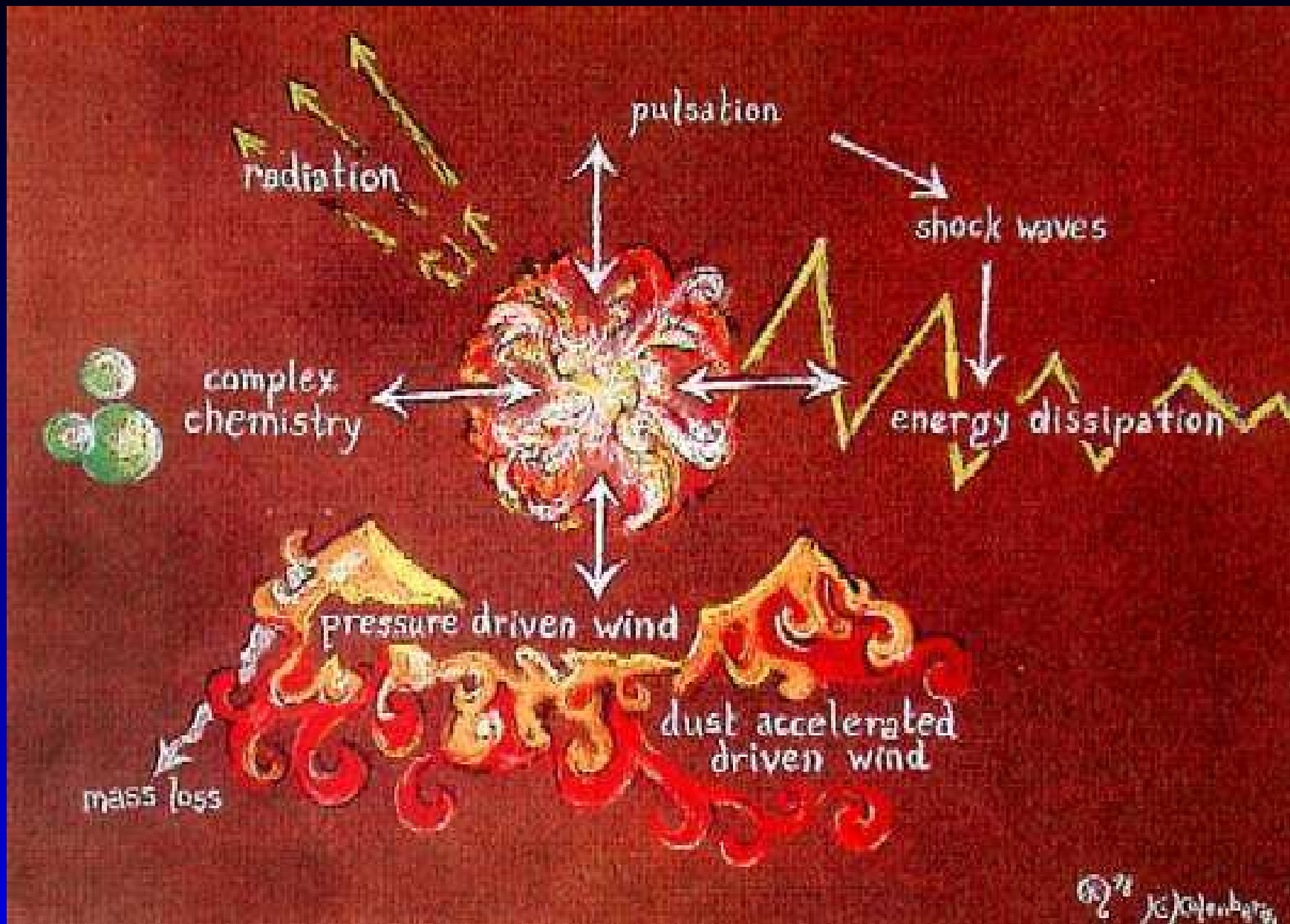


Predicted Spectral Properties of Dusty AGB Stars

