Evolution and Development of the Slow, Dusty Nova, V1280 Sco

SCTF
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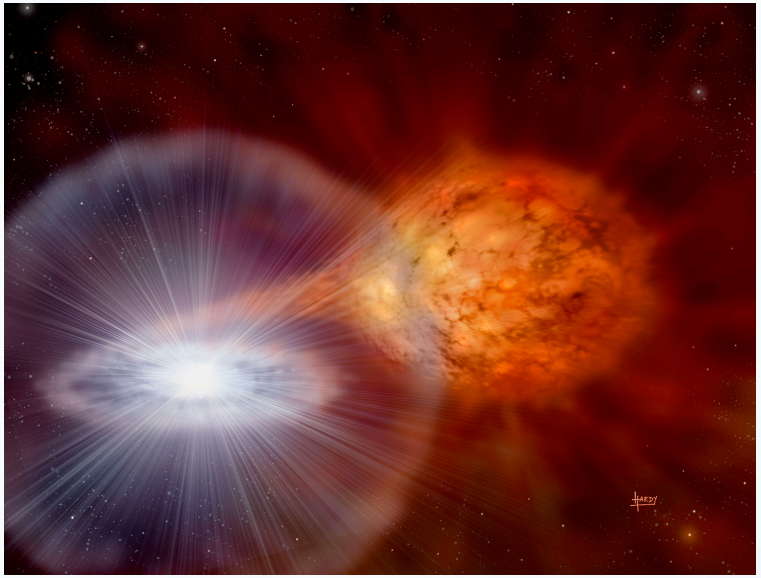
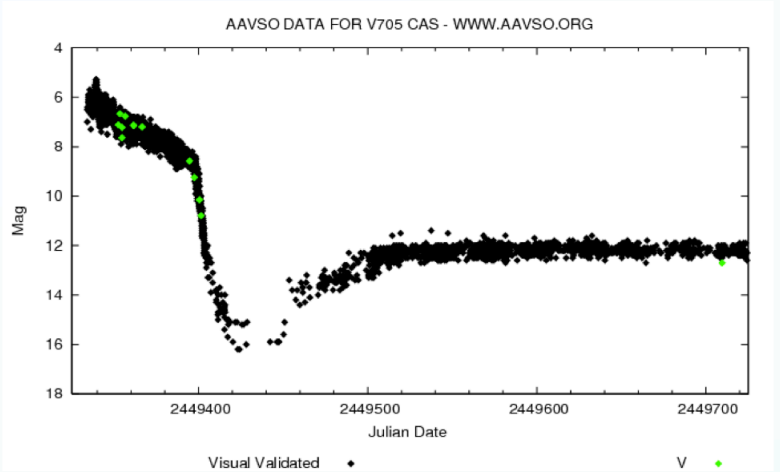
Classical Novae

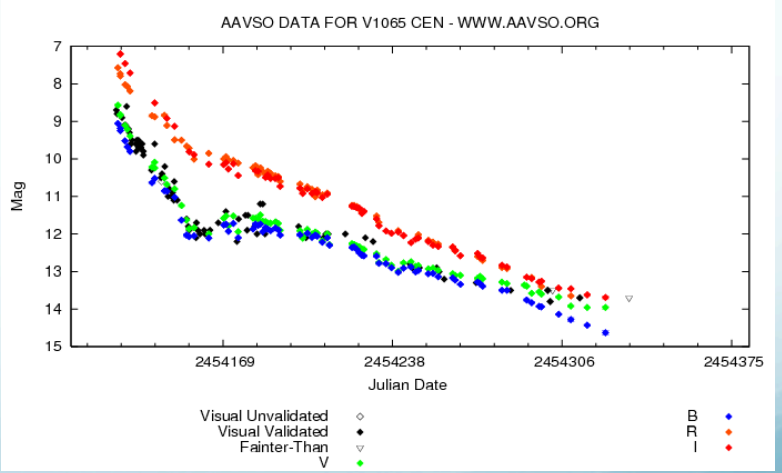
- Binary system with a WD primary & MS secondary
- Undergoes thermonuclear runaway
- Expands as a fireball
- Luminosity increases by up to 18 mag
- Ejects up to 10^{-4} M_{sol} of enriched material



Dust in Novae

- Known at least since DQ Her (1934)
- Often characterized by (deep) extinction event in optical light curve

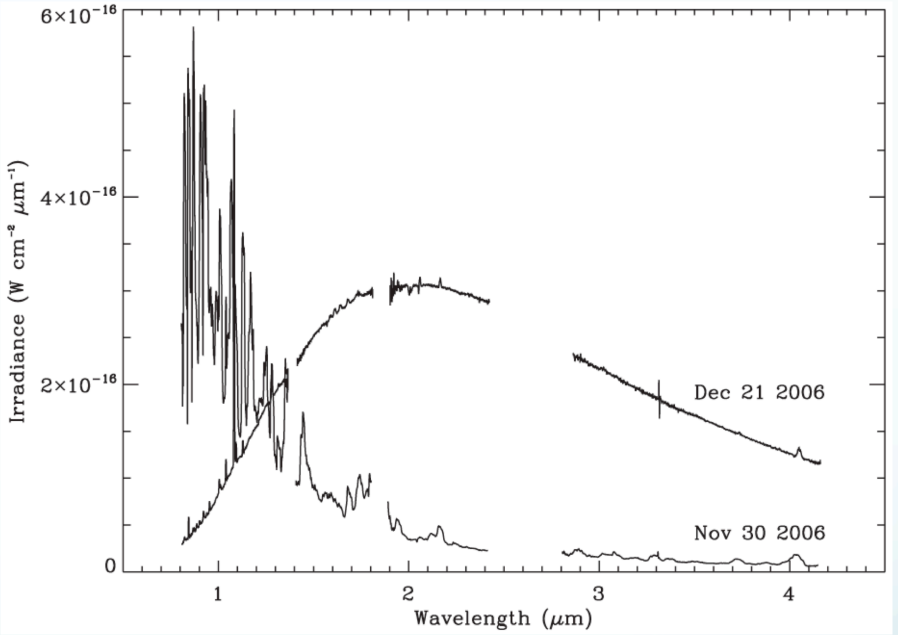




Dust in Novae

- Known at least since DQ Her (1934)
- Often characterized by (deep) extinction event in optical light curve
- Variety of dust species
  - Amorphous Carbon

V2362 Cyg

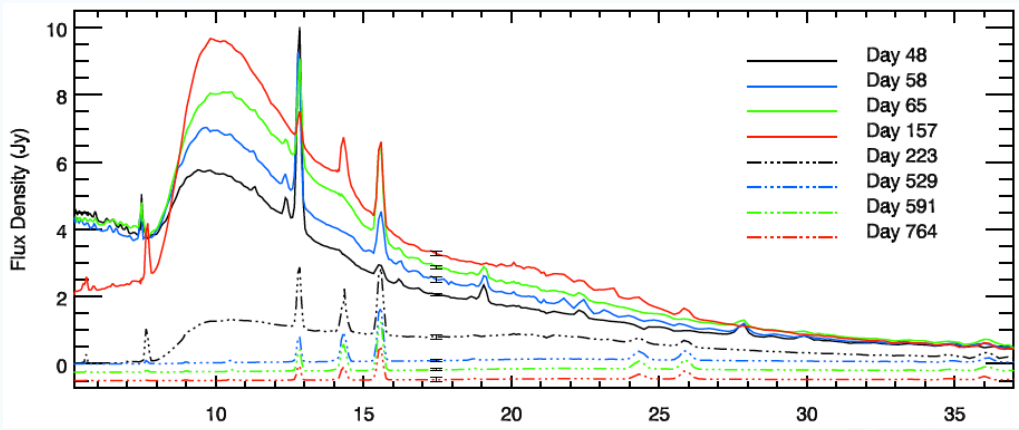


Lynch et al. 2008, AJ, 136, 1815

Dust in Novae

- Known at least since DQ Her (1934)
- Often characterized by (deep) extinction event in optical light curve
- Variety of dust species
  - Amorphous Carbon
  - Silicates

V1065 Cen

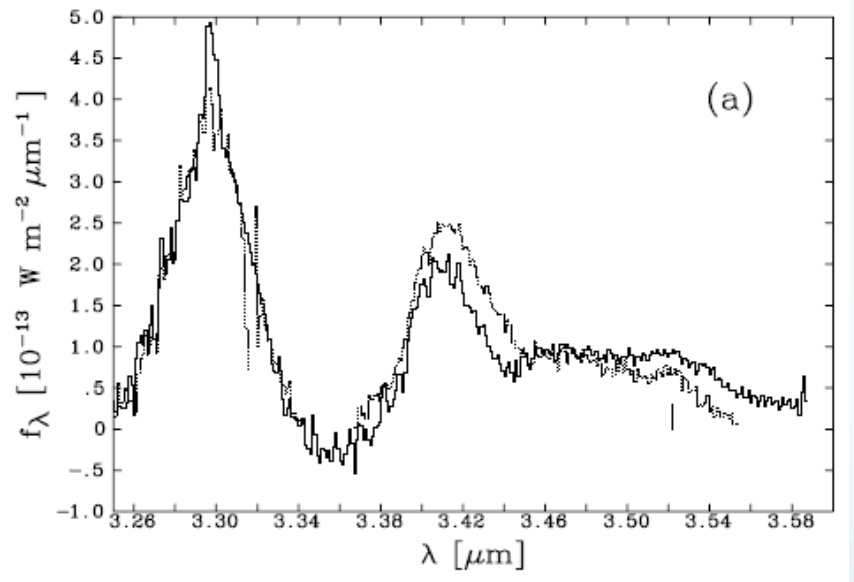


Helton et al. 2010, AJ, 140, 1347

Dust in Novae

- Known at least since DQ Her (1934)
- Often characterized by (deep) extinction event in optical light curve
- Variety of dust species
  - Amorphous Carbon
  - Silicates
  - Silicon Carbide
  - Hydrocarbons

