MESS - Mass loss of Evolved StarS
An overview

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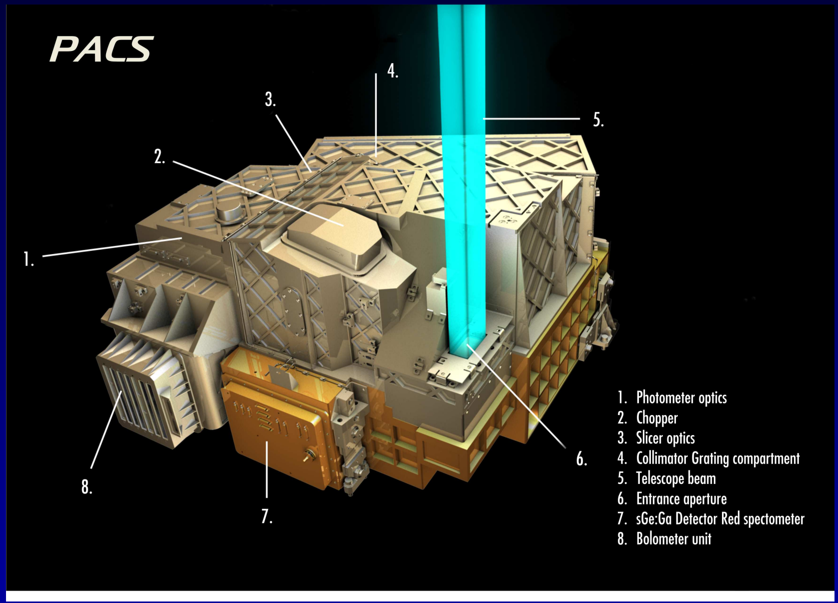
on behalf of the MESS consortium
www.univie.ac.at/space/MESS (consortium website)

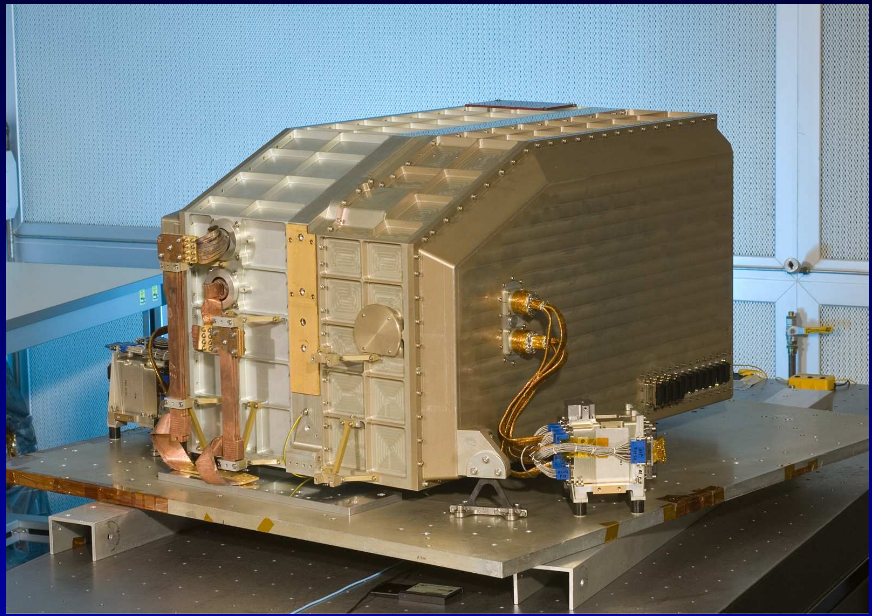
Herschel - Planck launch 14 May 2009

3.3m effective diameter

3 year of Routine Phase starting Dec. 2009

Herschel instruments





PACS - SPIRE - HIFI

FWHM:
5.6, 6.8, 11.4 (PACS), 18.1, 25.2, 36.6″ (SPIRE)

Evolved stars Key Programs

MESS (Mass loss of Evolved StarS) - PACS + SPIRE

HIFISTARS - HIFI (PI. Valentin Bujarrabal)

PACS (50-200 μm) SPIRE (200-650 μm)

both have bolometer arrays (FOV of a few arcmin)

both have a spectrometer (R= 1000-2000)

MESS First Results
8 papers in the A&A Volume 518 Special Issue
+ 1 Nature paper accepted

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

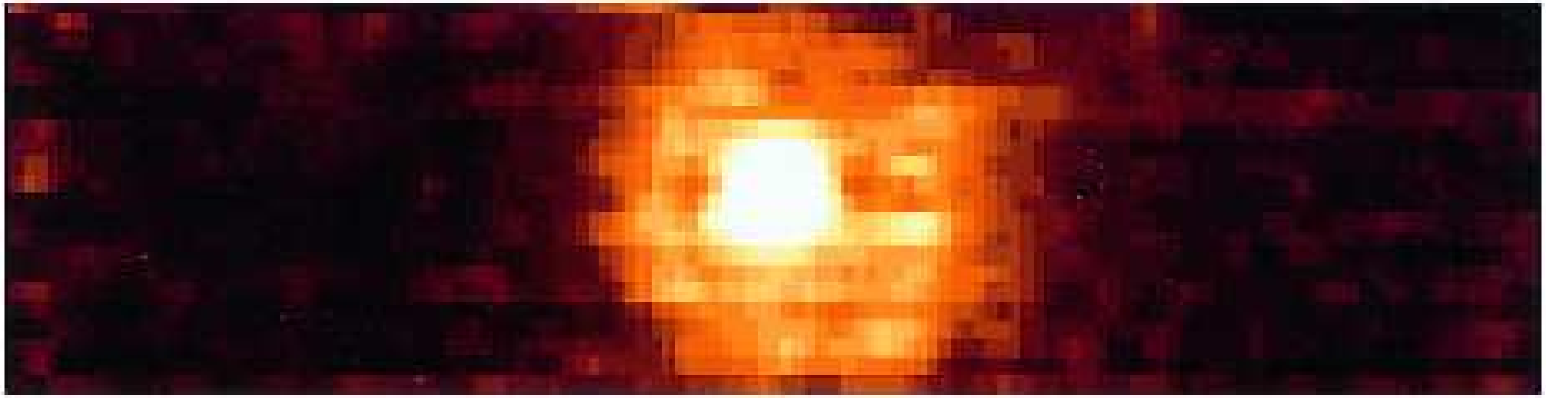


Fig. 1. 90 μm image of Y CVn taken with PHT-C100 array detector and C90 filter displayed in linear brightness scale.