Martin Groenewegen

Royal Observatory of Belgium, Brussels

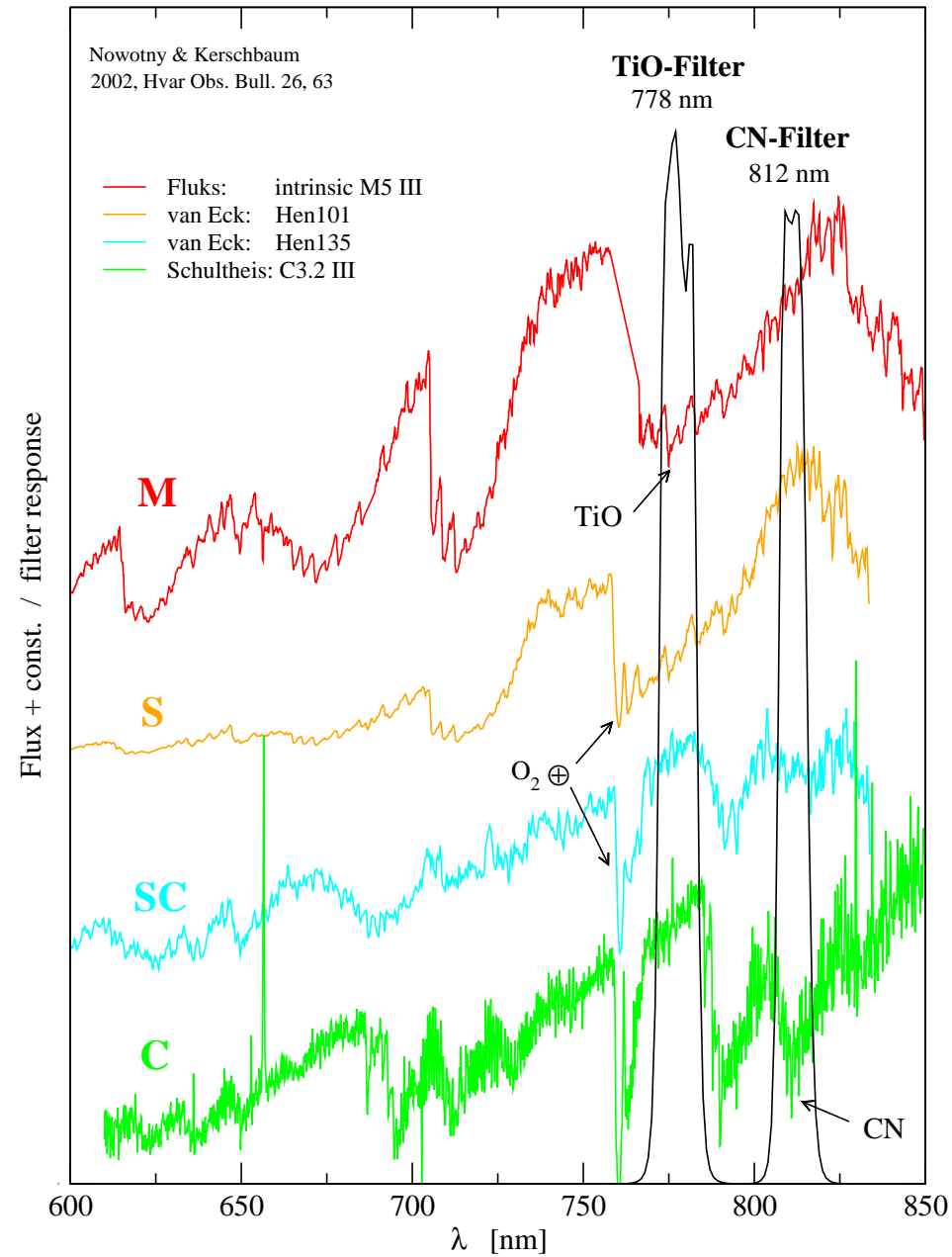