V705 Cas

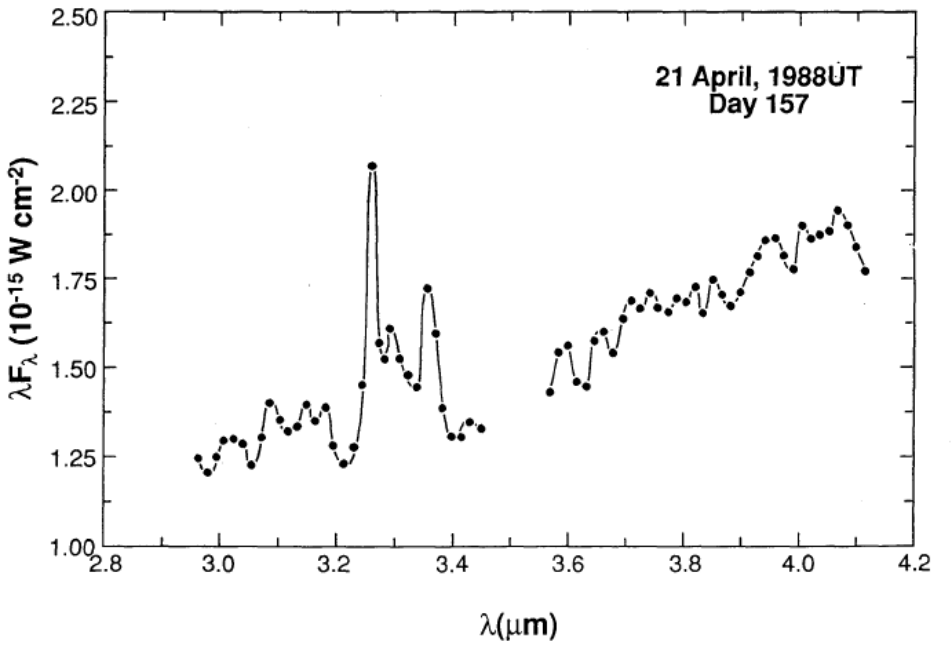


Evans et al. 2005, MNRAS 360, 1483

Hydrocarbons in Novae

- QV Vulpeculae

QV Vul

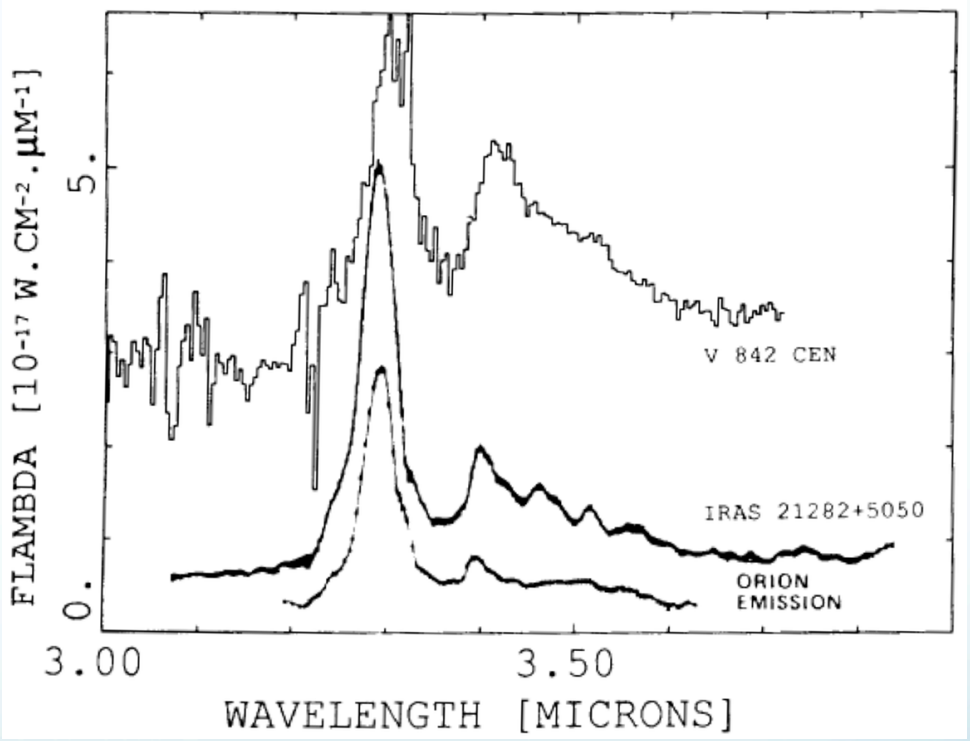


Gehrz et al. 1992, ApJ 400, 671

Hydrocarbons in Novae

- V842 Centauri
- 3.28/3.4 ratio smaller than that observed in other astronomical sources
- This ratio is indicative of the aromatic to aliphatic ratio

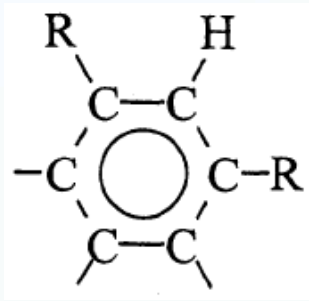
V842 Cen



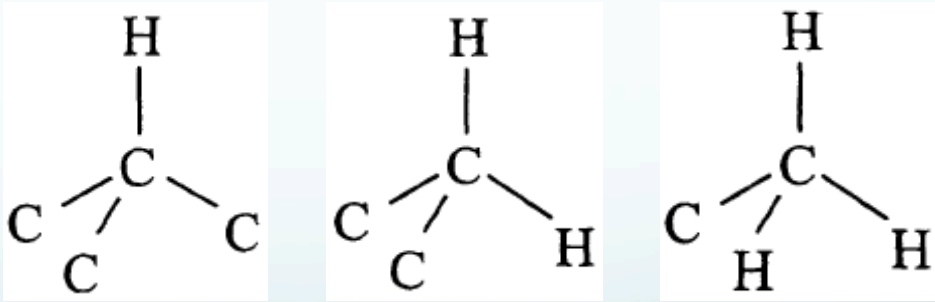
Hyland & McGregor 1986, IAU Symp. 135, 101

Aromatics & Aliphatics

- Aromatics → Carbon ring molecules
  - C–H stretching mode oscillations give rise to 3.3 μm feature



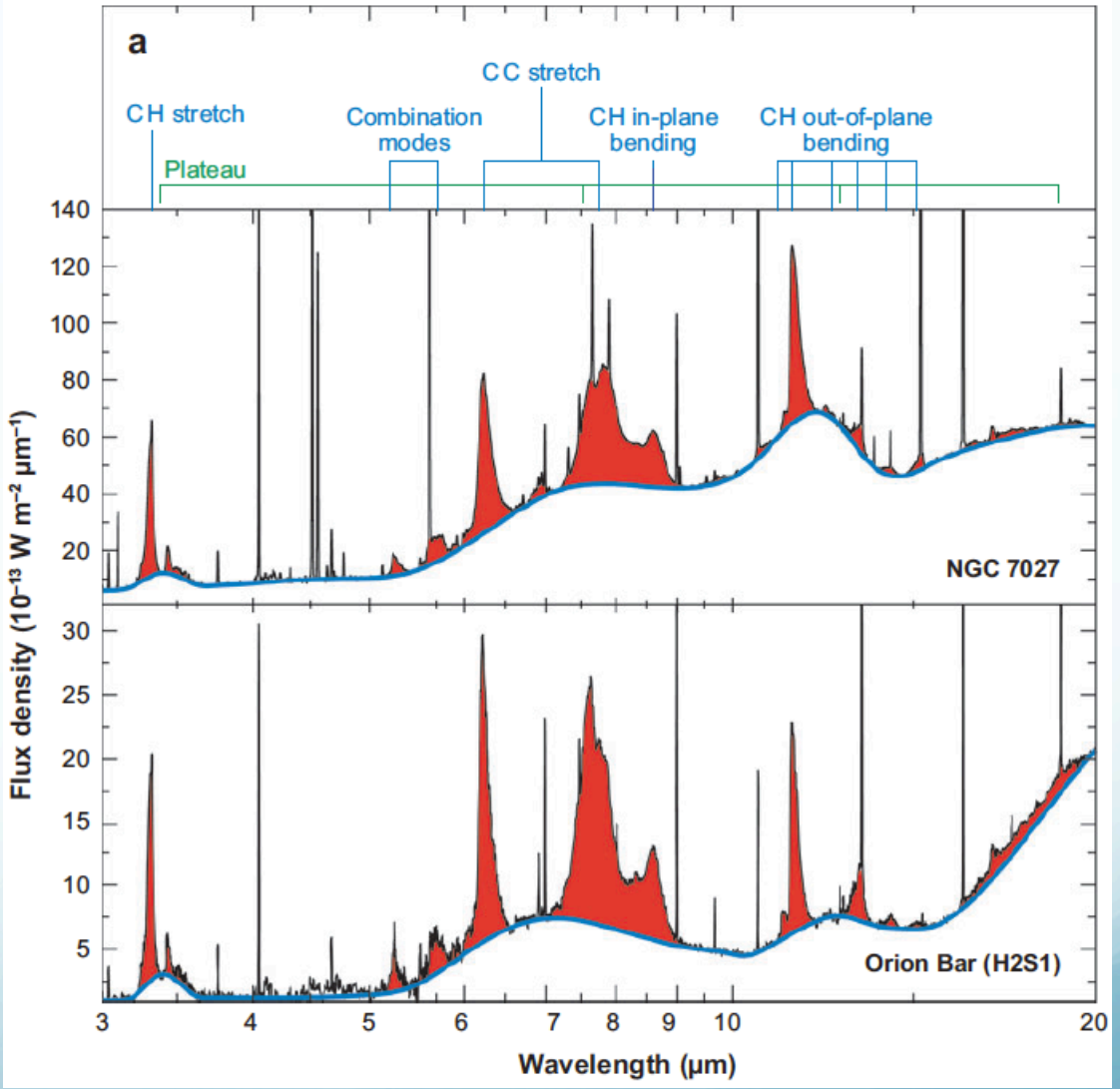
- Aliphatics → Carbon chains
  - C–H stretching mode oscillations give rise to 3.35 – 3.55 μm features