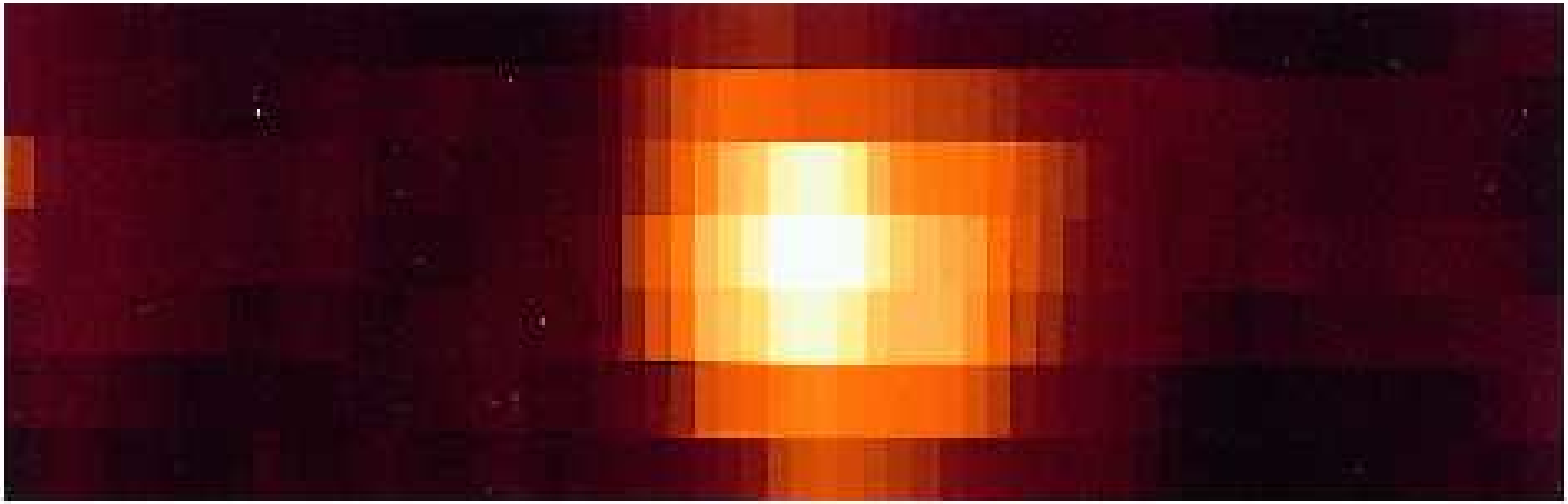
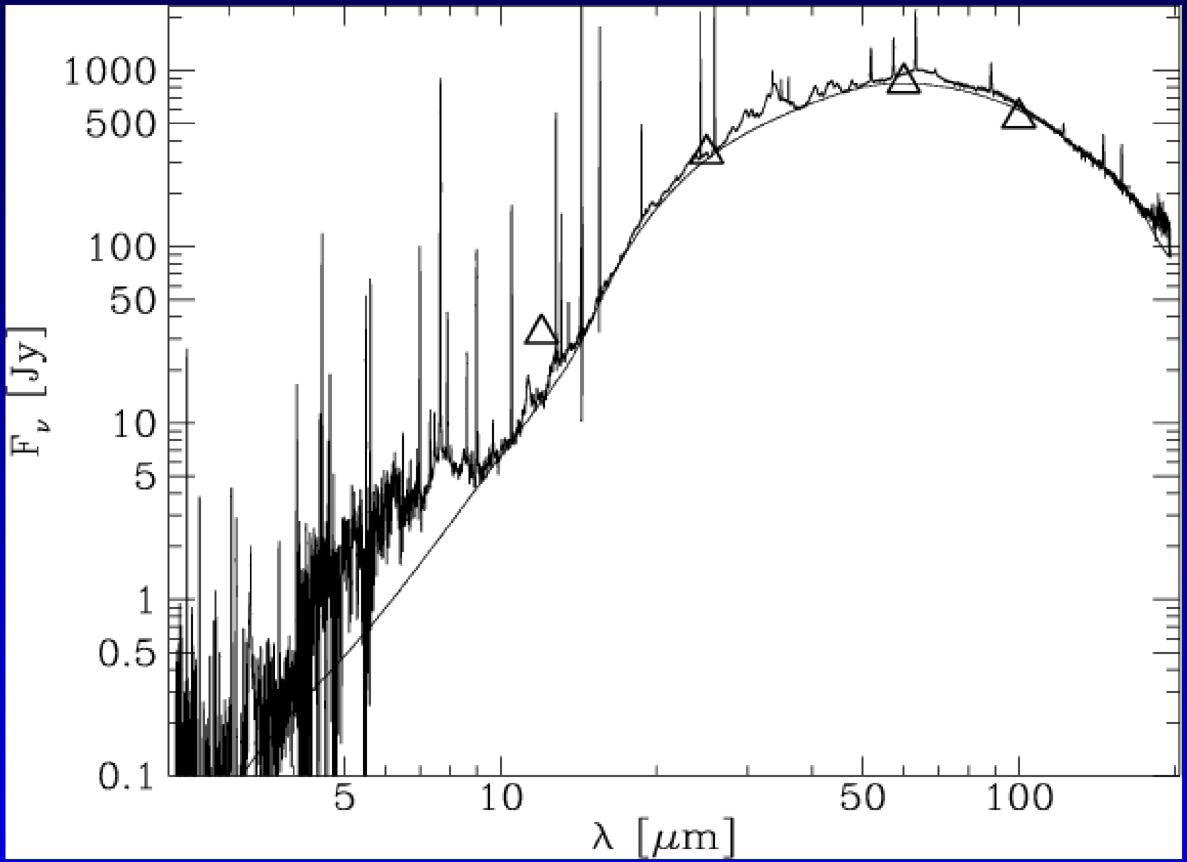


Fig. 2. 160 μm image of Y CVn taken with PHT-C200 array detector and C160 filter displayed in linear brightness scale.

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

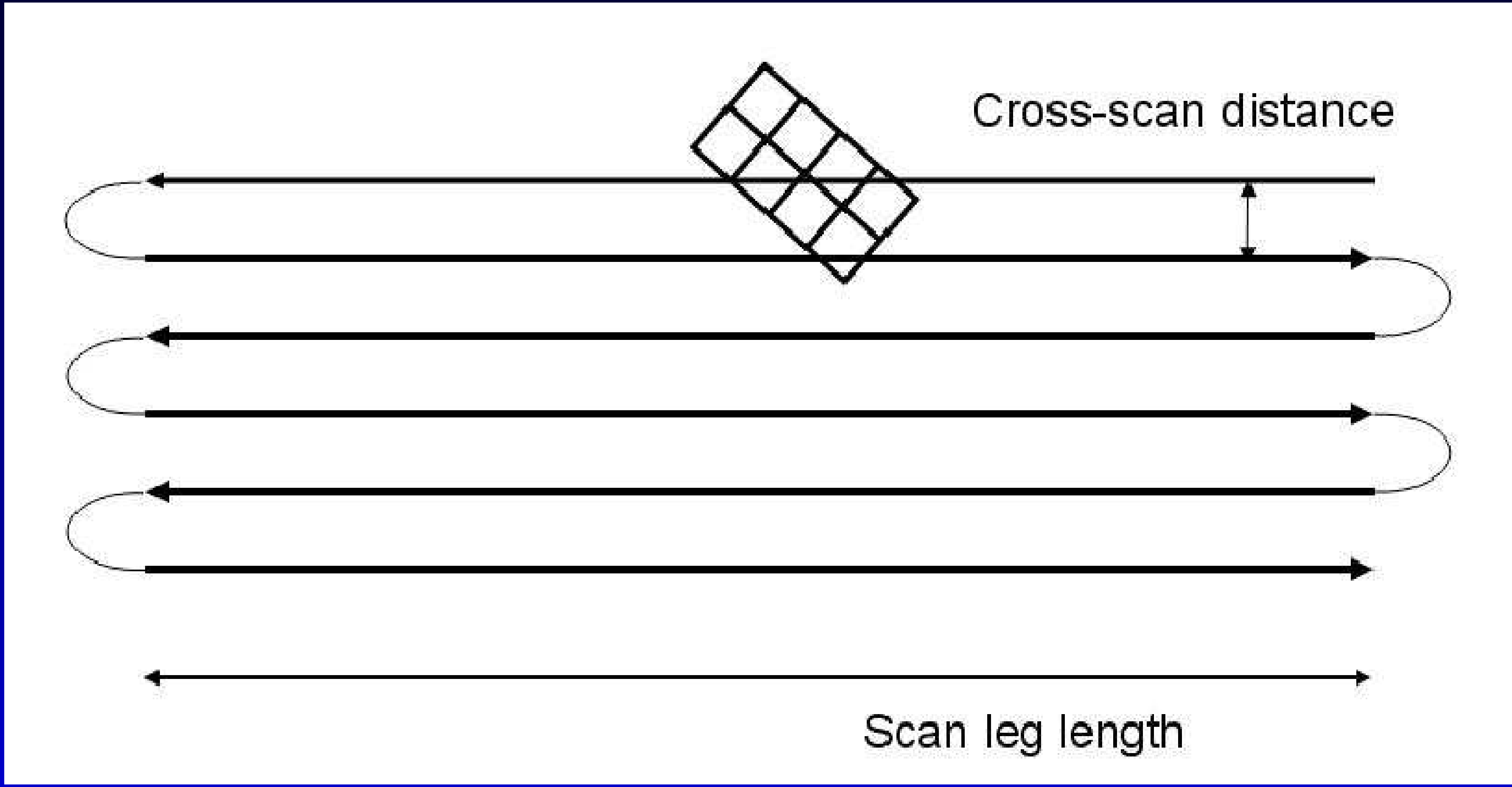
OBSERVED: 72

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

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

ALL but 3 OBSERVED

Mapping strategy



PACS: concatenate scan and cross-scan;
for SPIRE this is done in a single AOR.