marting@oma.be

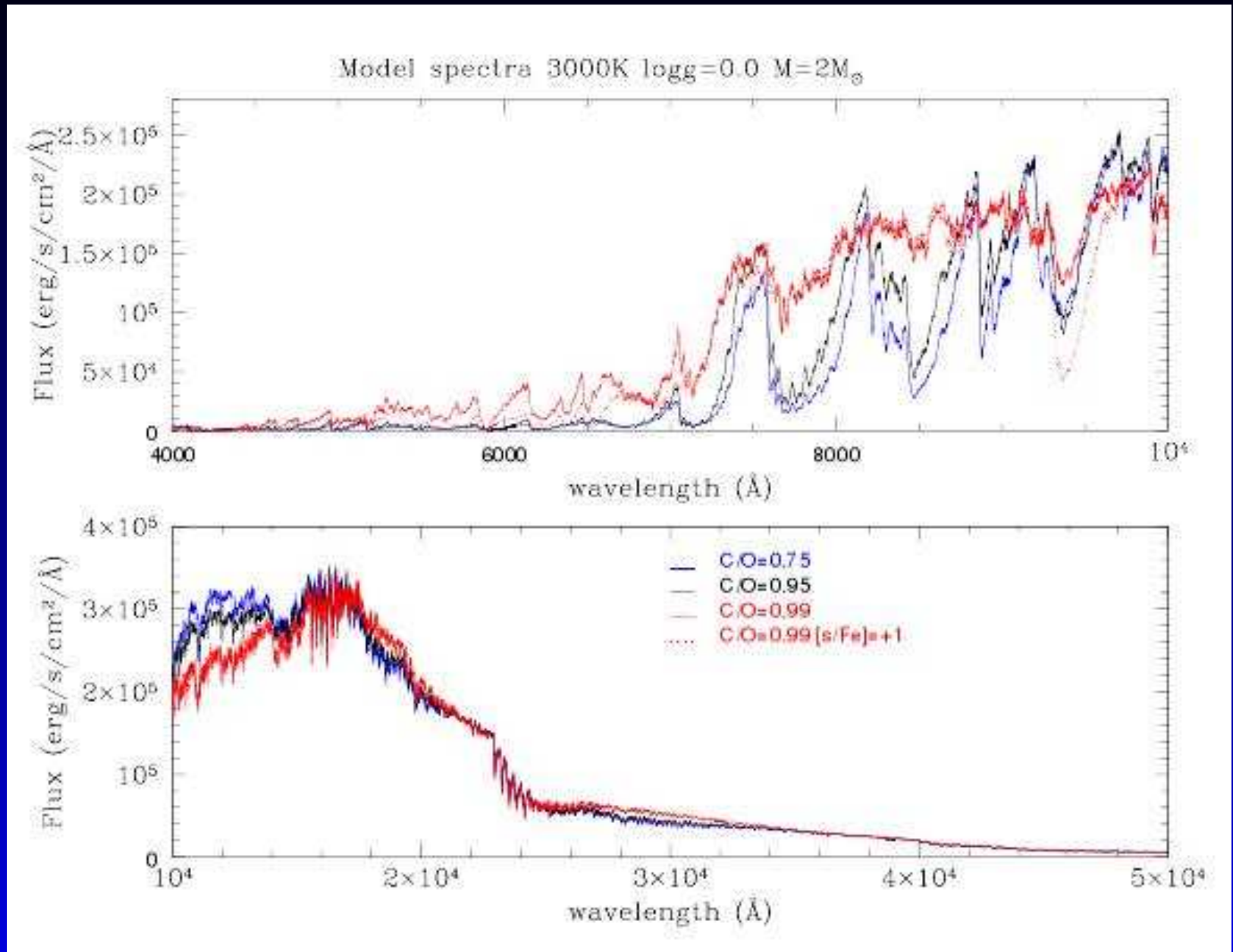


Overview Talk

