MESS - Mass loss of Evolved StarS First Results

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on behalf of the MESS consortium
www.univie.ac.at/space/MESS (consortium website)

MESS

This GT KP aims at studying the circumstellar matter in evolved objects

- AGB, Post-AGB, PNe, RSG, WR, LBV, SN
  - Photometric mapping of nearby objects
  - Spectroscopy of nearby objects
  - SPIRE and PACS
- Mass-loss dominates the evolution
  How? How much? Time evolution? Spherical?
  Production of dust

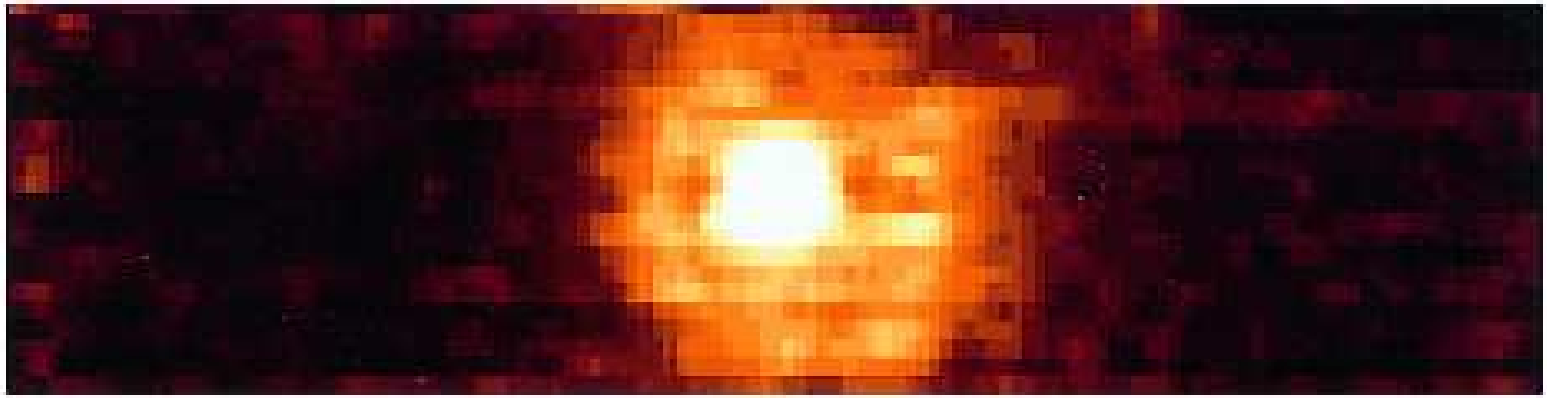


Fig. 1. 90 μm image of Y CVn taken with PHT-C100 array detector and C90 filter displayed in linear brightness scale.

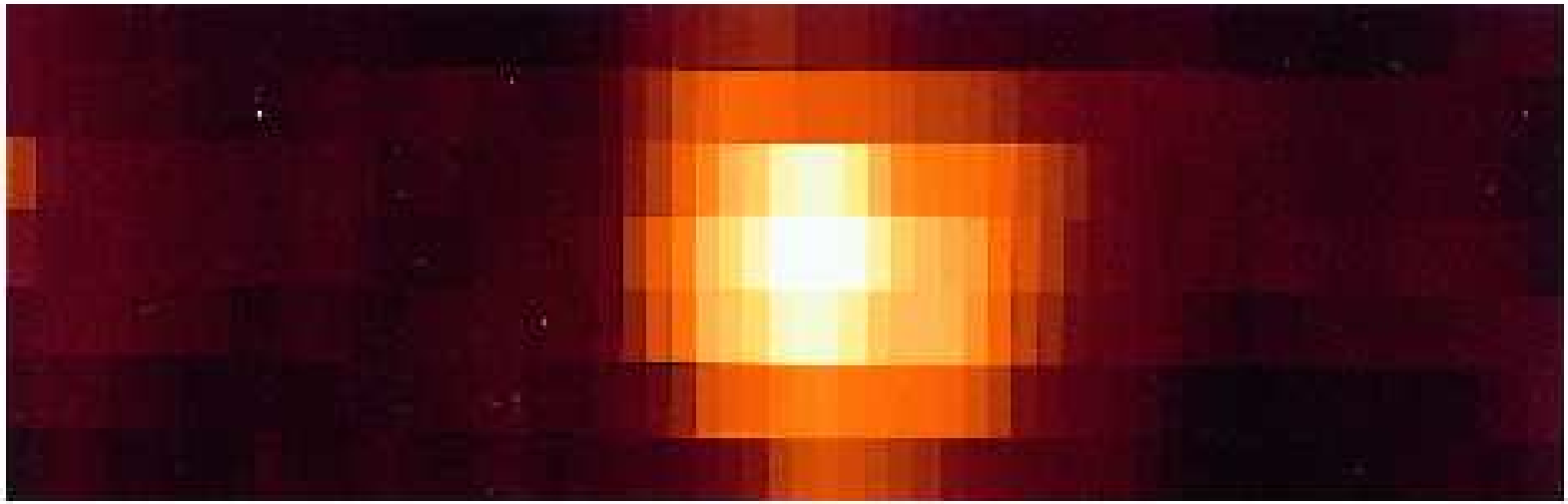
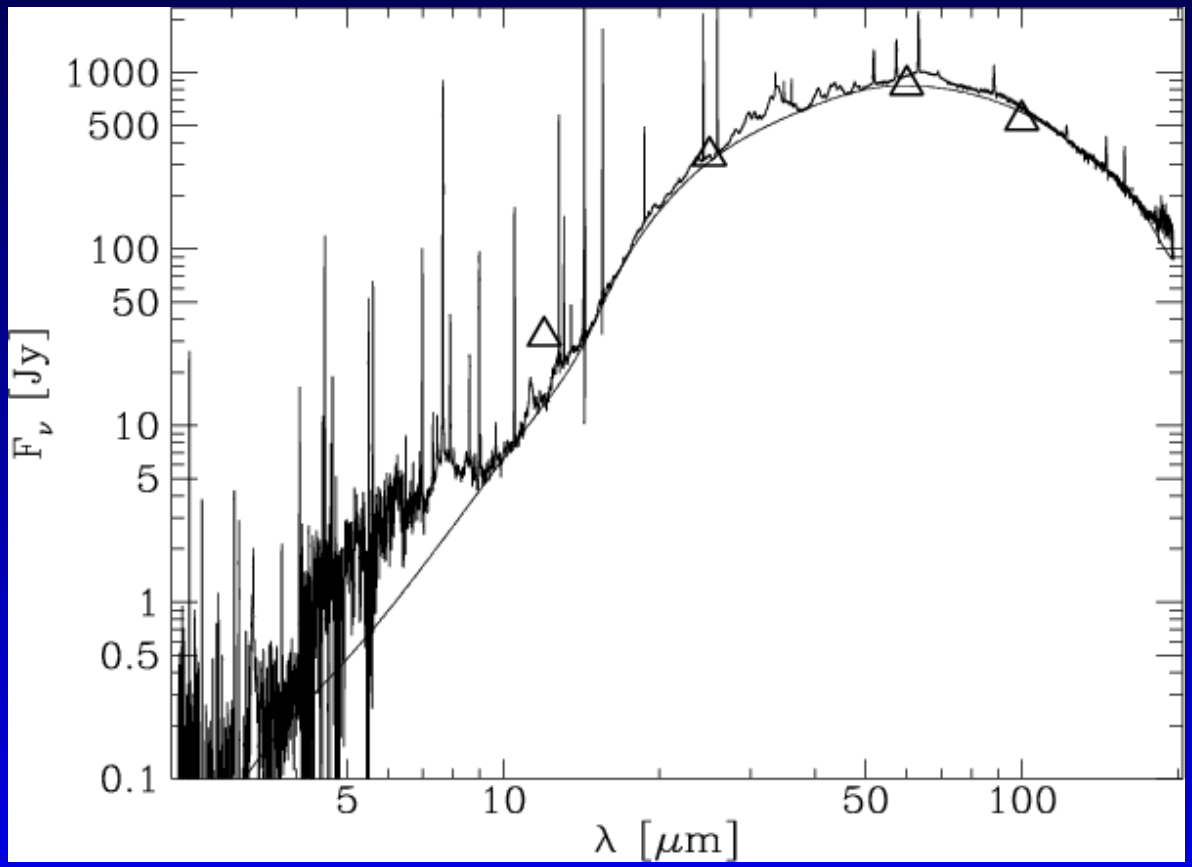


Fig. 2. 160 μm image of Y CVn taken with PHT-C200 array detector and C160 filter displayed in linear brightness scale.