Implementation (Spectro)

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

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

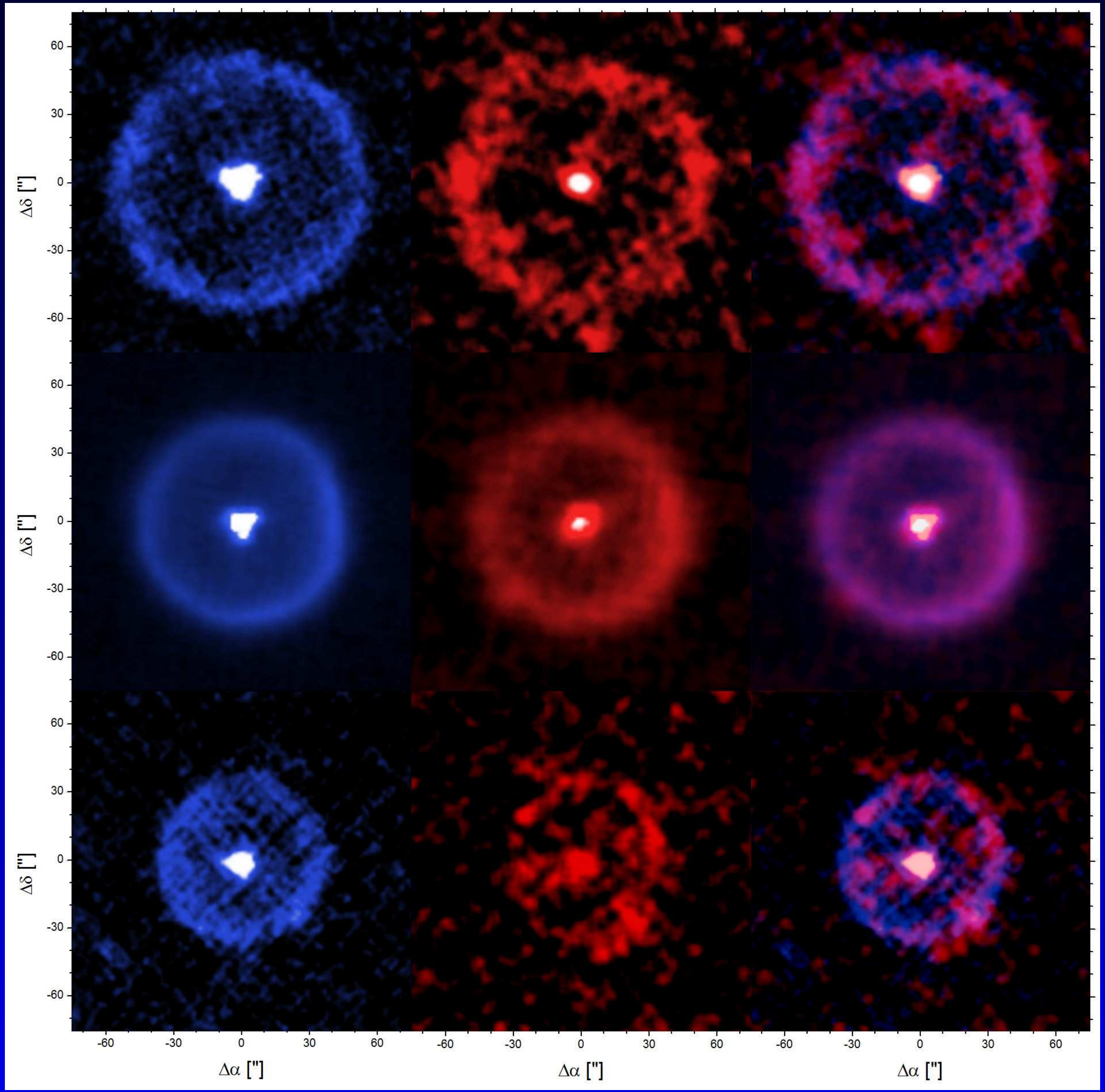
OBSERVED: 3 PV/SDP + 14

SPIRE:
Complete FTS scan in a single AOR

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

ALL but 1 OBSERVED

Detached shells



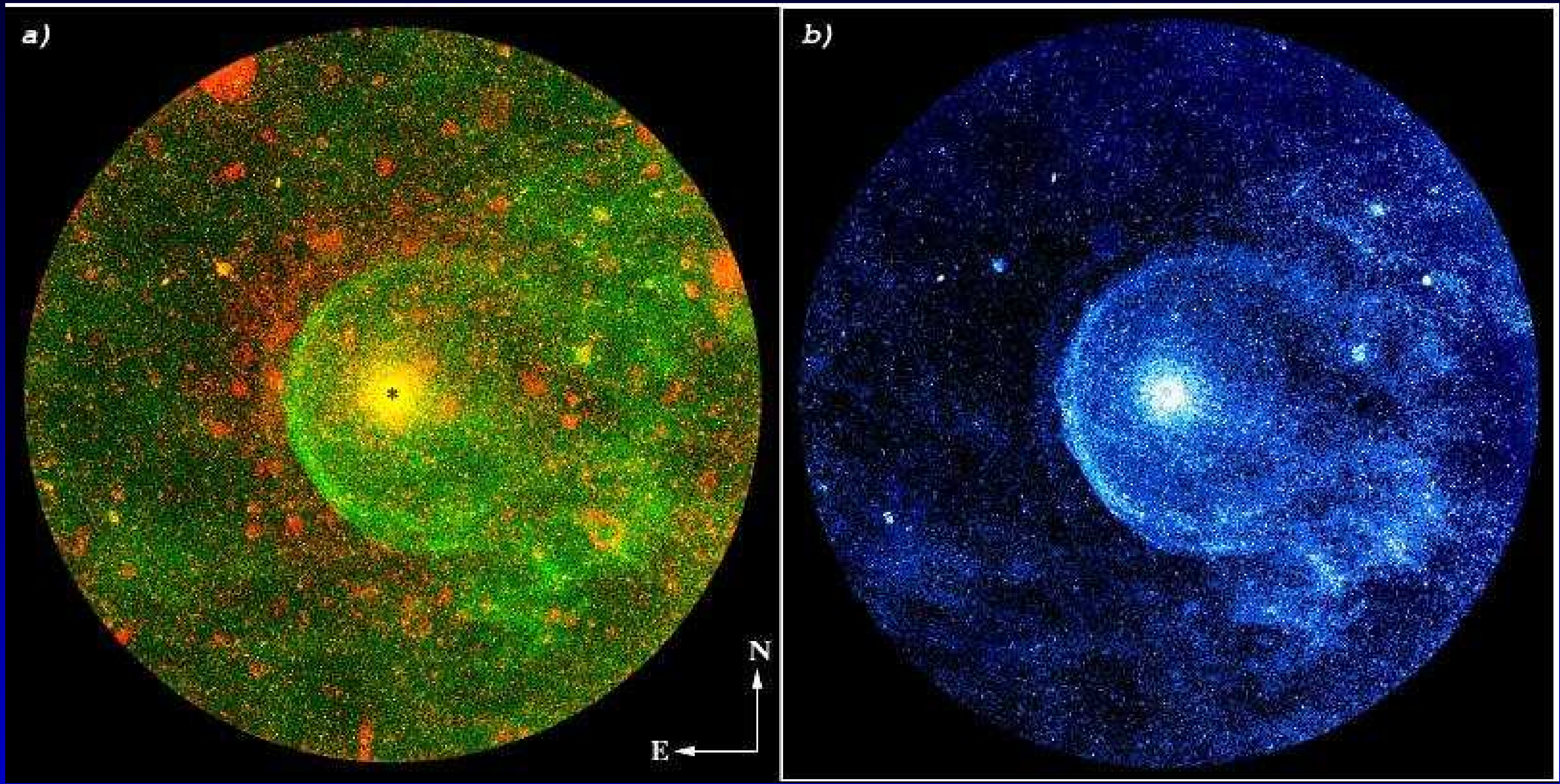
Kerschbaum et al. (2010)

