & spectroscopy

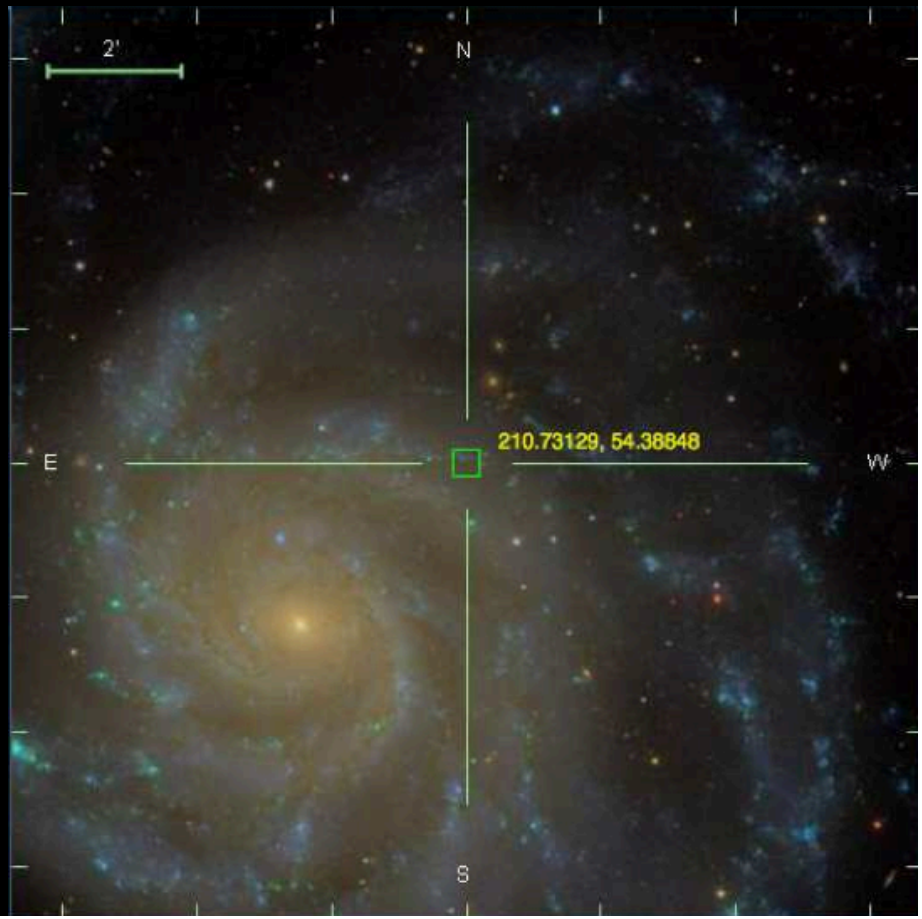
M101 Spitzer 3.6μ images

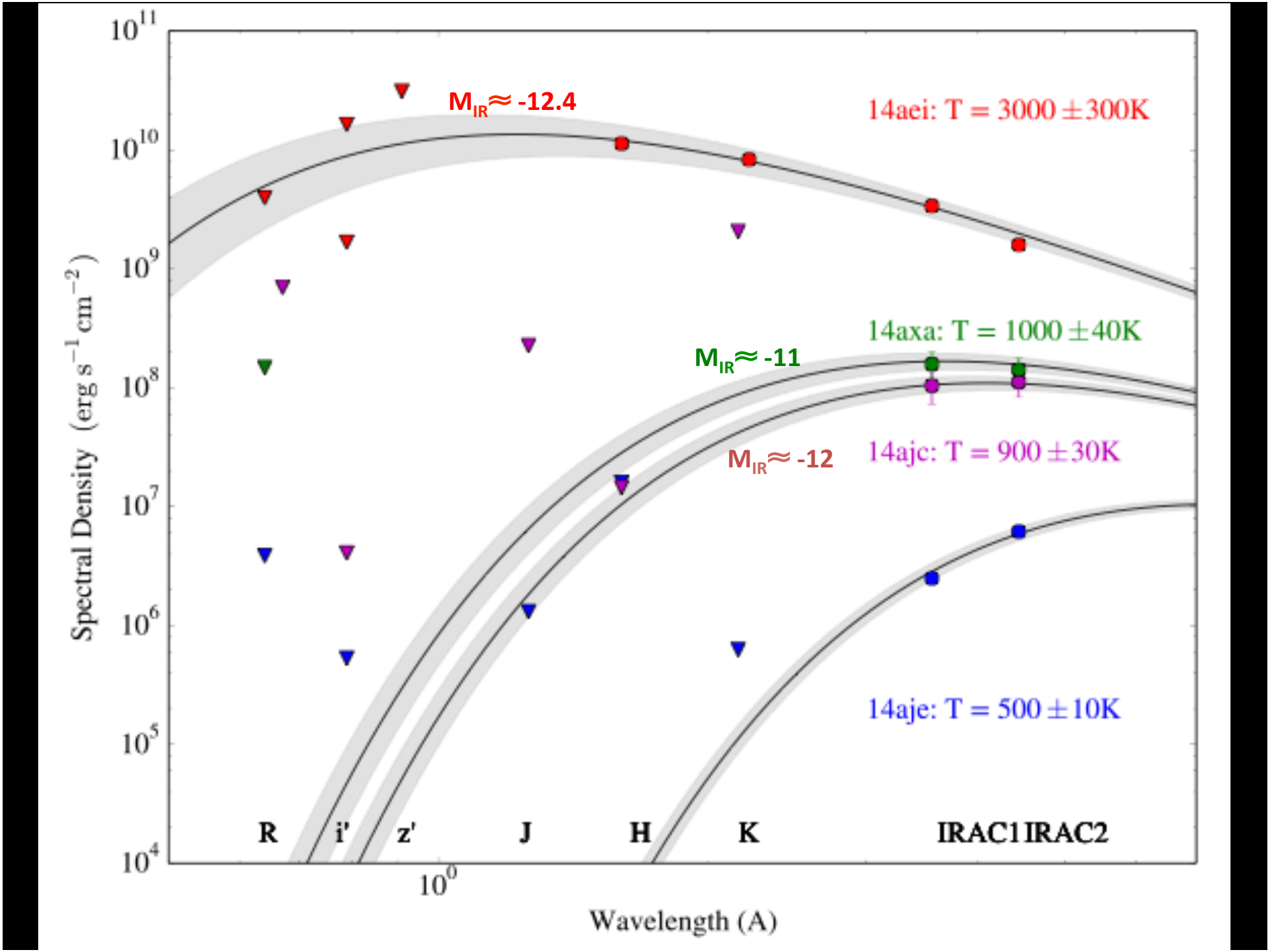


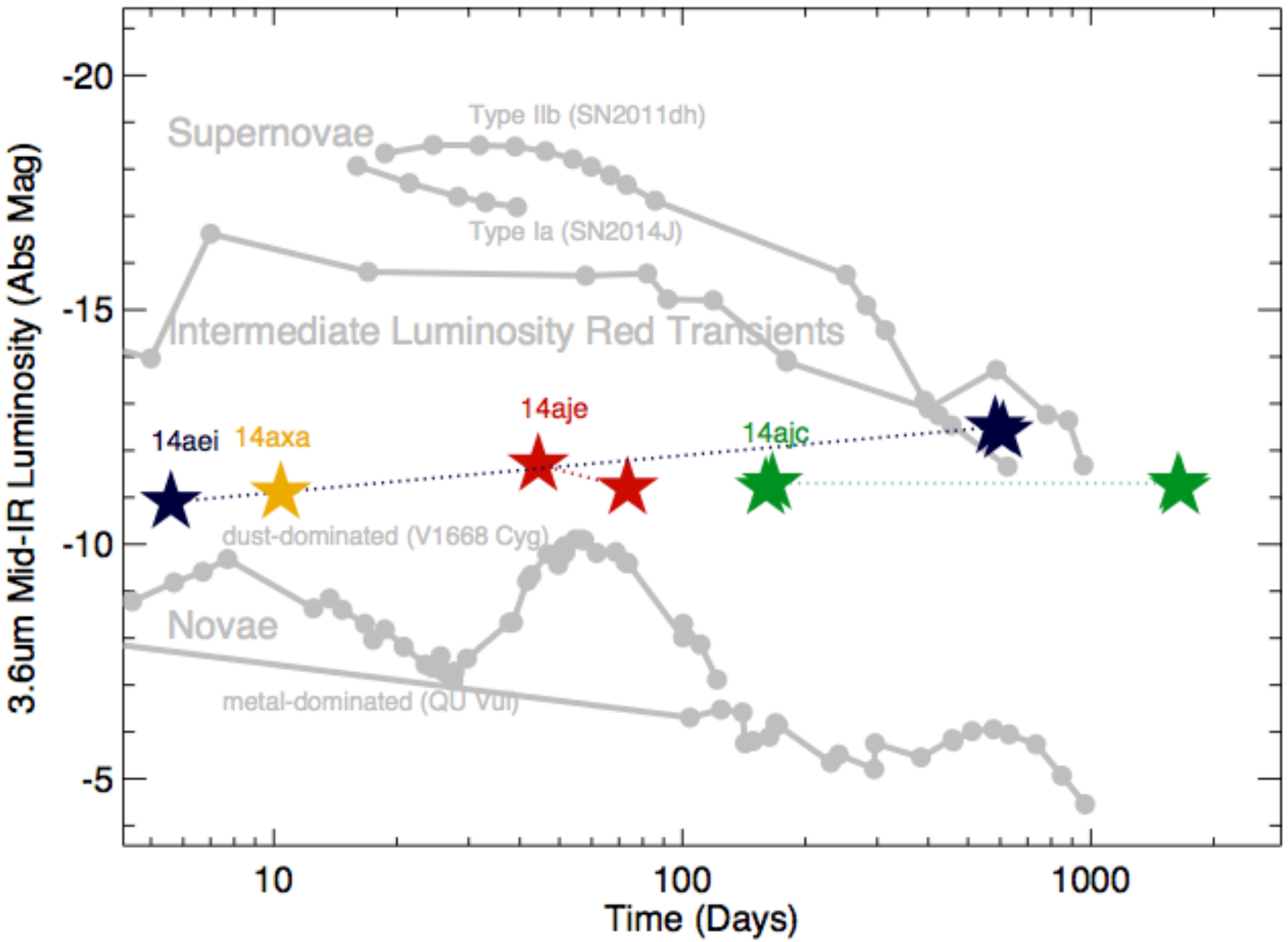


SPIRITS has detected (Spitzer C10):

- 21 SNe
- 4 novae
- 15 'gap' transients (in spirals; no optical counterparts)
- 1200 IR variables




$M_{IR} \approx -12.4$
14aei: T = 3000 ±300K
14axa: T = 1000 ±40K
$M_{IR} \approx -11$
$M_{IR} \approx -12$
14ajc: T = 900 ±30K
14aje: T = 500 ±10K
R
i'
z'
J
H
K
IRAC1
IRAC2
Spectral Density (erg s^{-1} cm^{-2})
Wavelength (A)
10^{11}
10^{10}
10^{9}
10^{8}
10^{7}
10^{6}
10^{5}
10^{4}
10^{0}


-20
-15
-10
-5
3.6um Mid-IR Luminosity (Abs Mag)
Supernovae
Type IIb (SN2011dh)
Type Ia (SN2014J)
Intermediate Luminosity Red Transients
14aei
14axa
14aje
14ajc
dust-dominated (V1668 Cyg)
Novae
metal-dominated (QU Vul)
10
100
1000
Time (Days)