Y CVn
Izumiura et al. (1996), $8' \times 35'$ ISOPHOT map

Spectroscopy of nearby objects

Goal: Study of
dust properties, molecular lines, emission lines



NGC 6302; Molster et al., SWS + LWS spectrum

Partners involved

Partner	"origin"	hours	special interest
Belgium	PACS GT	145	KUL (AGB, post-AGB, PN, WR, LBV)
			ROB (AGB, PN)
			ULB (binary AGB)
			IAGL (WR, LBV)
Vienna	PACS GT	47	AGB
Heidelberg	PACS GT	10	SN remnants
SAG 6	SPIRE GT	80	SN, AGB, post-AGB, PN
HSC	HSC	26	special type of post-AGB
MS	MS	5	Molecules in specific stars
		313	

Implementation (Photo)

PACS:
"Scan Maps" at 70 + 160 μm

78 AGB/RSG, 16 post-AGB/PN, 8 WR/LBV, 5 SN

OBSERVED: 70

SPIRE:
"Large maps" at 250, 350, 500 μm

26 AGB/RSG, 8 post-AGB/PN, 5 SN

ALL but 3 OBSERVED

Implementation (Spectro)

PACS:
Concatenation of two AORs to cover entire 60-210 μm region

Spatial information: 5×5 pixels = $47'' \times 47''$

27 AGB/RSG, 26 post-AGB/PN, 2 WR/LBV, 4 SN

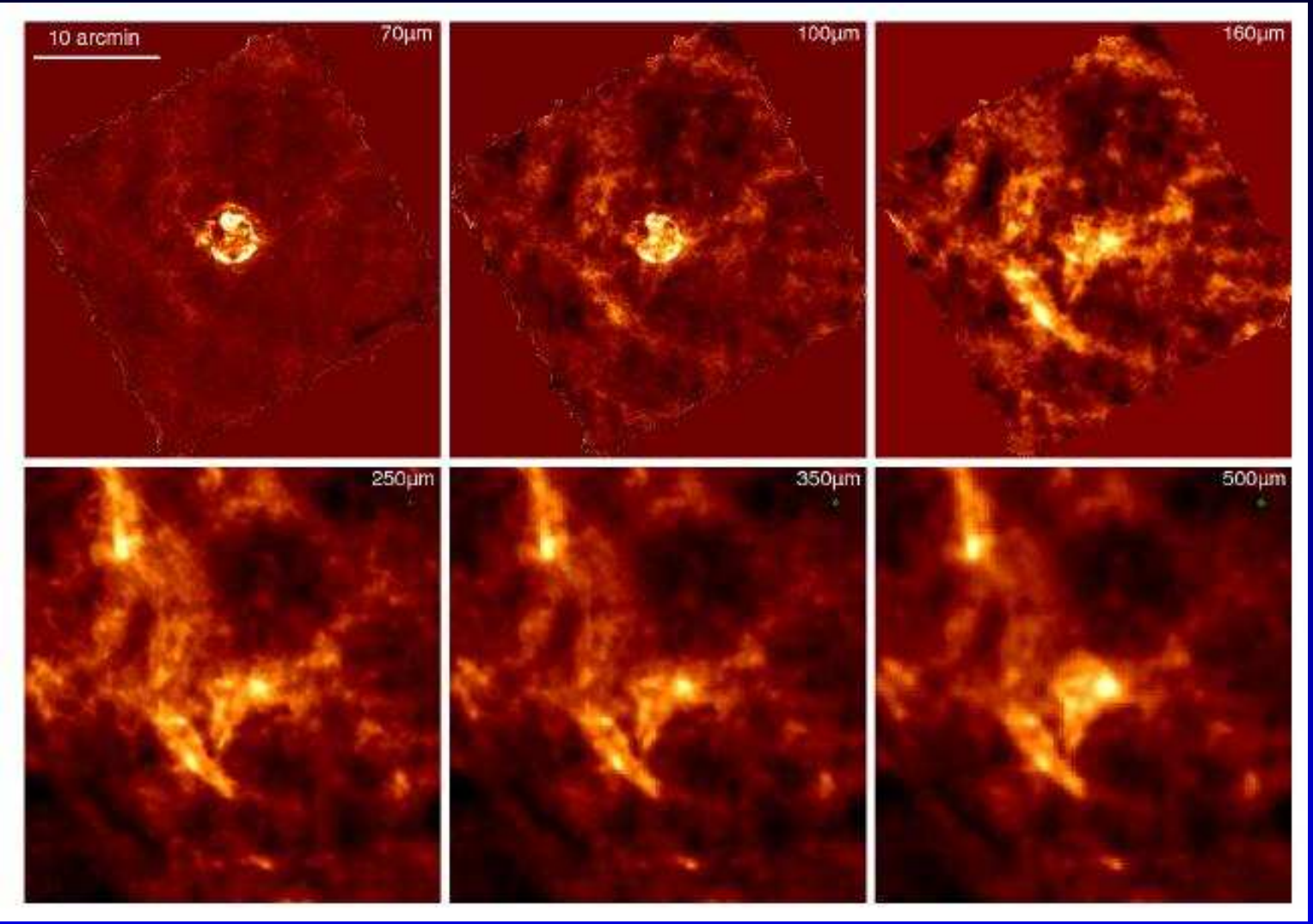