PACS:
blue / red / combined

AQ And,
U Ant,
TT Cyg

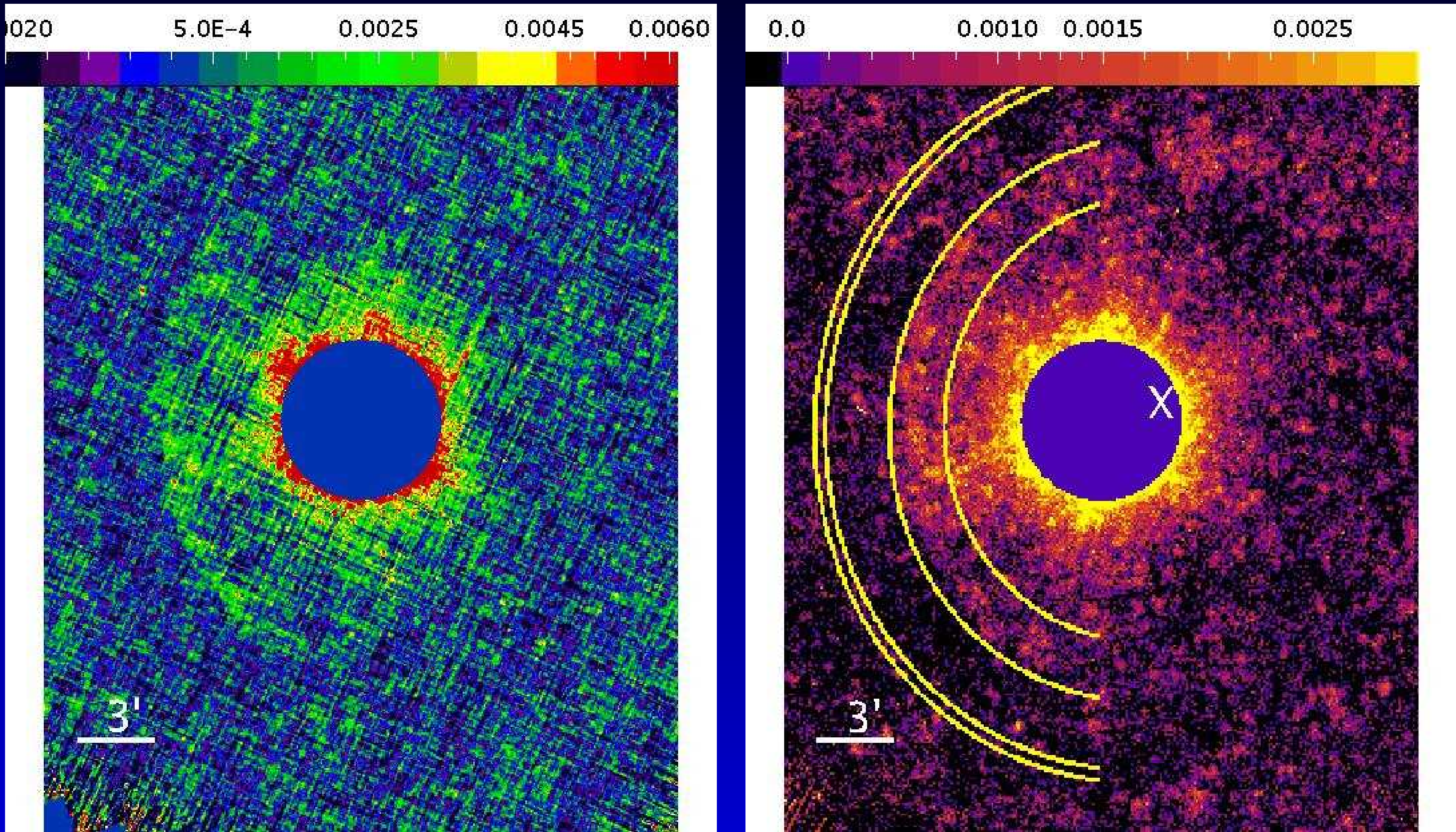
talk by Franz Kerschbaum,
and poster II.23 by Marko Mecina et al.

CW Leo



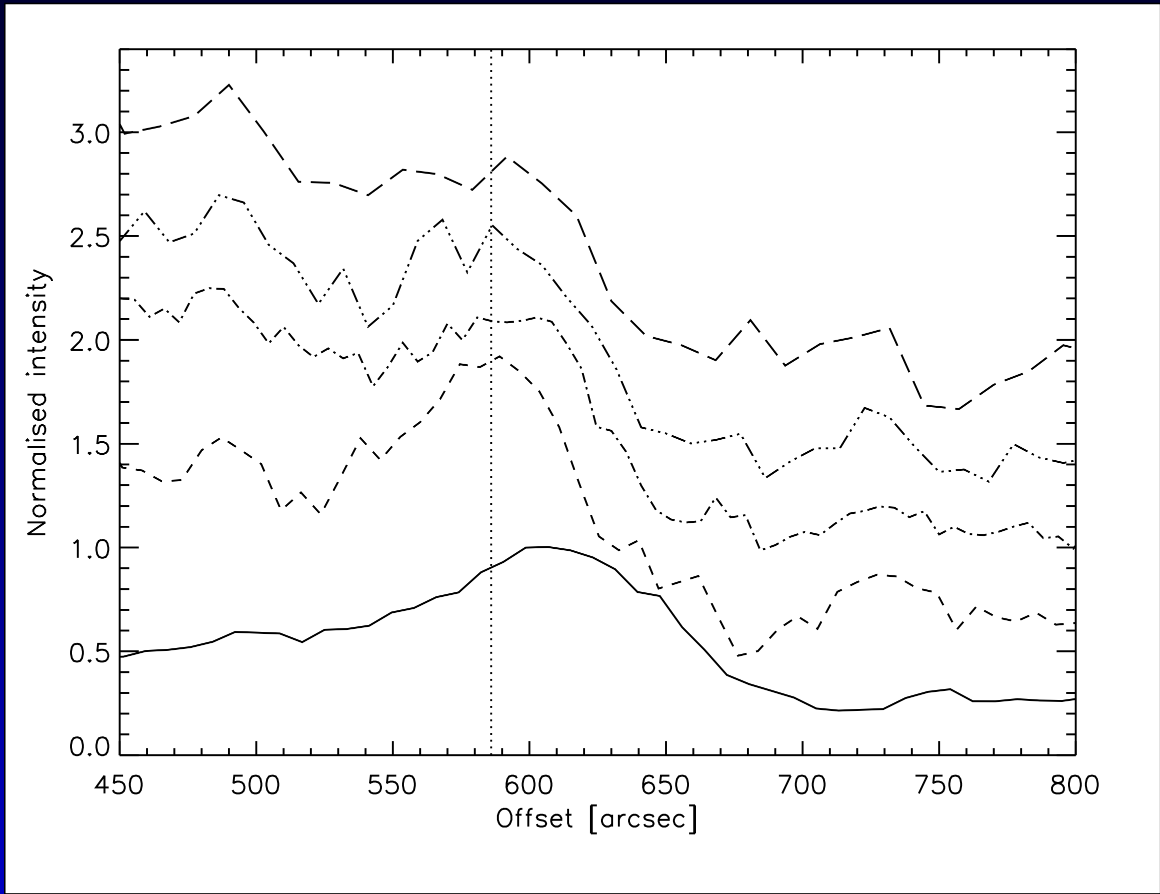
GALEX NUV/FUV composite (left), FUV (right).
Sahai & Chronopoulos (2010)

CW Leo



PACS 160 and SPIRE 250 micron
$23' \times 27'$ (Ladjal et al. 2010 and Poster II.15)