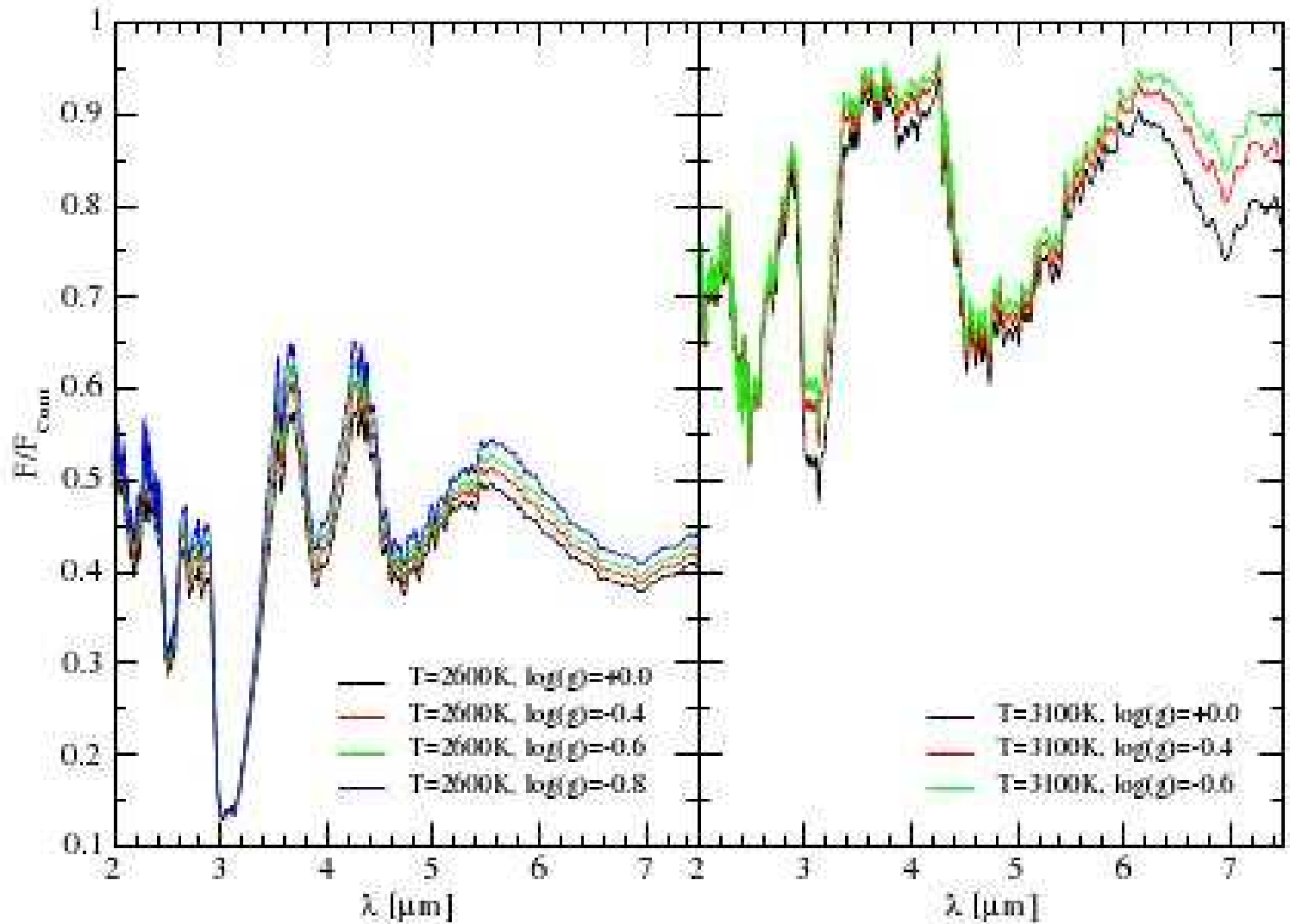
- Optical to NIR
- mid-IR region
- far-IR region
- Prospects