OBSERVED: 3 PV/SDP + 12

SPIRE:
Full FTS scans

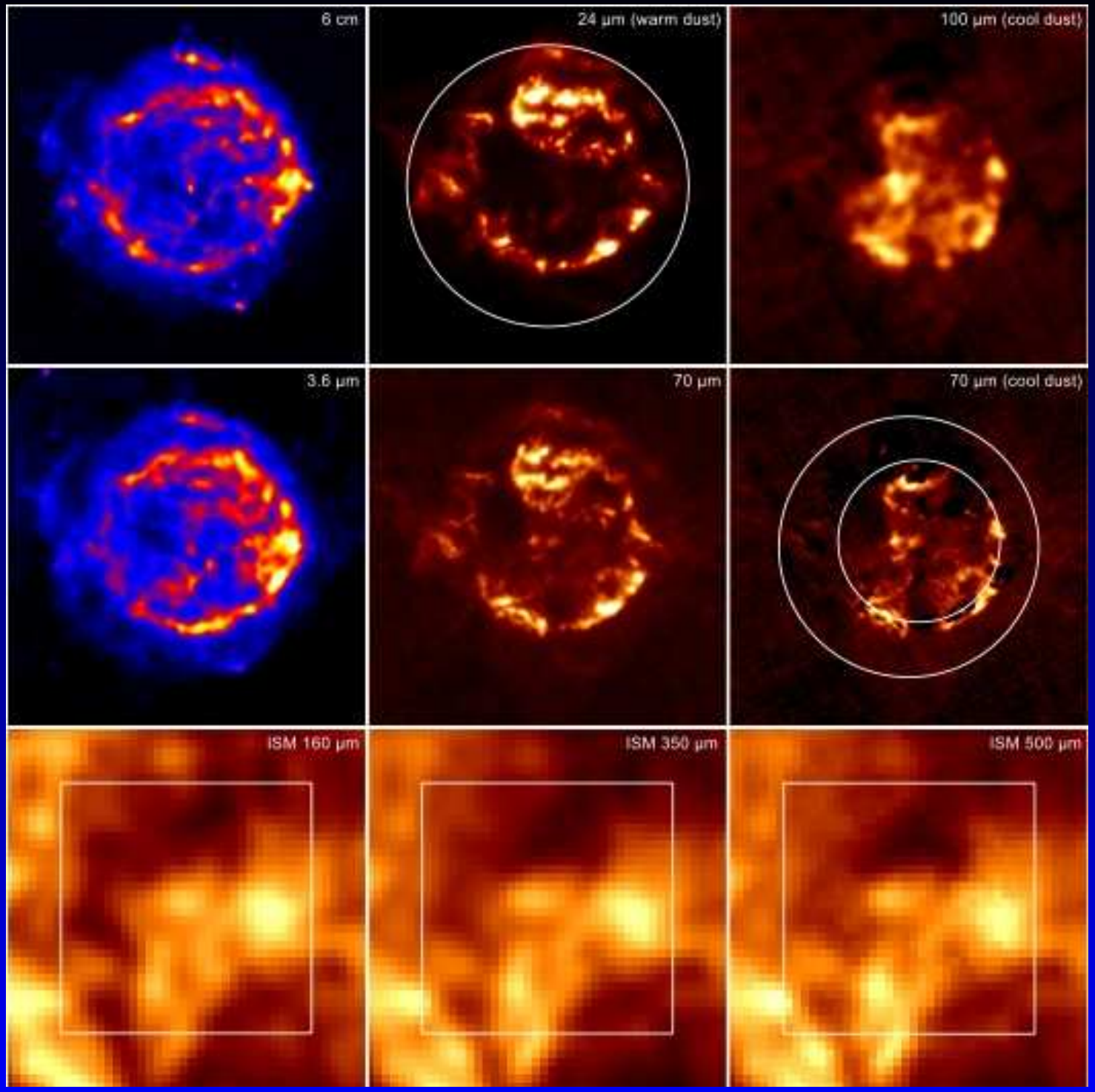
9 AGB/RSG, 10 post-AGB/PN, 2 WR/LBV, 1 SN

ALL but 1 OBSERVED

SN remnant: Cas A



Barlow et al. (2010)


6 cm
24 μm (warm dust)
100 μm (cool dust)
3.6 μm
70 μm
70 μm (cool dust)
ISM 160 μm
ISM 350 μm
ISM 500 μm

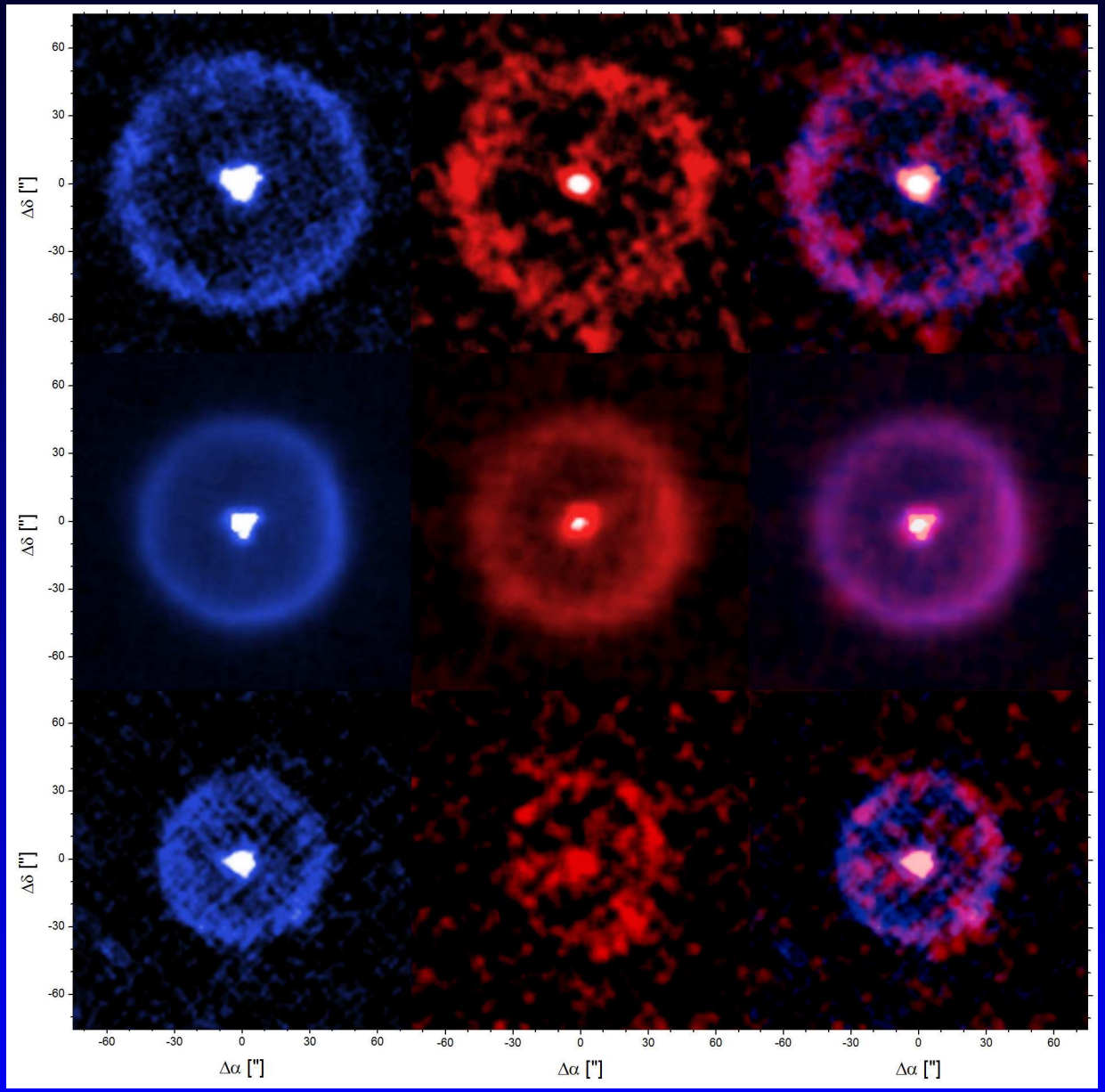
SN remnant: Cas A

- non-thermal component: based on 6-cm VLA and 3.6-μm IRAC image
- warm dust component: based on scaled 24-μm MIPS image
- cold interstellar component: iterative procedure
- line contributions: archival LWS spectrum

"We confirm ..... a cool dust component, emitting at 70-160 um, that is located interior to the reverse shock region, with an estimated mass of 0.075 $M_{\odot}$"

"The present observations provide no direct evidence for the presence of significant quantities of cold dust. The cause of the 850-μm excess in the SCUBA map of the northern part of the remnant is therefore unresolved. "