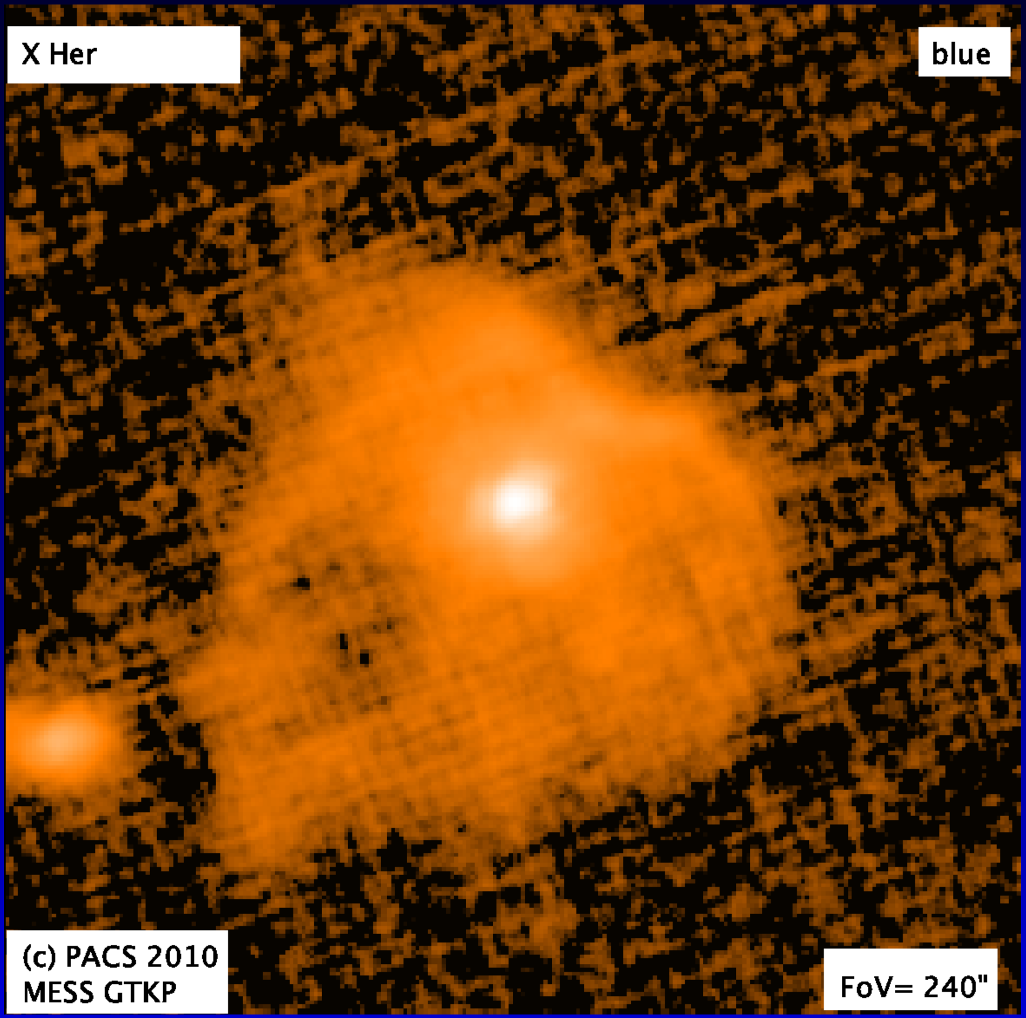
CW Leo



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

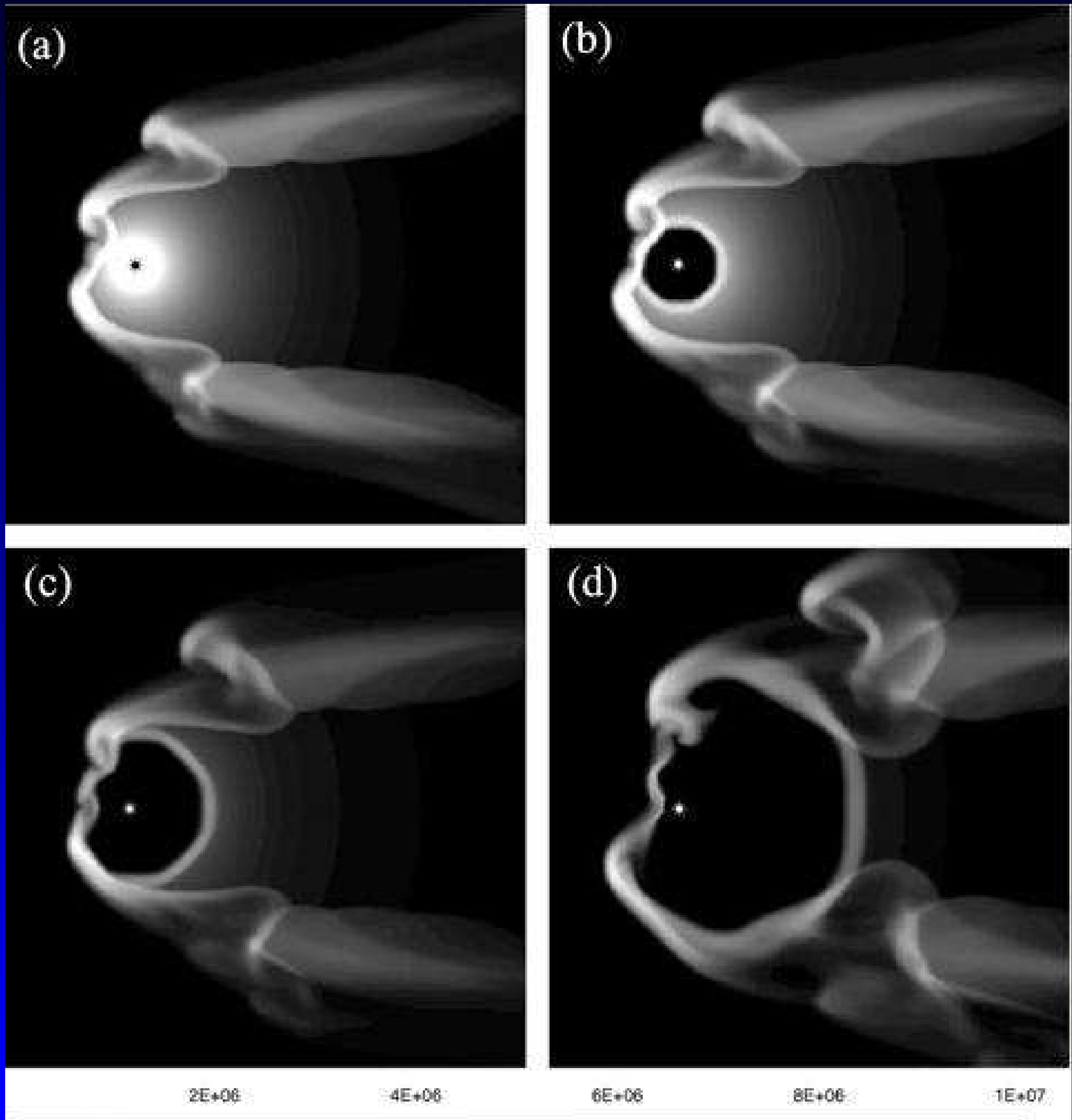
$T_{\rm dust}$ = 25 K $\qquad V_{\star{\rm relativeISM}} = 107/\sqrt{n_{\rm ISM}}$ km s^{-1}