Papoular et al. 1996, A&A 315, 222

Polycyclic Aromatic Hydrocarbons (PAHs)

- Prominent Features at 6.2, 7.7, 8.6, & 11.3 μm
- Found in a tremendous variety of astronomical sources
- Arise from single FUV photon excitation of PAHs



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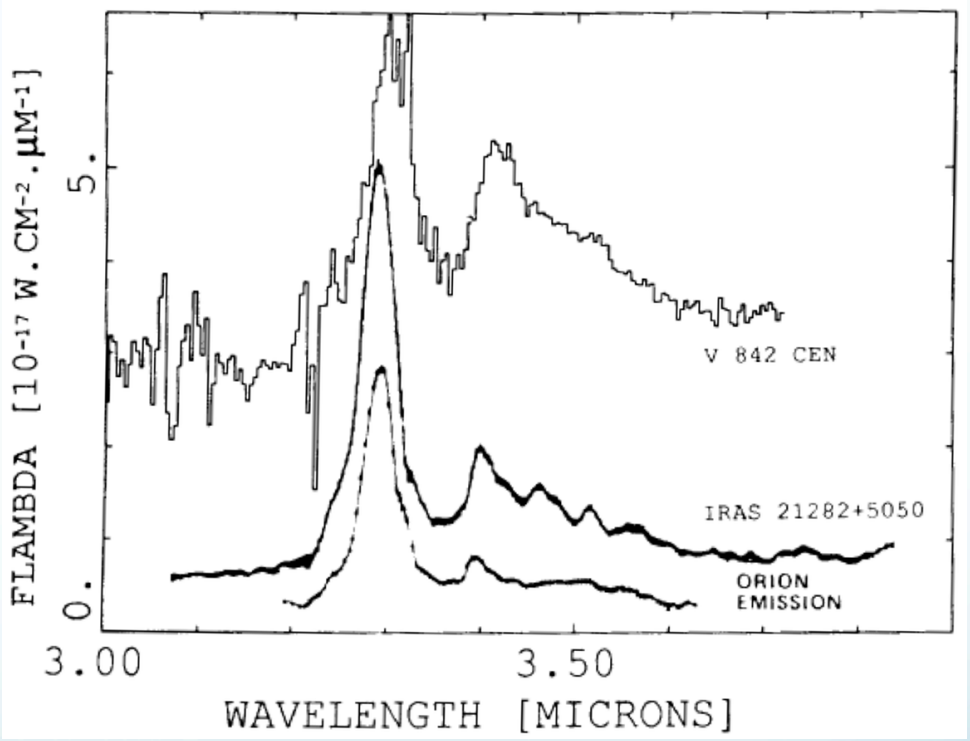
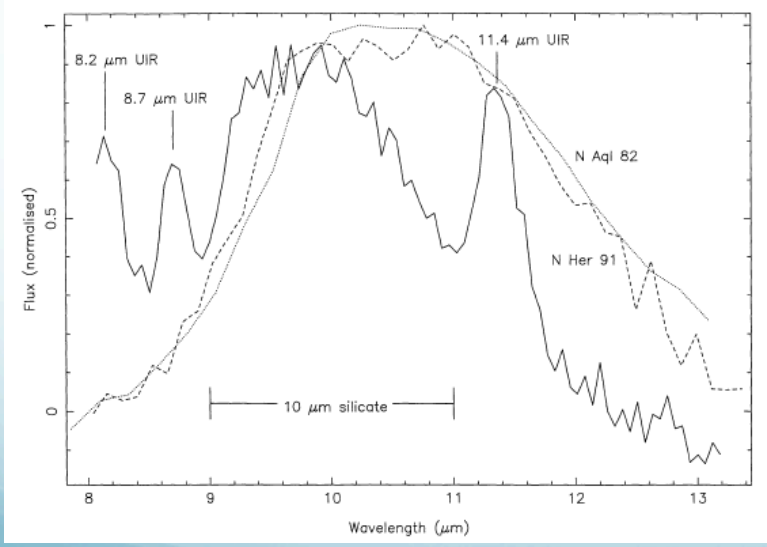


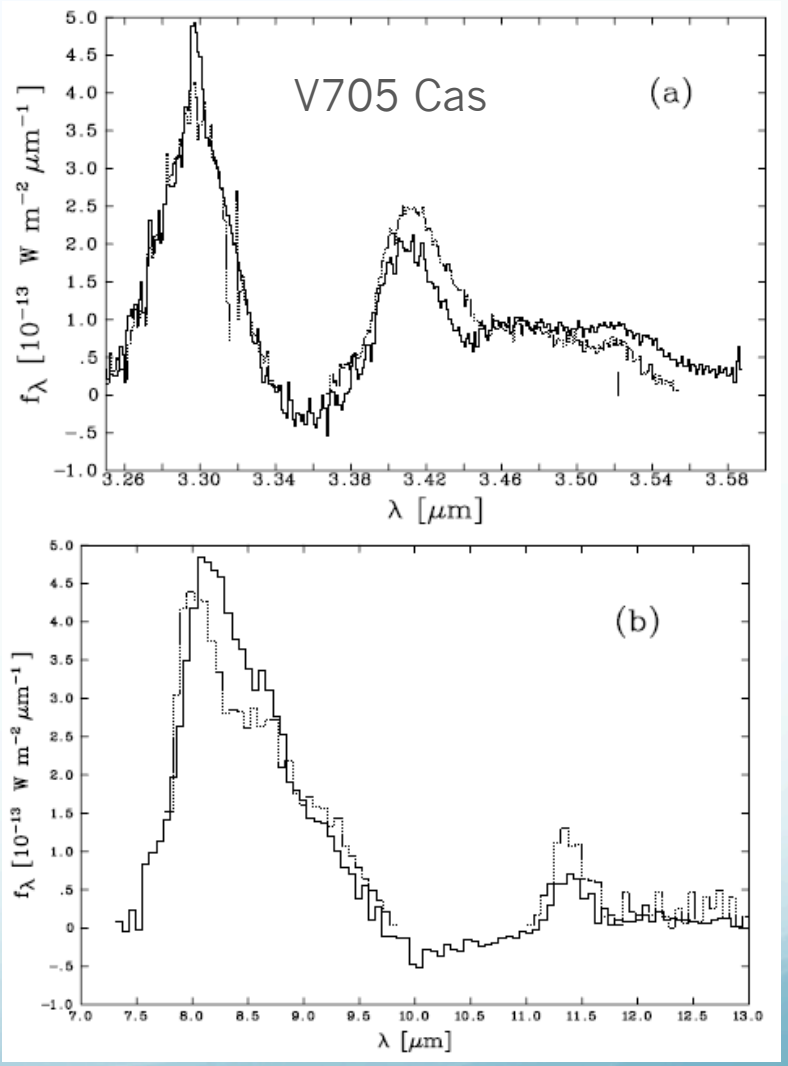
Hyland & McGregor 1986, IAU Symp. 135, 101

Hydrocarbons in Novae

- V705 Cassiopieae
- 3.28/3.4 ratio comparable to V842 Cen
  - An order of magnitude greater than stars with a high UV flux
  - More similar to post-AGB stars