Detached shells

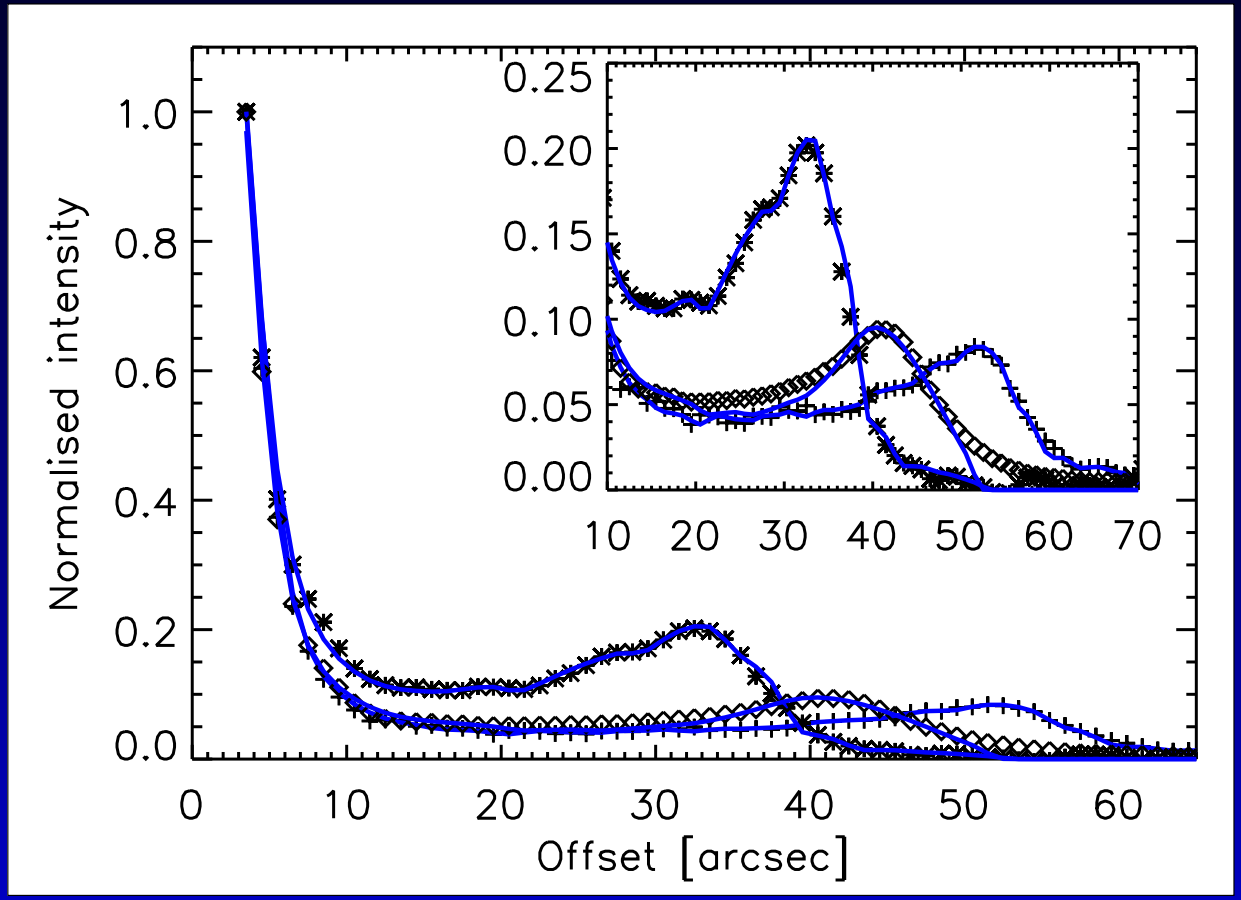


Kerschbaum et al. (2010)