Interaction ISM



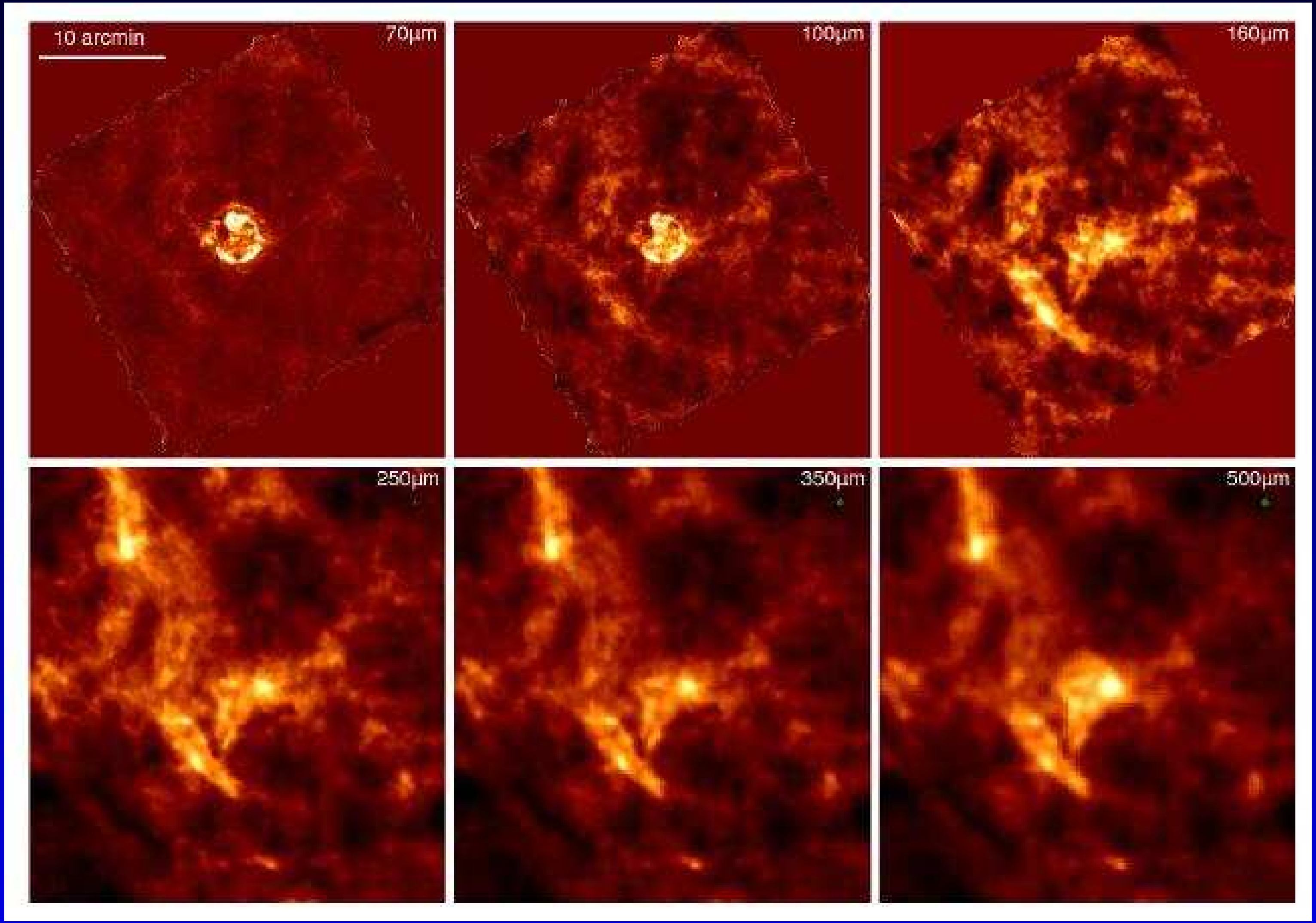
Talk by Alain Jorissen and Poster II.22 by Mayer et al.
Akari: Ueta, his talk and poster V.5

Models

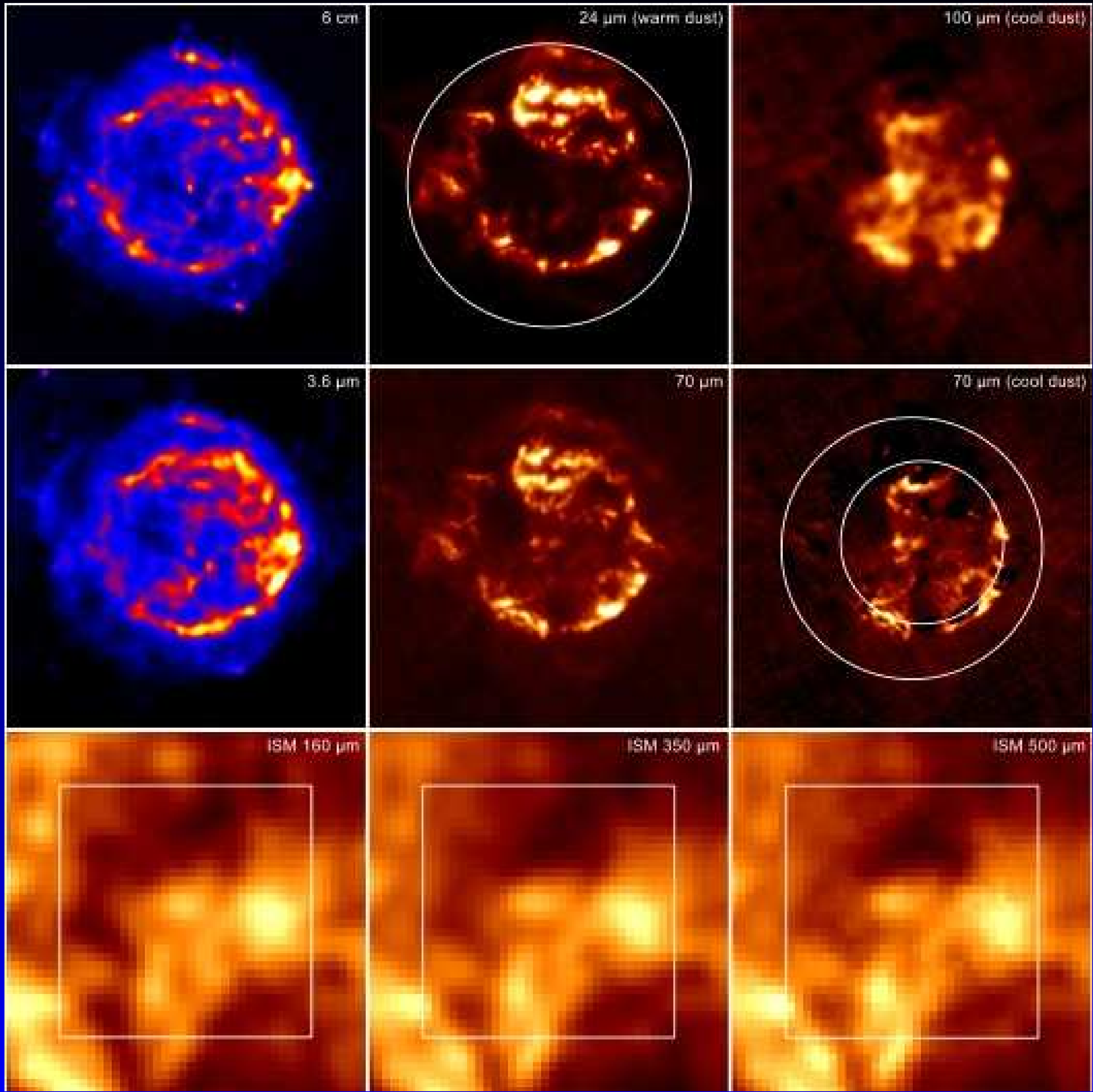


Wareing et al. (2007)