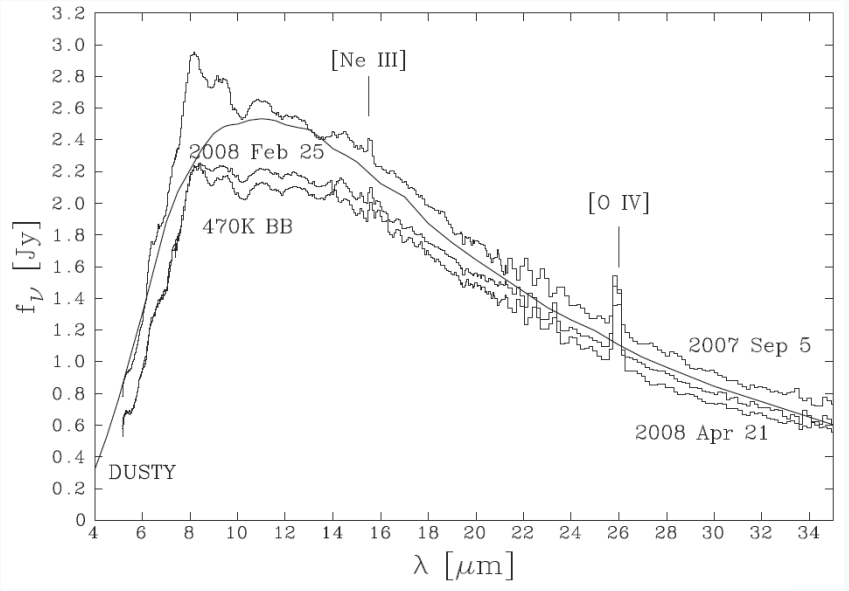
Evans et al. 1997, MNRAS 292, 192

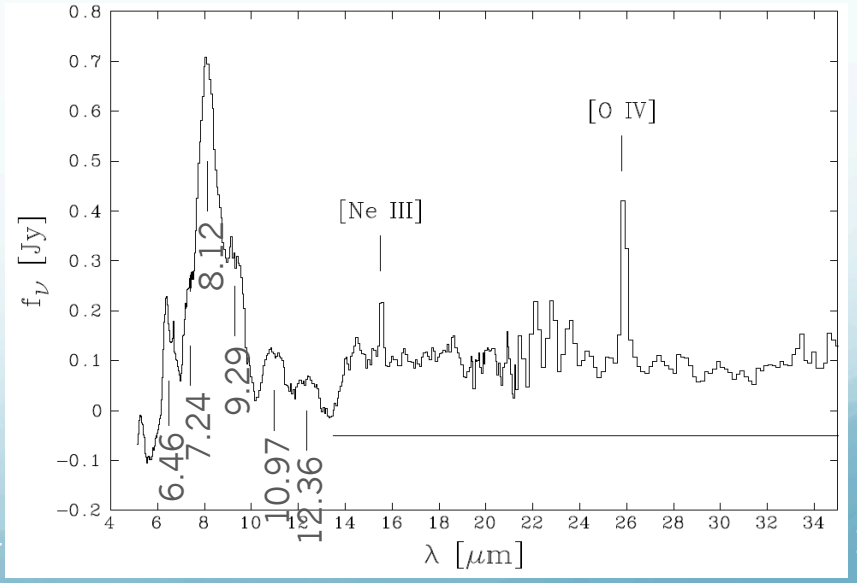


Evans et al. 2005, MNRAS 360, 1483

Hydrocarbons in DZ Cru

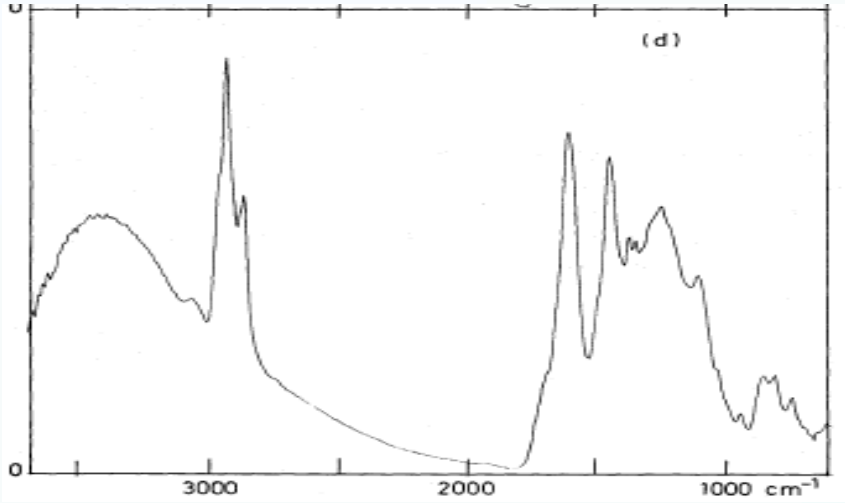
- Evans et al. 2010 MNRAS 406, L85
  - Fitted with 470K DUSTY model
  - Residual features inconsistent with PAHs
  - Cannot be explained by excitation effects alone



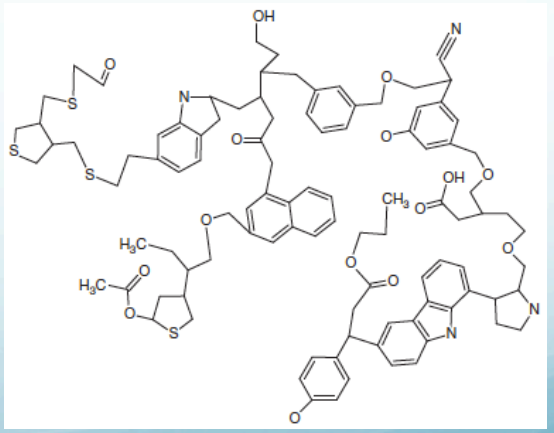


The Nature of the Carrier

- Evans & Rawlings 1994, MNRAS 269, 427
  - The nova environment is not conducive to the survival of free flying PAHs
- Kwok & Zhang 2011, Nature, 479, 80; Kwok 2004, Nature 430, 985
  - Features consistent with what would be expected from complex, "disordered" hydrocarbons
  - Similar to coal, hydrogenated amorphous carbon (HACs), or quenched carbon composites (QCCs)