PACS: blue / red / combined

AQ And, U Ant, TT Cyg

Detached shells

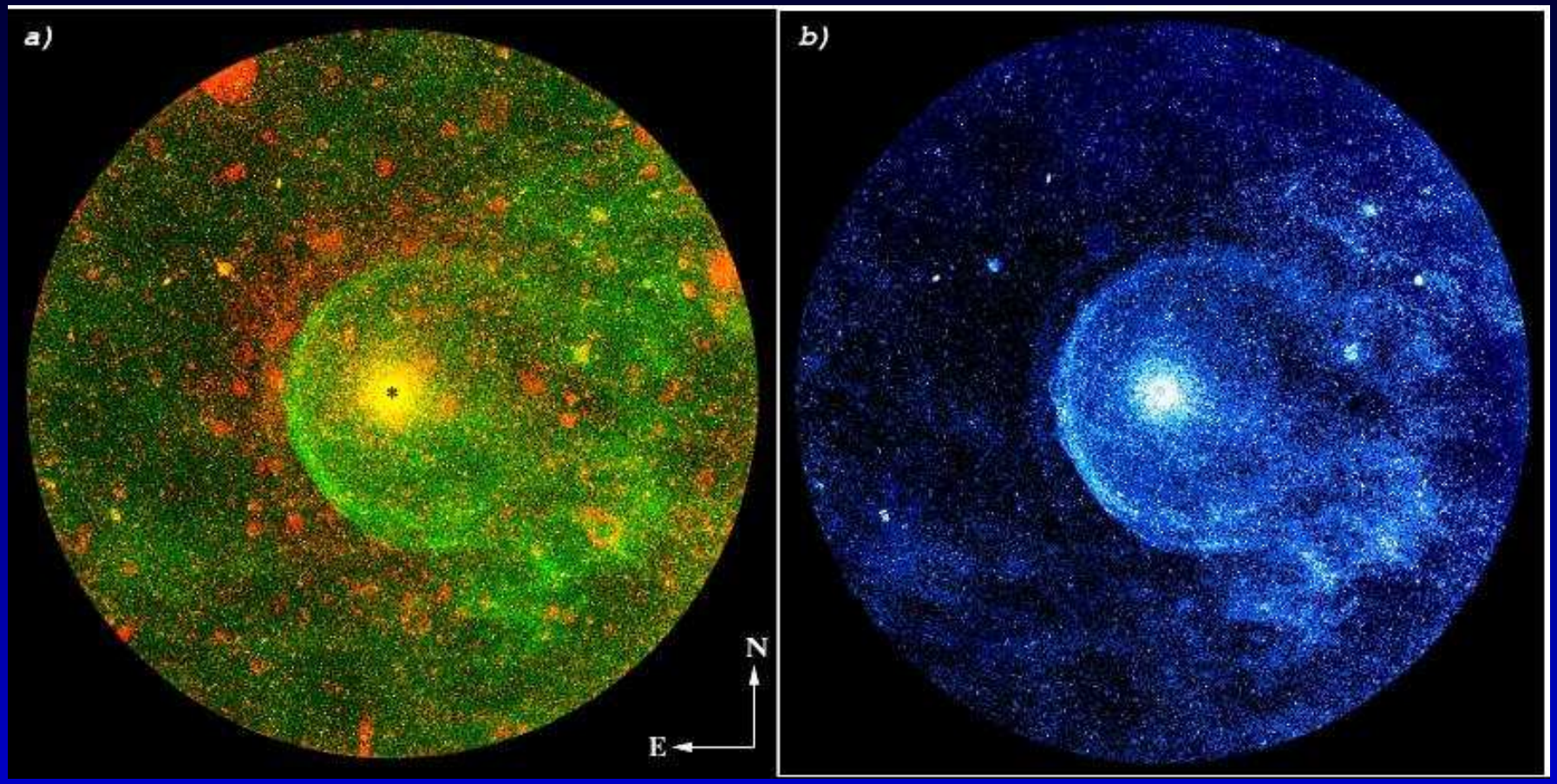


AQ And=+
U Ant=◇
TT Cyg=×

DUSTY multiple-shells $T_{\rm dust}$ = 25-50 K

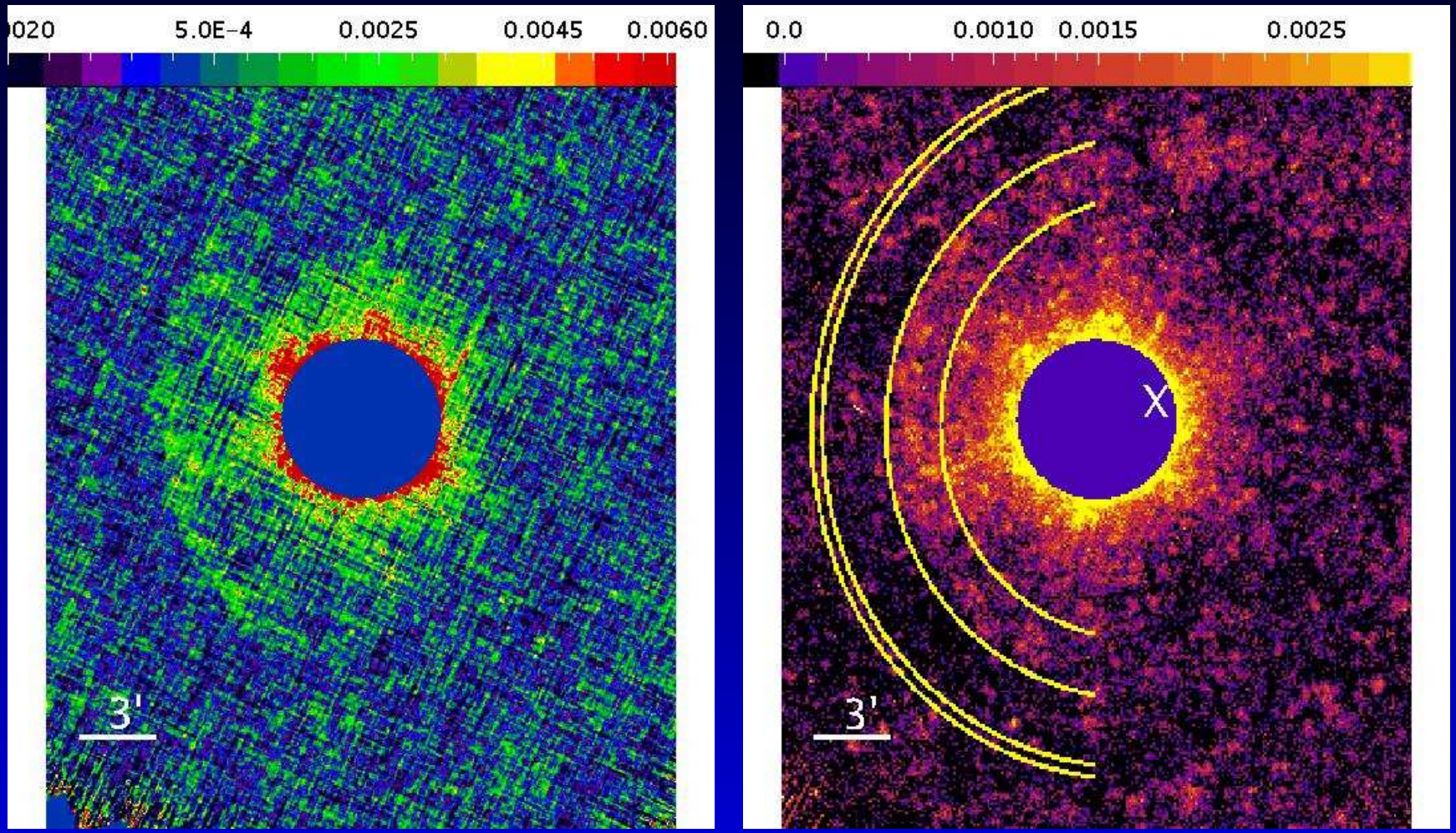
Kerschbaum et al. (2010)

CW Leo



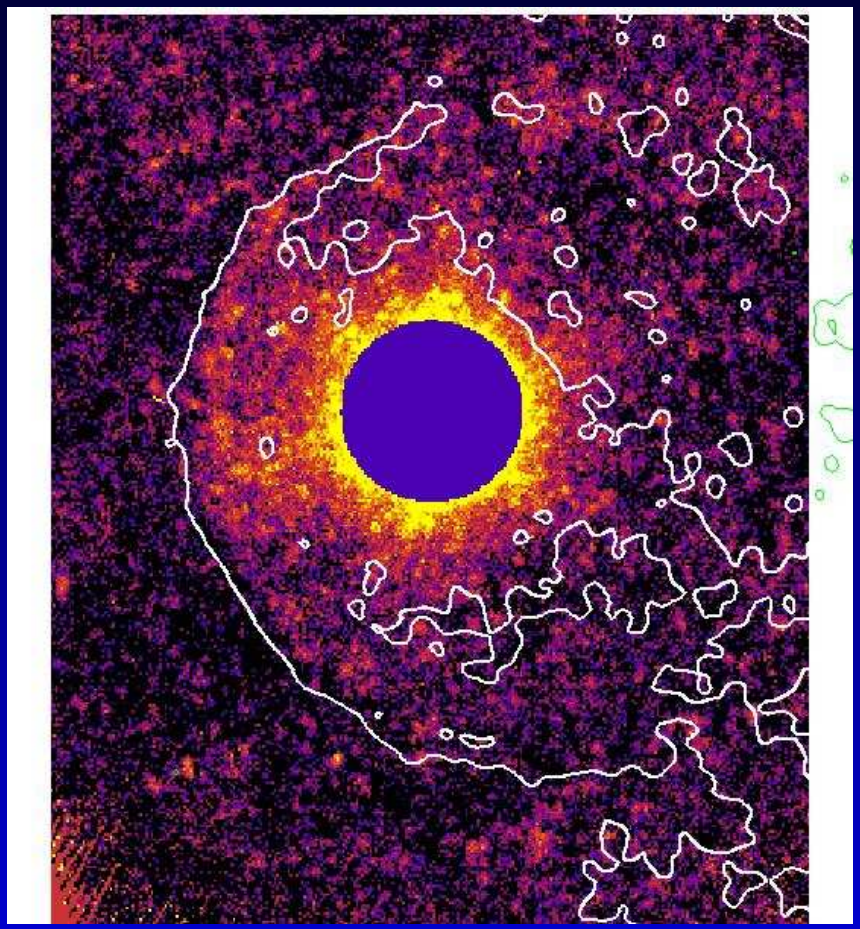
GALEX NUV/FUV composite (left), FUV (right).
Sahai & Chronopoulos (2010)