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

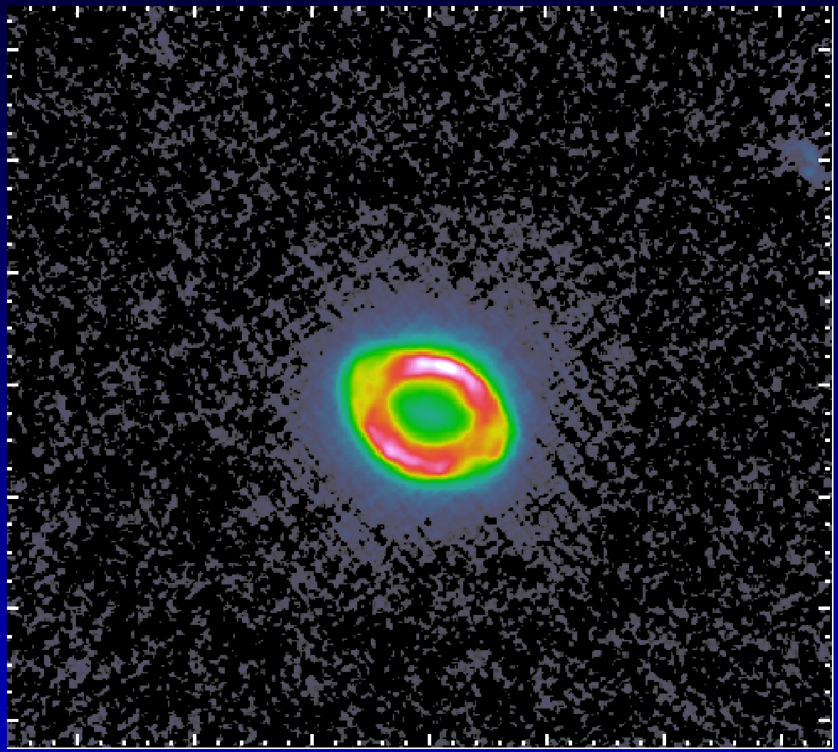
SN remnant: Cas A

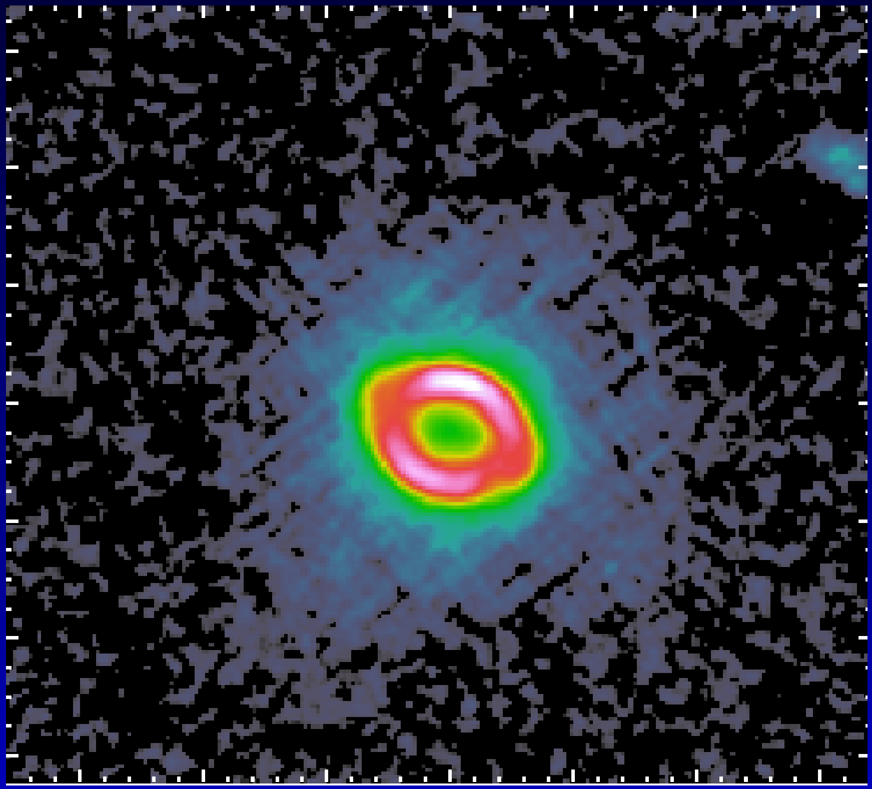
• non-thermal component: based on 6-cm VLA and 3.6-μm IRAC image
• warm dust component: based on scaled 24-μm MIPS image
• cold interstellar component: iterative procedure
• line contributions: archival LWS spectrum

“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. ”