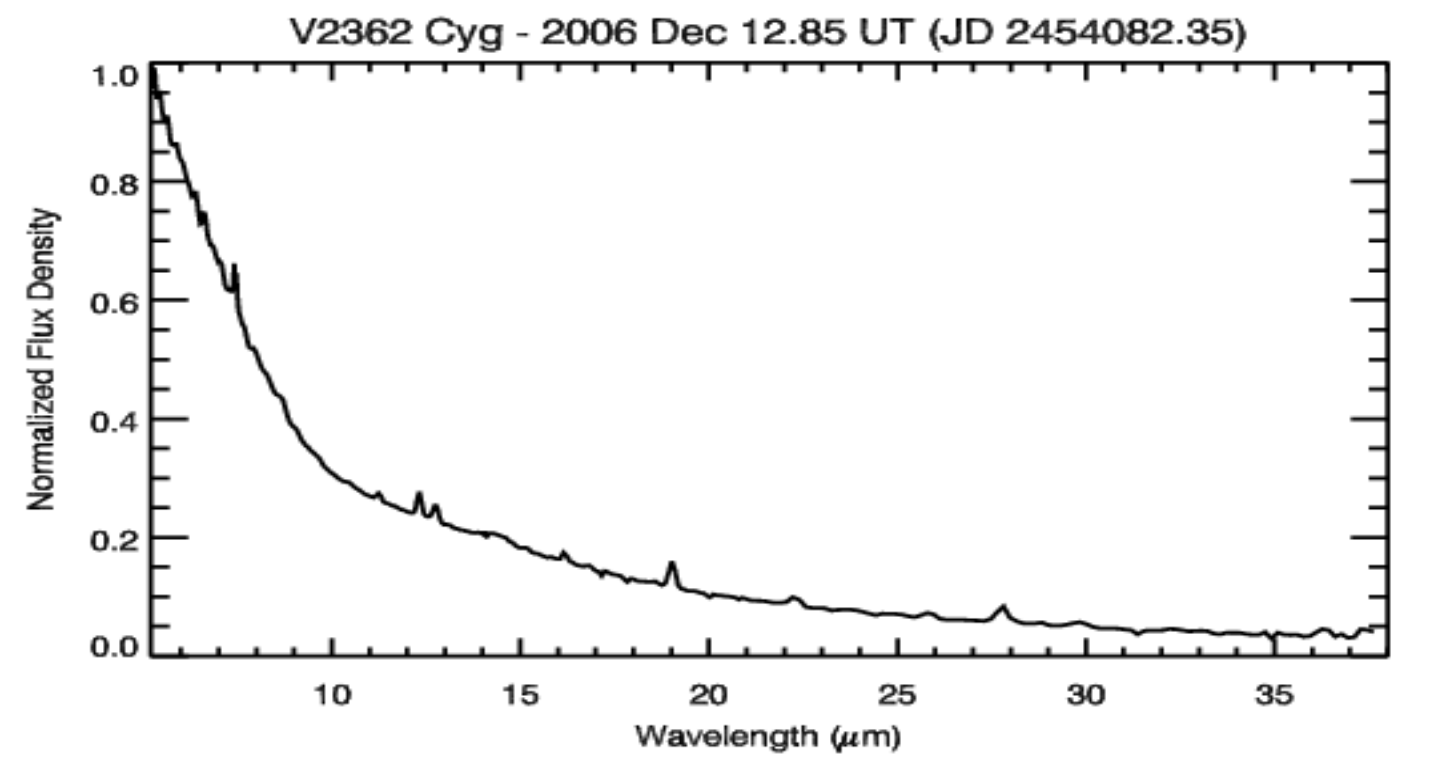
Papoular et al. 1989, A&A 217, 204



Kwok & Zhang 2011, Nature, 479, 80

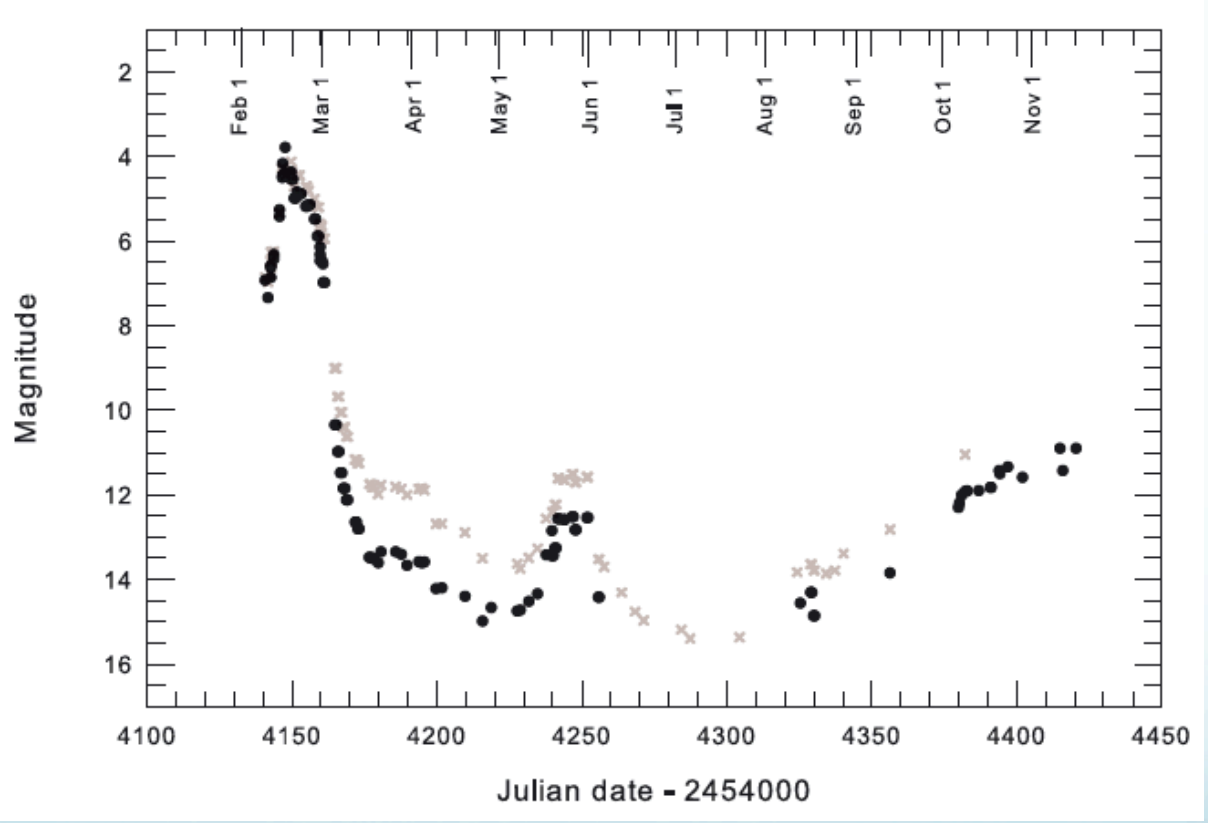
Hydrocarbons in V2362 Cyg

Andrew asks that, if the viewer wants to see an animated version of this plot, just open the attached gif -- V2362Cyg_Movie_2.gif in your browser.