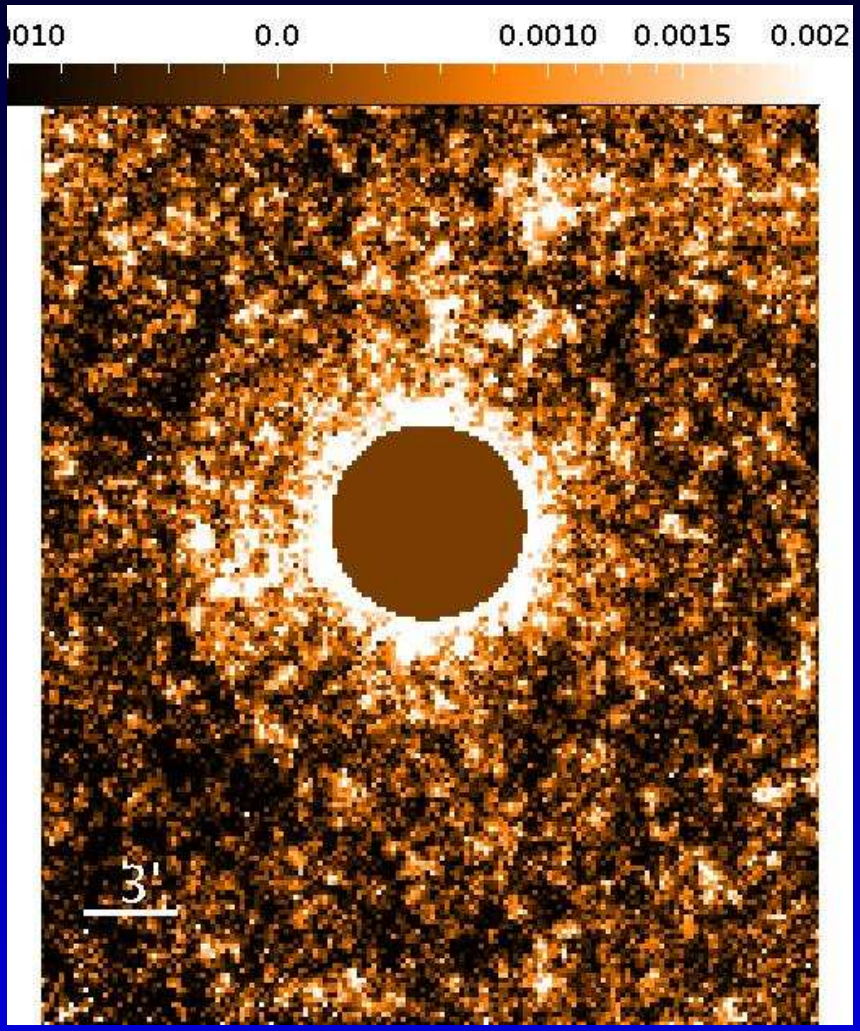
CW Leo



PACS 160 and SPIRE 250 micron
$23' \times 27'$ (Ladjal et al. 2010)

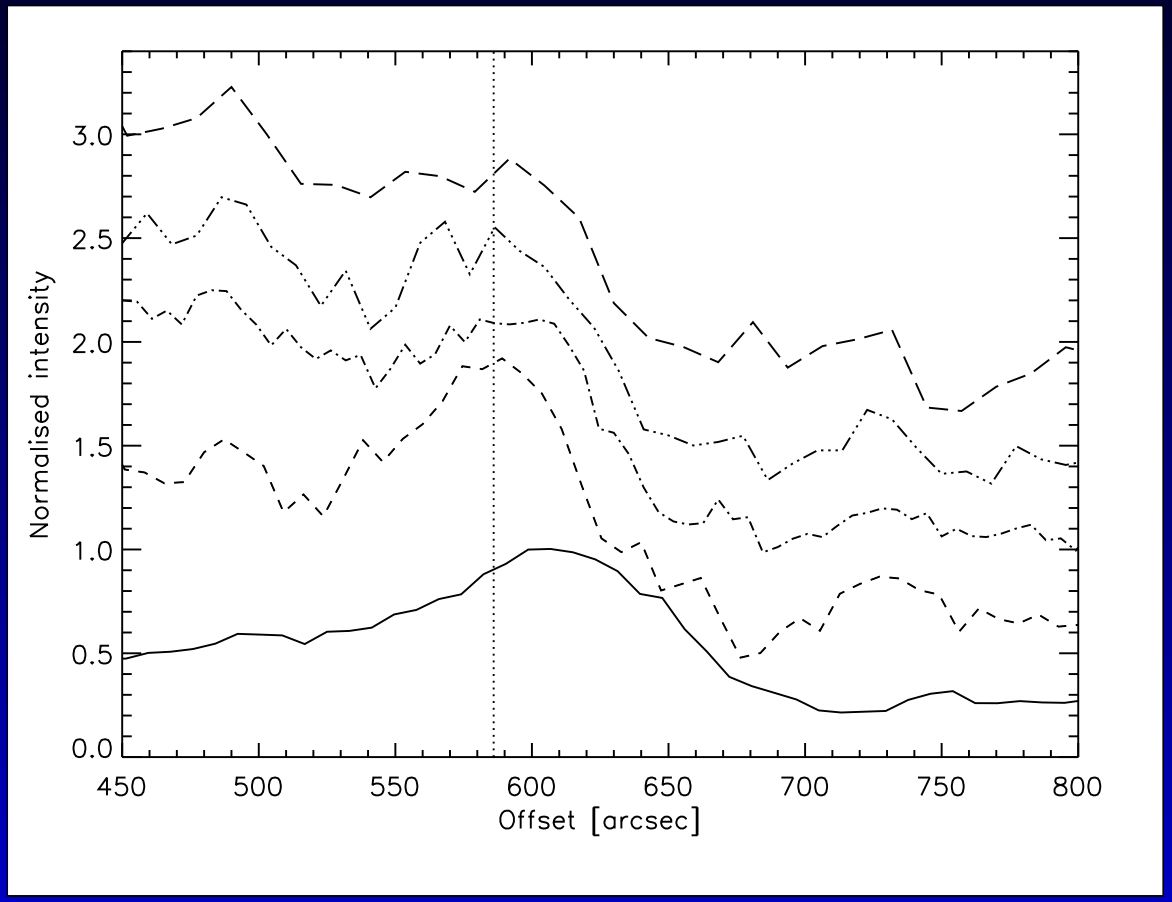
CW Leo





SPIRE 250 micron with Galex FUV contours (left),
SPIRE 350 micron (Ladjal et al. 2010)