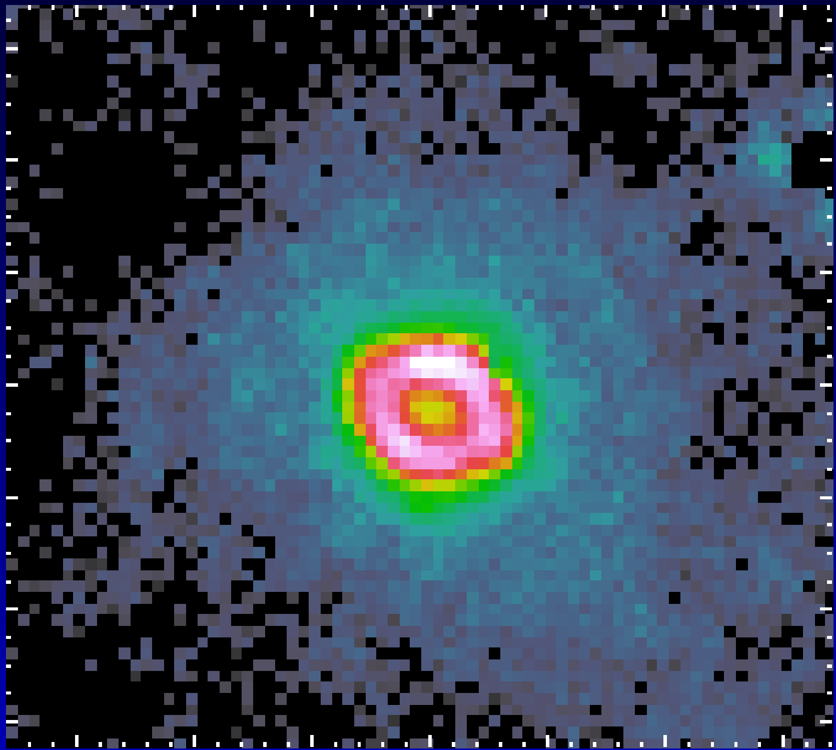
NGC 6720

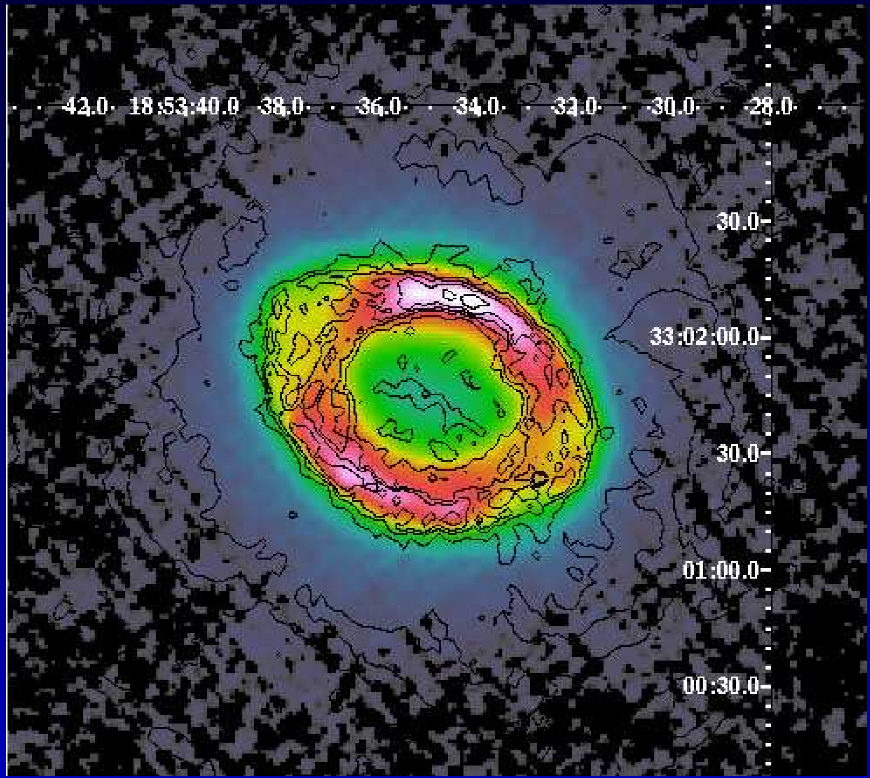




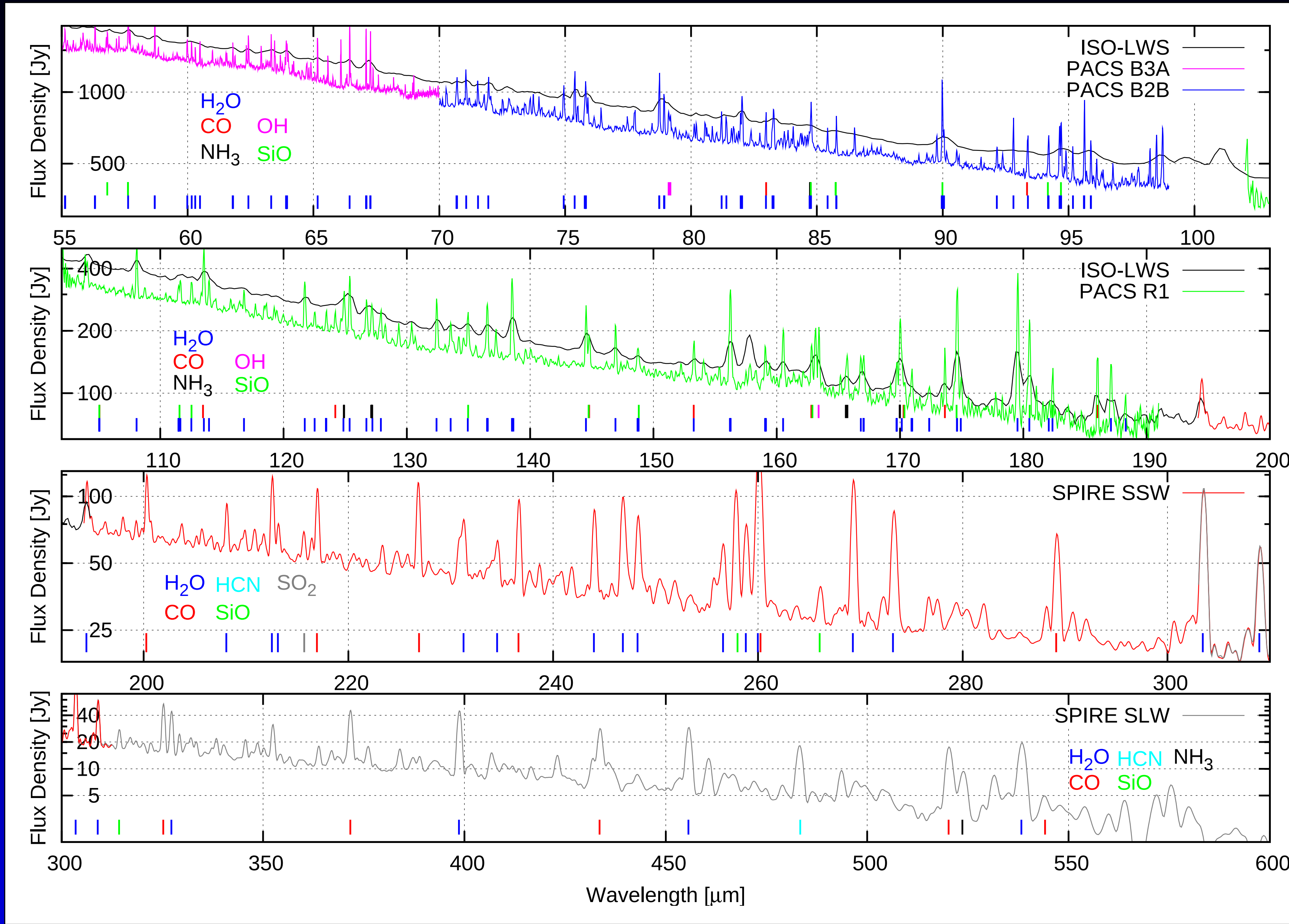
van Hoof et al. (2010)
PACS 60 and 160 micron

NGC 6720





van Hoof et al. (2010)
SPIRE 250, and PACS 70 micron with H_2 contours
⇒ H_2 formation on dust grains, in high density knots.



VY CMa, Royer et al. (2010)

talk by Leen Decin, and Poster IV.8 by Matsuura et al.

MESS - Spectroscopy

- AFGL 2688, AFGL 618 and NGC 7027

Wesson et al. 2010, and his talk

- CW Leo

-HCl lines from J=1-0 up to J=7-6 have been detected.
(Cernicharo et al. 2010)

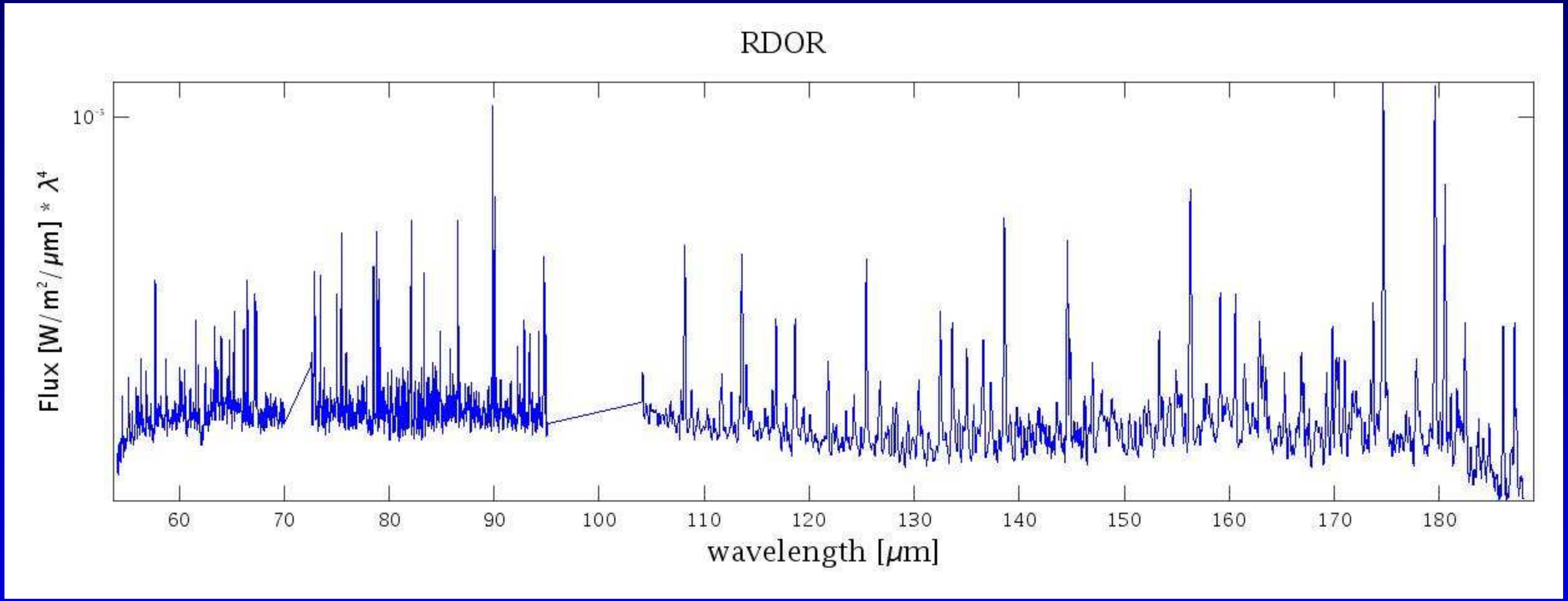
-Tens of lines from SiS and SiO, including lines from the v=1 vibrational level.
Both species trace the dust formation zone.
(Decin et al. 2010)

-Water
(Decin et al. 2010 accepted by *Nature*)

Dust spectroscopy

de Vries et al., Poster V.2

Fosterite at 69μm in HD 161796



R Dor, full PACS spectrum

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
    and other techniques
  - Dust emission close to the star
    PSF subtraction / deconvolution
    (Ottensamer et al., Poster V.4)
  - Dust spectroscopy
    Improved data reduction; RSRF;
    removal of molecular lines

Perspectives

- Complete the program..... (next few months)
- Hopefully MESS follow-up proposals will be accepted
  - Some new targets where detached shells and/or wind-ISM interaction are expected
  - Spectroscopy on a few of the bow-shocks
  - mass loss in RGB stars
- Mid-IR interferometry
- multi-wavelength studies (scattered light, interferometry)
- Hydrodynamical simulations ...!!

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, A. Jorissen, 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, C. Vamvatira-Nakou, B. Vandenbussche, G. Van de Steene, S. van Eck, 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
PRODEX C90371

THE END