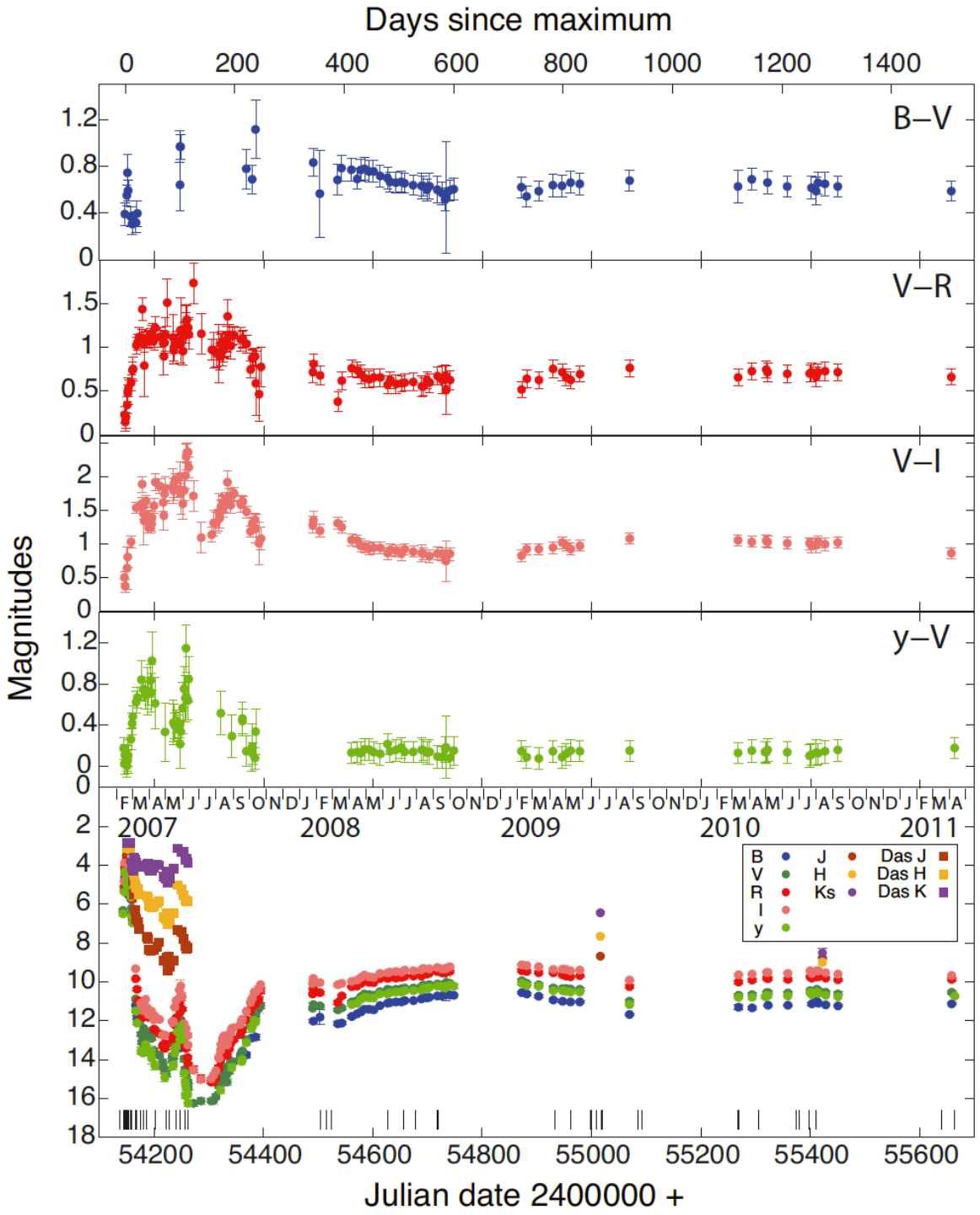
Helton et al. 2011, EASP 46, 407

V1280 Scorpii



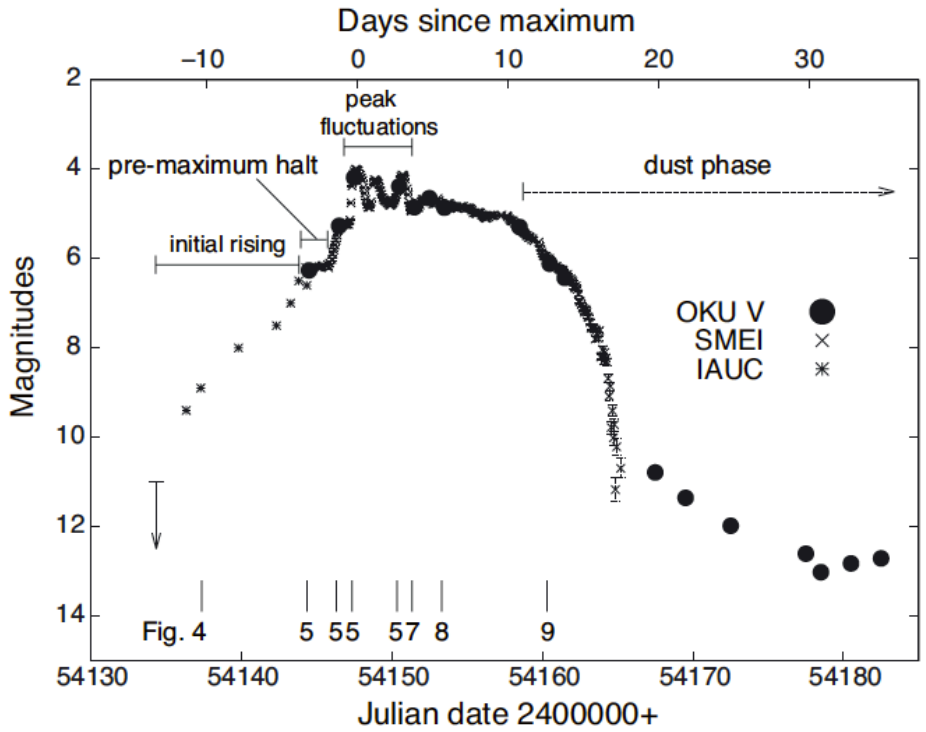
Das et al. 2008, MNRAS 391, 1874

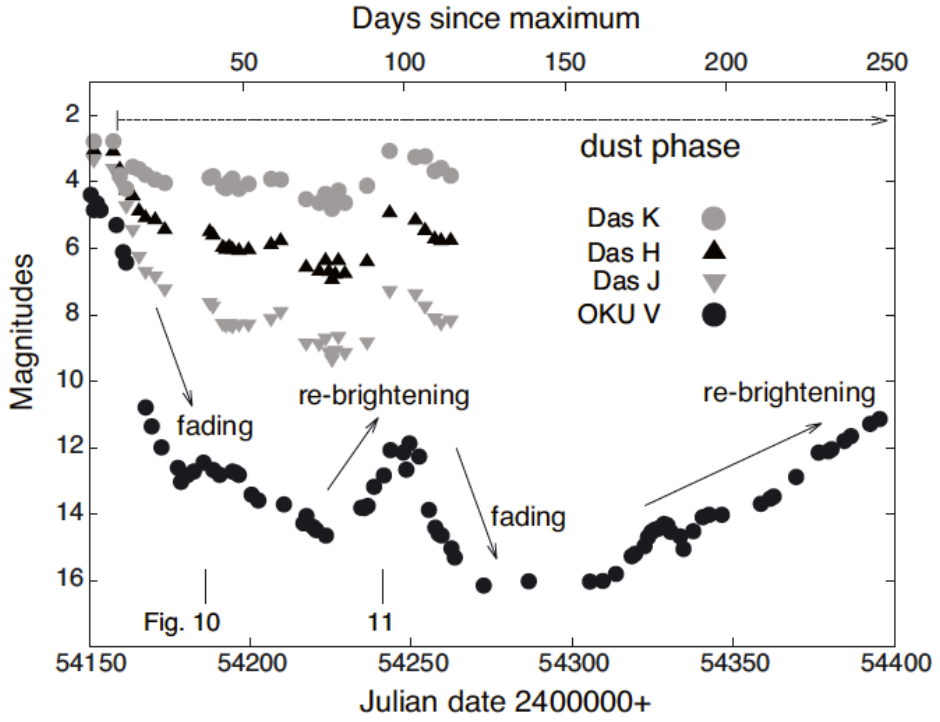
V1280 Scorpii



Naito et al. 2012, A&A 543, A86

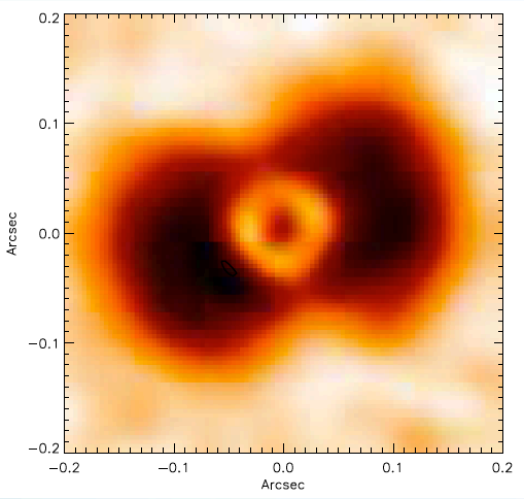
V1280 Scorpii

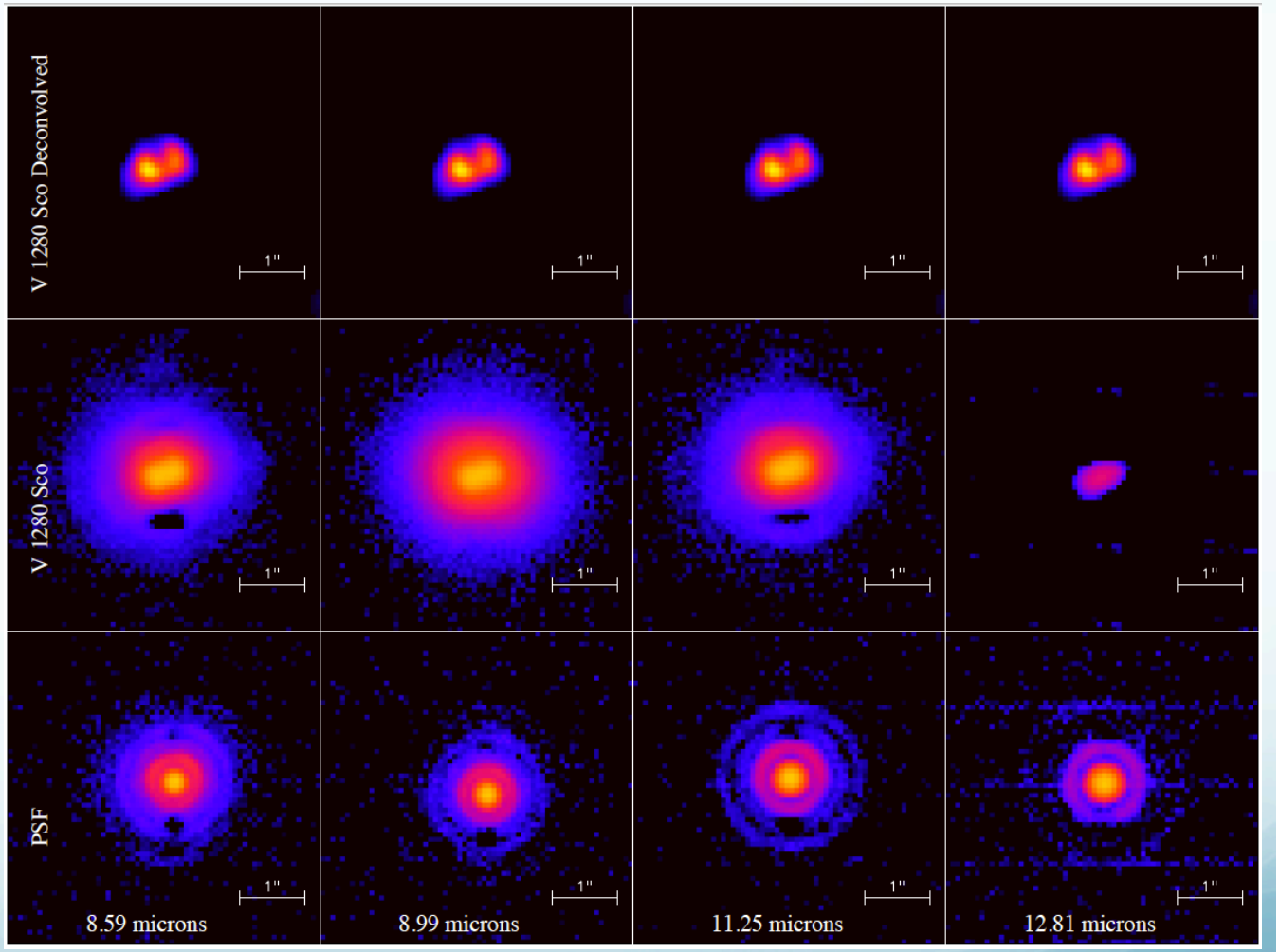




Naito et al. 2012, A&A 543, A86; Hounsell et al. 2010, ApJ 724, 480

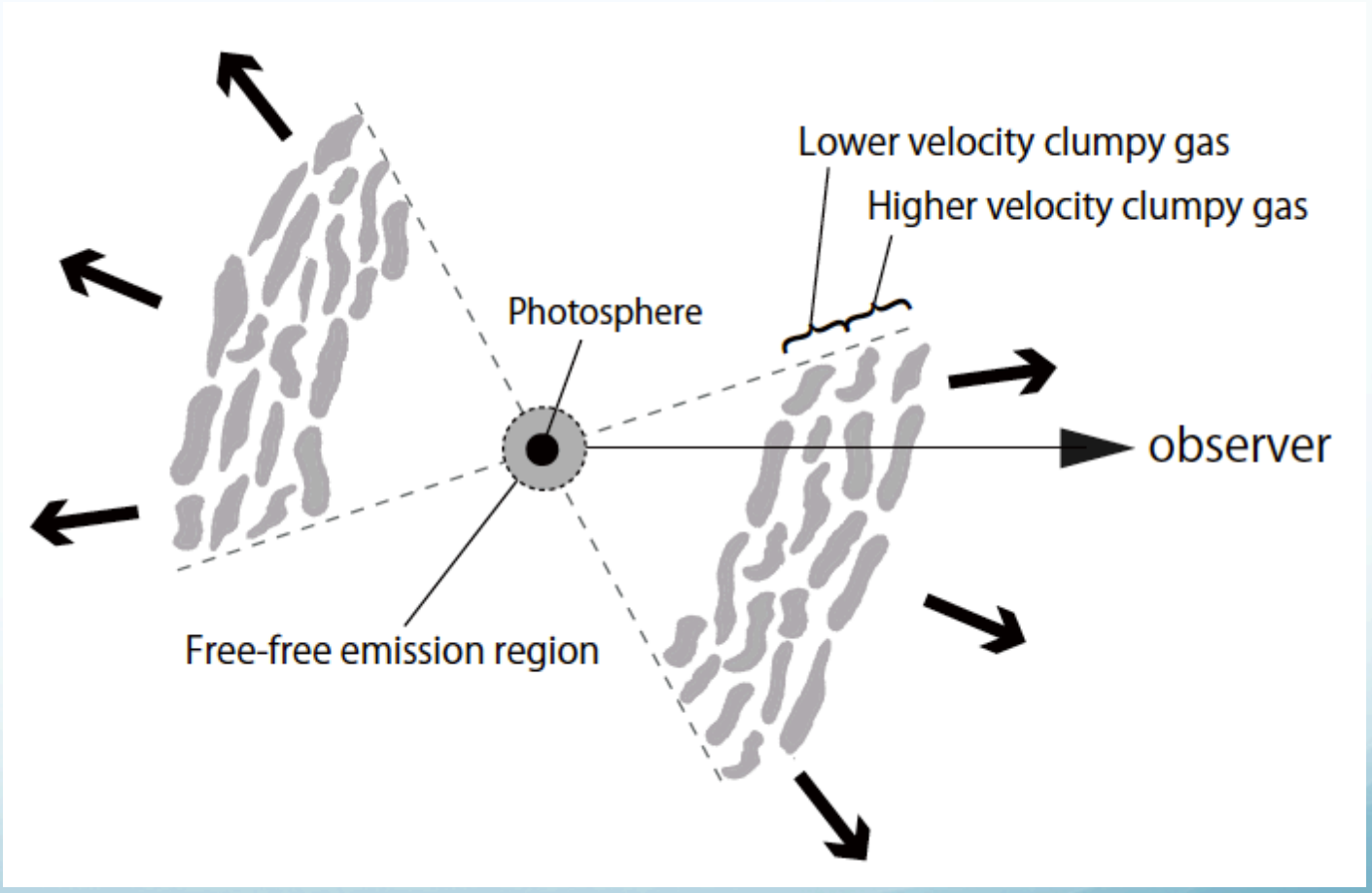
V1280 Scorpii





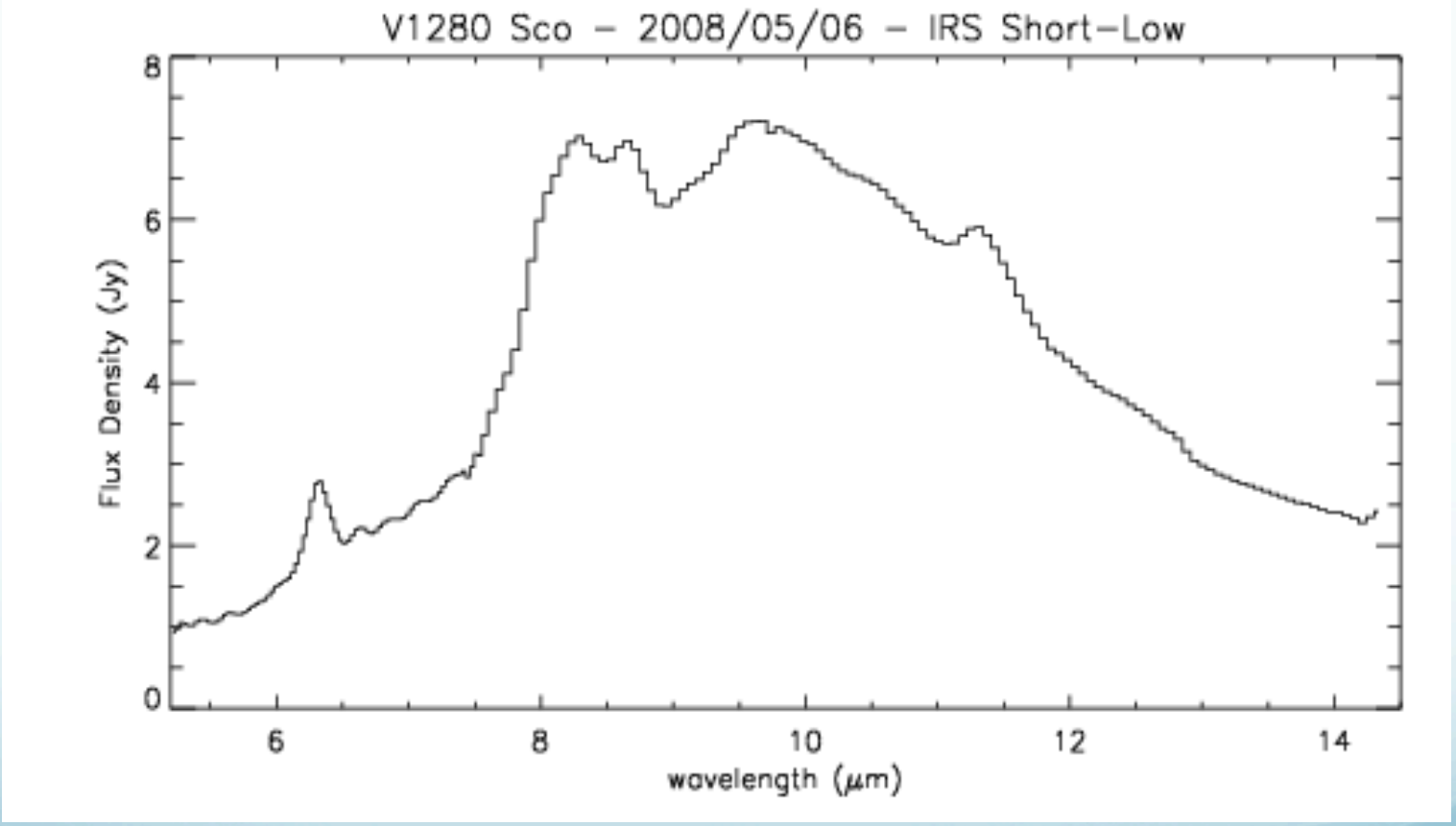
Chesneau et al. 2012, A&A 545, 63