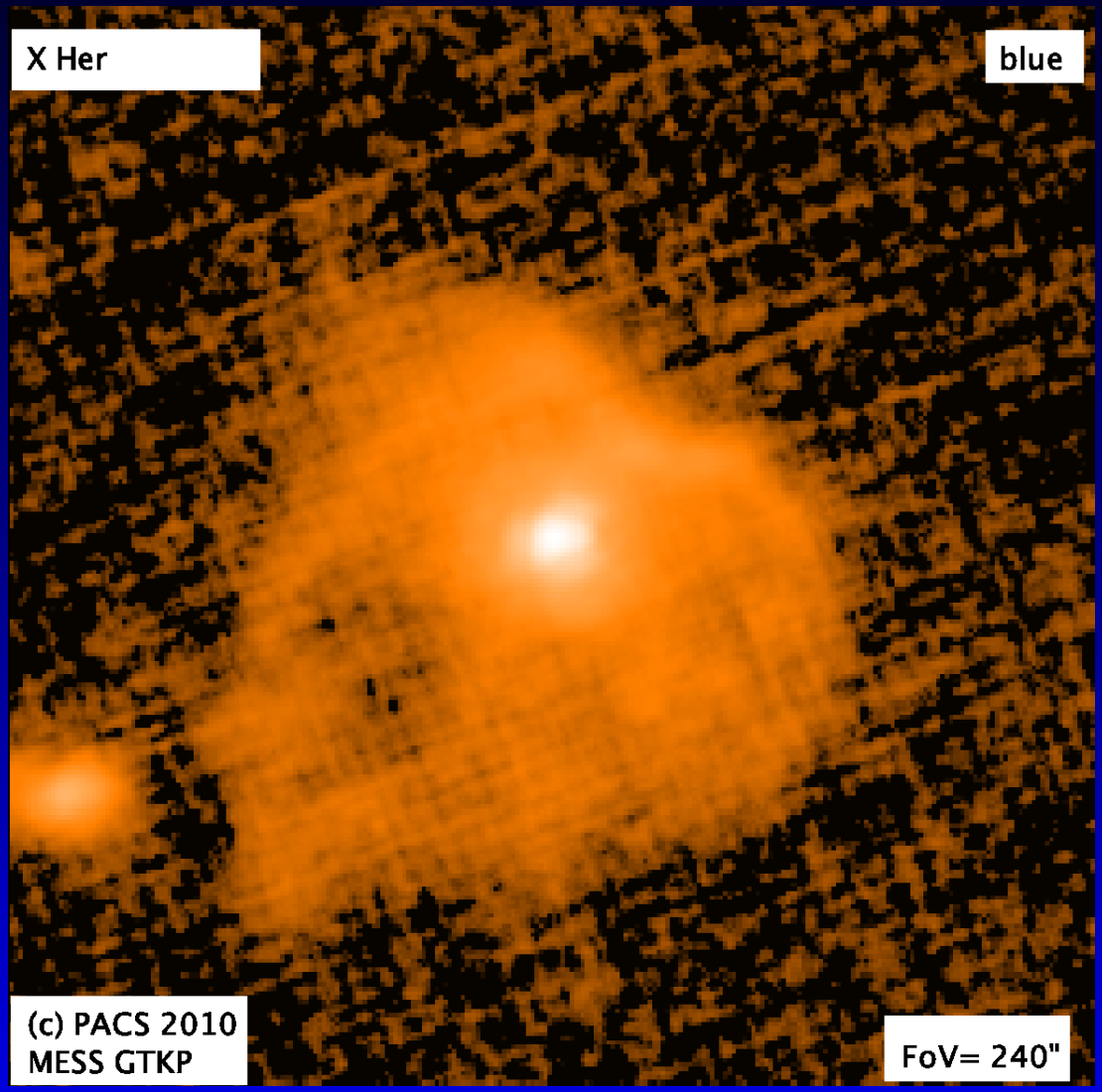
CW Leo



Intensity profiles FUV, 160, 250,350,550 micron

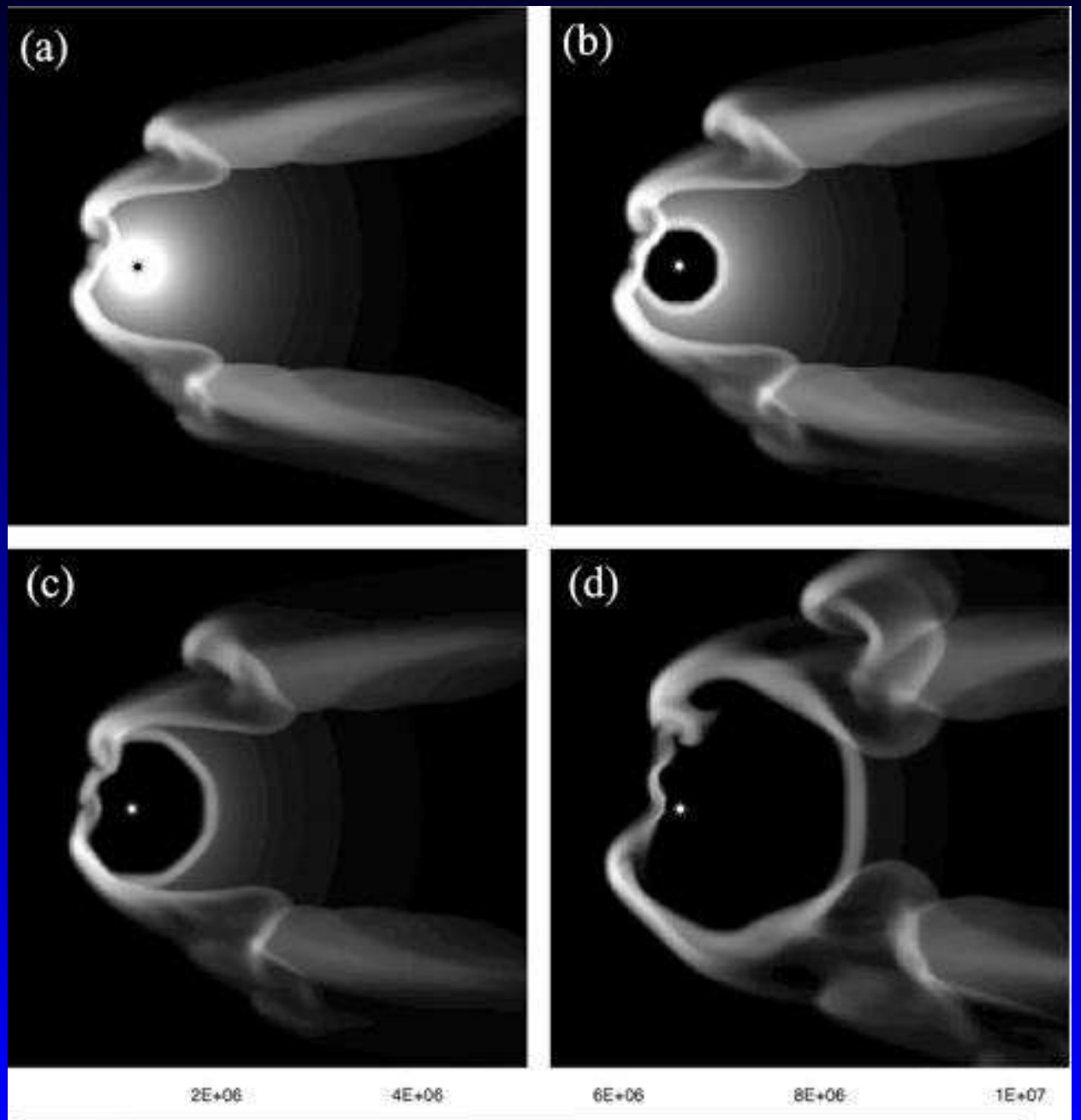
$T_{\rm dust}$ = 25 K $\qquad$ $V_{\star{\rm relativeISM}} = 107/\sqrt{n_{\rm ISM}}$ km s^{-1}