V1280 Scorpii



Naito et al. 2013, PASJ 65, 37

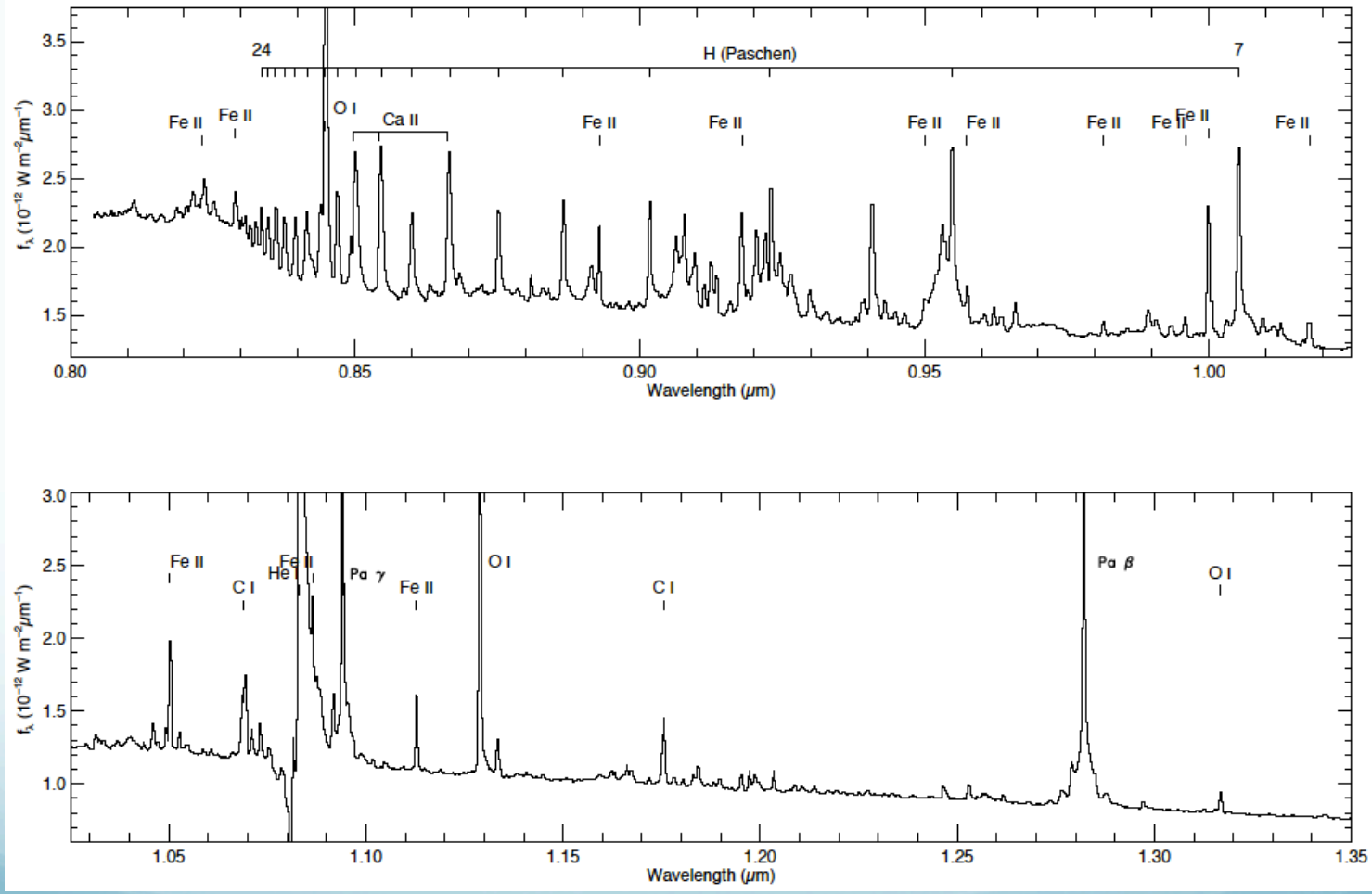
V1280 Scorpii



Program Goals

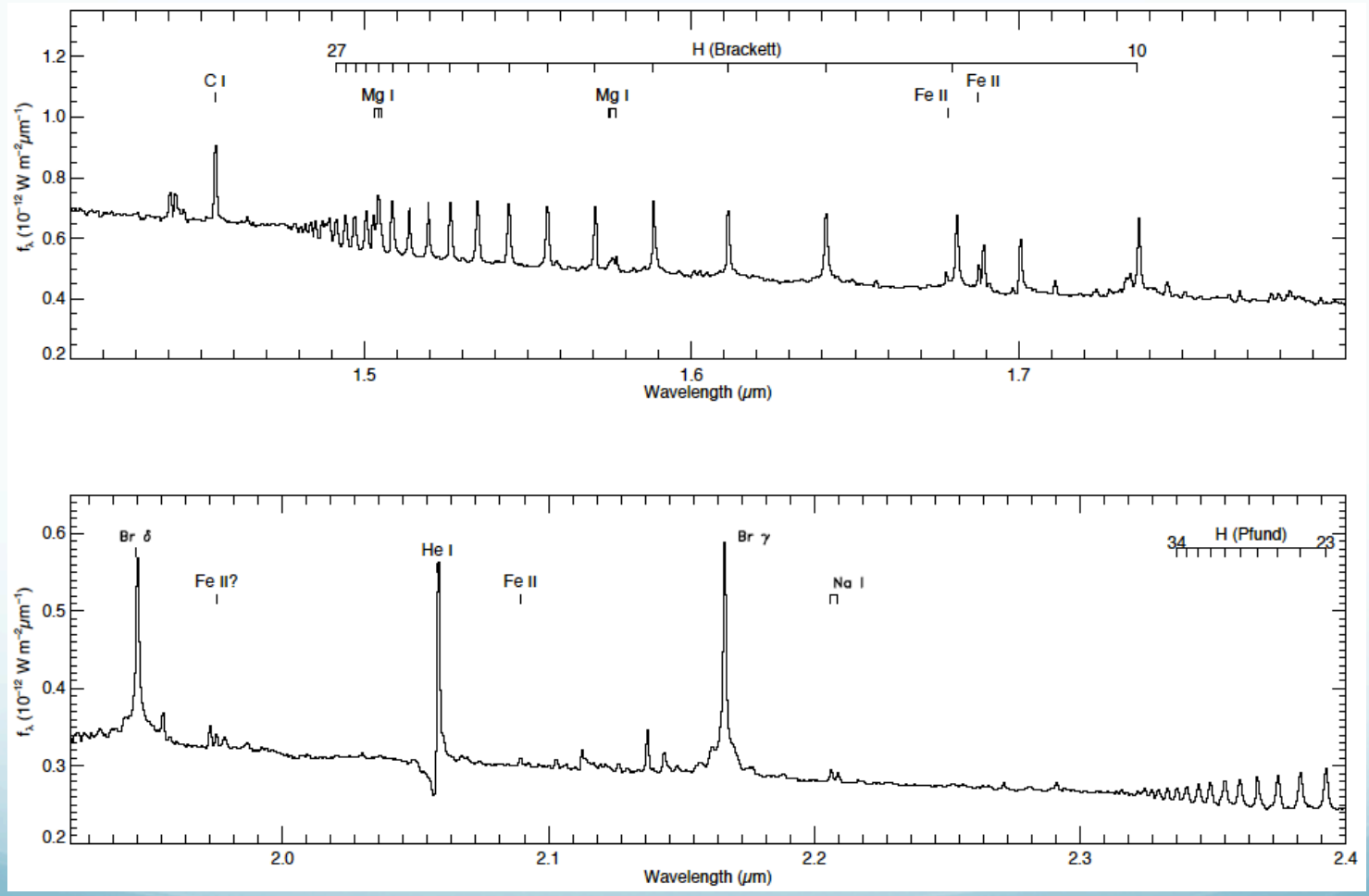
- Measure the conditions within the dust forming zone
- Estimate the dust mass
- Determine the composition and mineralogy of the dust
- Determine the relative composition of aromatic and aliphatic species
- Constrain the identity of carriers of any hydrocarbons that may be present

V1280 Sco

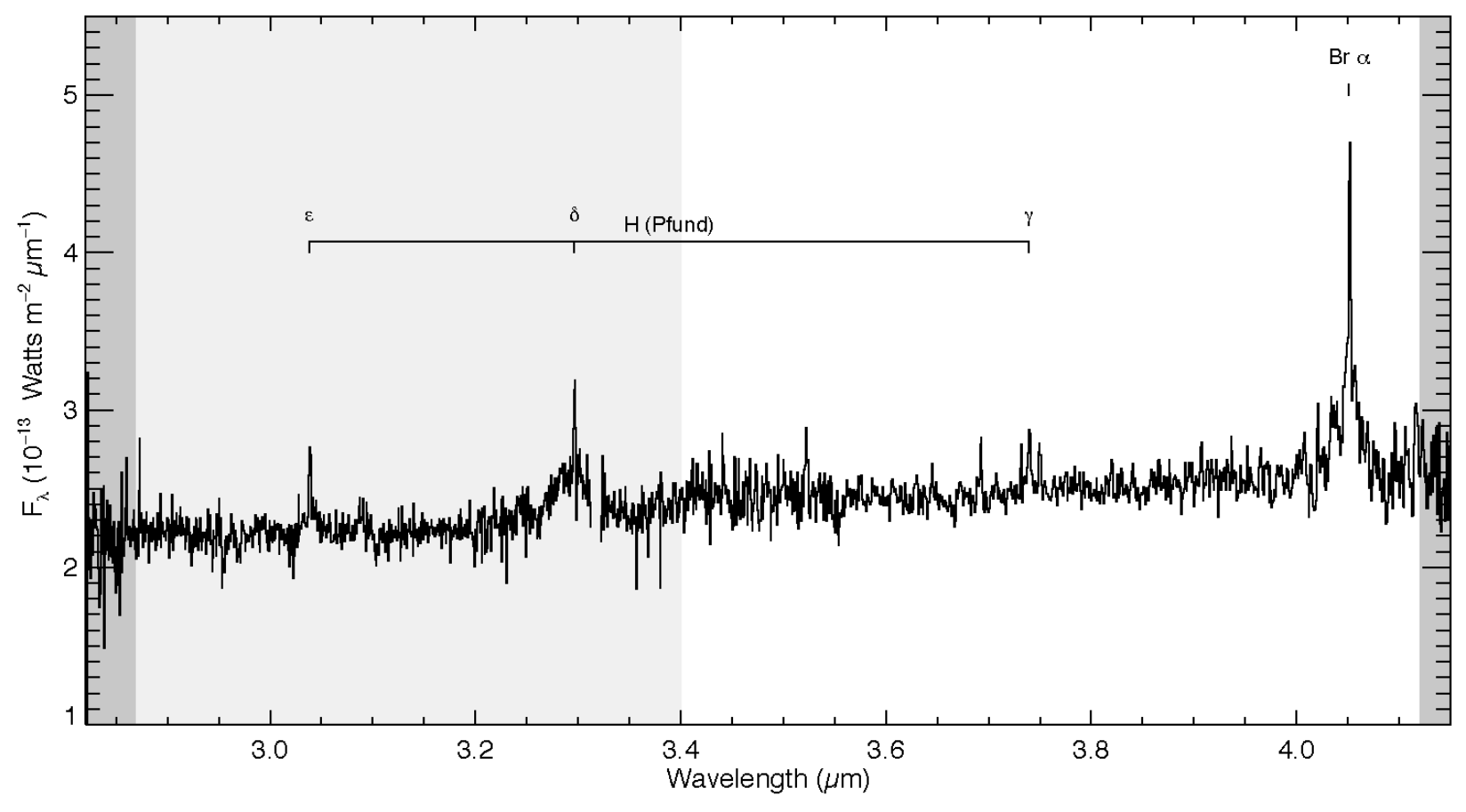


IRTF SpeX – 17 Aug 2012 – Day 2019

V1280 Sco


27
H (Brackett)
10
C I
Mg I
Mg I
Fe II
Fe II
1.2
1.0
0.8
0.6
0.4
0.2
1.5
1.6
1.7
Wavelength (μm)
Br δ
Fe II?
He I
Fe II
Br γ
Na I
34
H (Pfund)
23
0.6
0.5
0.4
0.3
0.2
2.0
2.1
2.2
2.3
2.4
Wavelength (μm)

V1280 Sco – LXD



IRTF SpeX – 17 Aug 2012 – Day 2019

Future Work

- Nova Del 2013 / V339 Del
  - ToO Program to observe novae throughout their early evolution – P.I. Gehrz
  - Appears to now be forming dust
  - Observations
    - One epoch of FORCAST observations completed with FLITECAM observations scheduled for this week
    - One more visit each w/ FORCAST and FLITECAM during Cycle 1