Interaction ISM

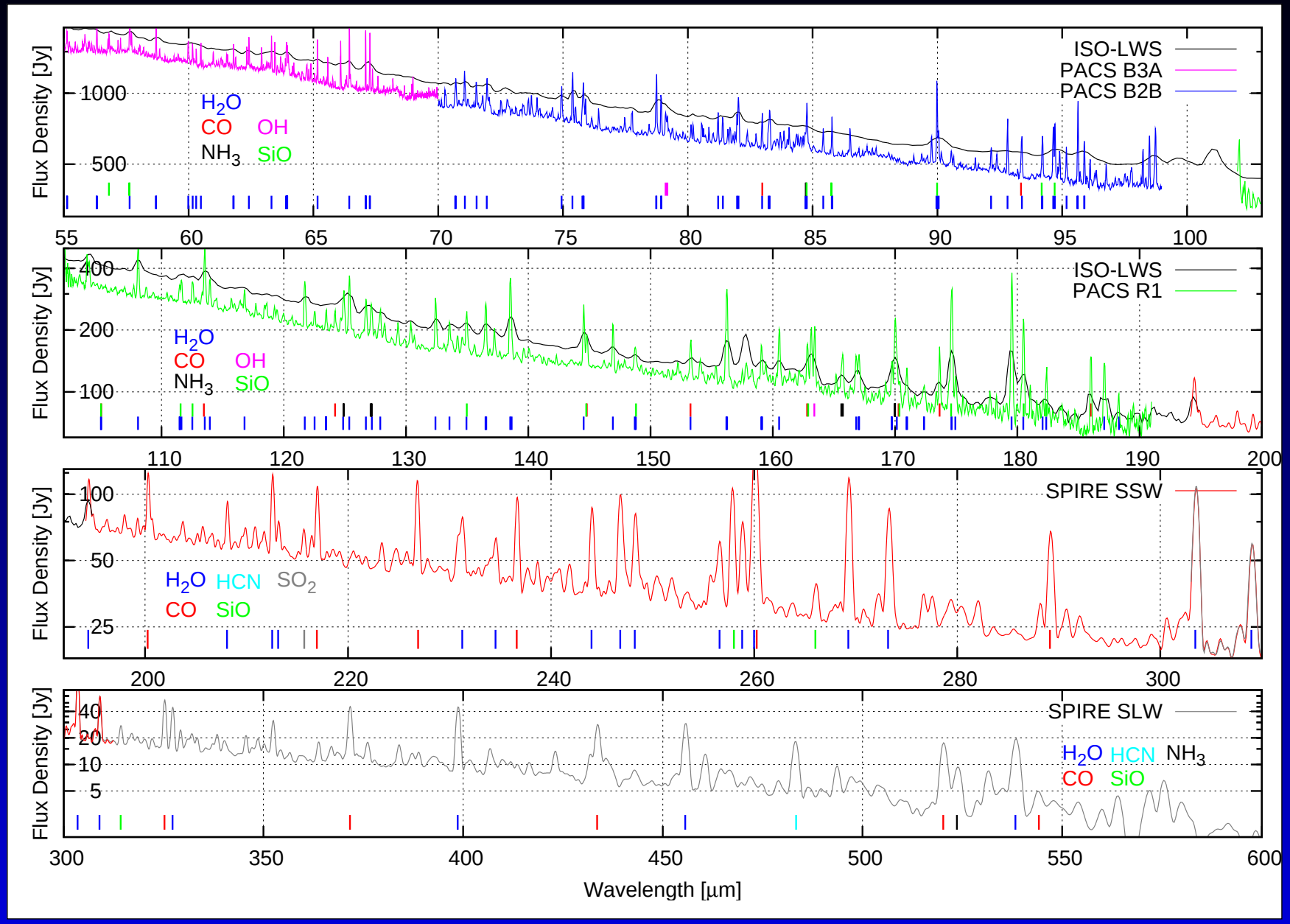


Jorissen, Kerschbaum, Van Eck, et al. (in prep.)

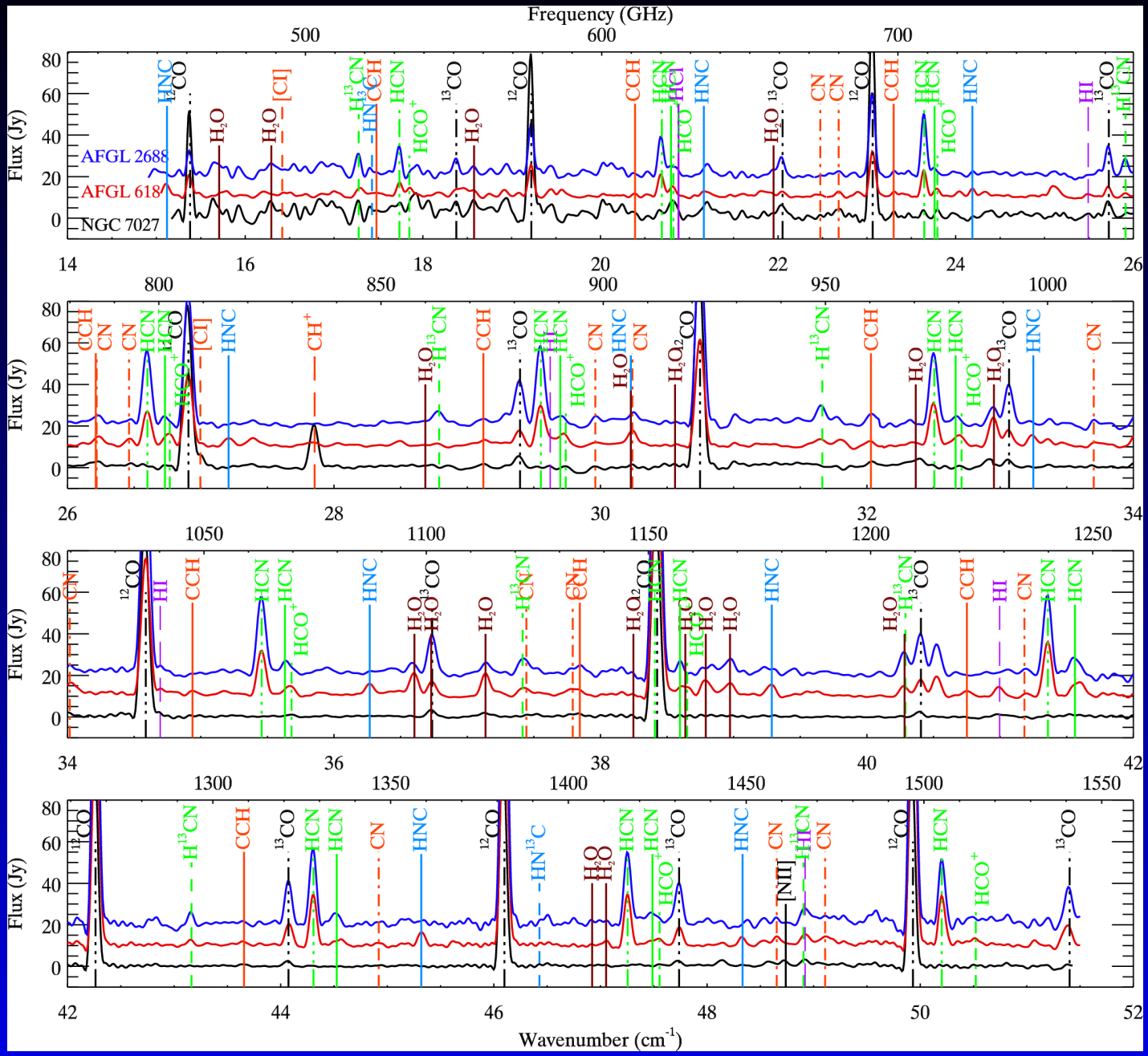
Models



Wareing et al. (2007)



VY CMa, Royer et al. 2010



Wesson et al. (2010).

Continuum-subtracted SPIRE FTS spectra of NGC 7027 (black), AFGL 618 (red) and AFGL 2688 (blue)

MESS - Spectroscopy

- AFGL 2688, AFGL 618 and NGC 7027

150 lines in each object. Lines due to 18 different species are detected.
First detection of water in AFGL 2688 for the first time, and confirm its presence in AFGL 618 in both ortho and para forms. In addition, we report the detection of the J=1-0 line of CH^+ in NGC 7027.

- VY CMa

Detection of more than 900 emission lines of various chemical species.
Derivation of HCN, SiO and water abundances.
Suprisingly low ortho-to-para water ratio, close to 1.

MESS - Spectroscopy

- CW Leo

-HCl lines from J=1-0 up to J=7-6 have been detected. HCl is produced in the innermost layers of the circumstellar envelope and extends until the molecules reach its photodissociation zone.
(Cernicharo et al. 2010)

-Tens of lines from SiS and SiO, including lines from the v=1 vibrational level.
Both species trace the dust formation zone.
(Decin et al. 2010)

-Water
(Decin et al. 2010 in *Nature*)

Conclusions

- Detected ”old” dust mass loss in AGB stars !
- Interaction with the ISM is common
- Line spectroscopy very succesfull
- Issues
  - Faint extended emission
    PhotProject/NaiveMapper versus MADMap
  - Dust emission close to the star
    PSF subtraction / deconvolution
  - Dust spectroscopy
    Better understanding of RSRF

MESS is produced by

A. Baier, M. Barlow, B. Baumann, J. Blommaert, J. Bouwman, P. Cernicharo, M. Cohen, L. Decin, L. Dunne, K. Exter, P. Garcia-Lario, H. Gomez, M.A.T. Groenewegen, P. Hargrave, Th. Henning, D. Hutsemékers, R. Ivison, F. Kerschbaum, O. Krause, D. Ladjal, T. Lim, M. Mecina, W. Novotny-Schipper, G. Olofsson, R. Ottensamer, E. Polehampton, Th. Posch, G. Rauw, P. Royer, B. Sibthorpe, B. Swinyard, T. Ueta, B. Vandenbussche, G. Van de Steene, P. van Hoof, H. Van Winckel, E. Verdugo, H. Walker, C. Waelkens, R. Wesson

FWF-projects: P18939-N16 & I163, P21988
FWO
STFC
ASAP-CO-016/03
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THE END