Spectra of AGB stars with different chemistry
+ Wing-type narrow-band filters

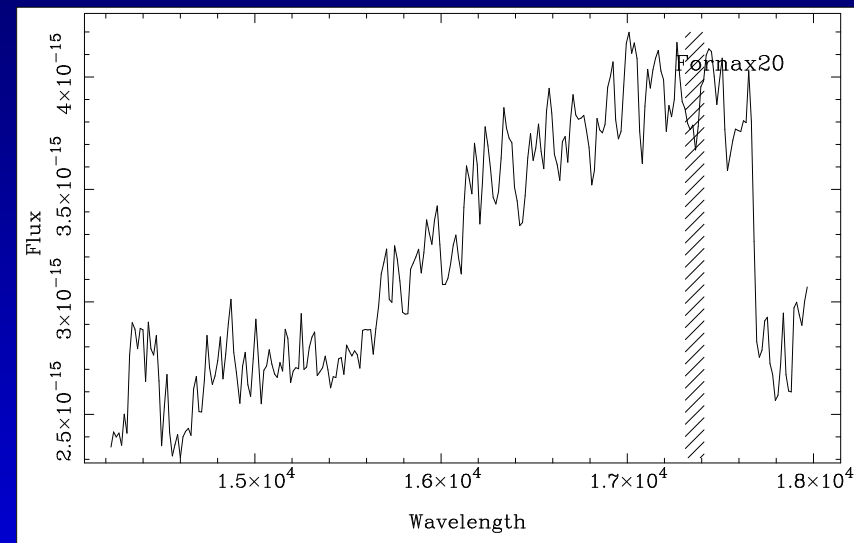
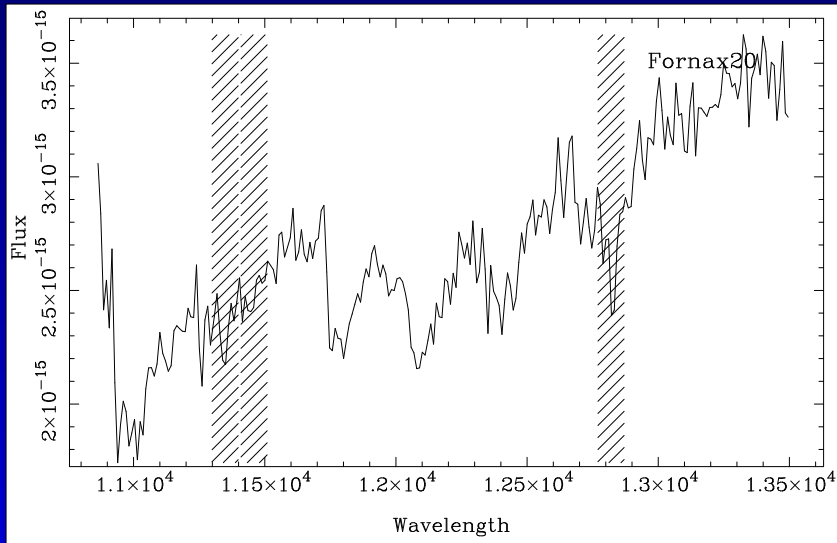
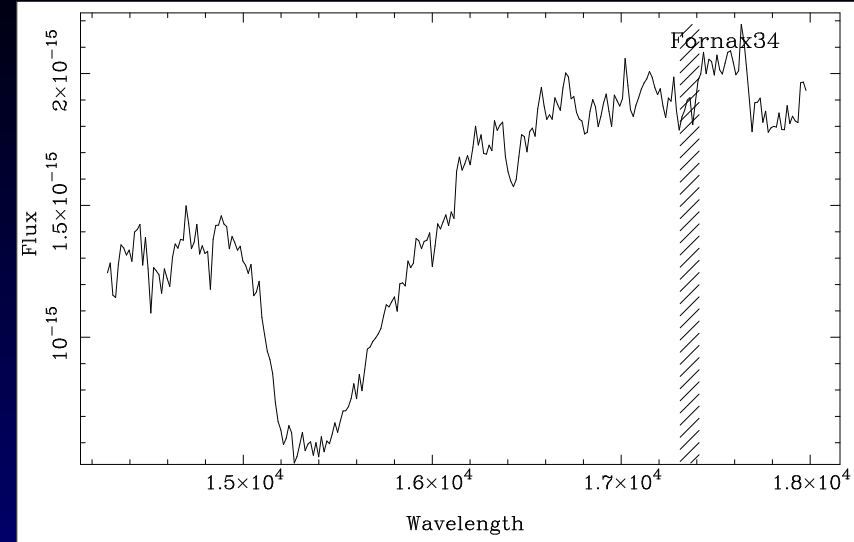
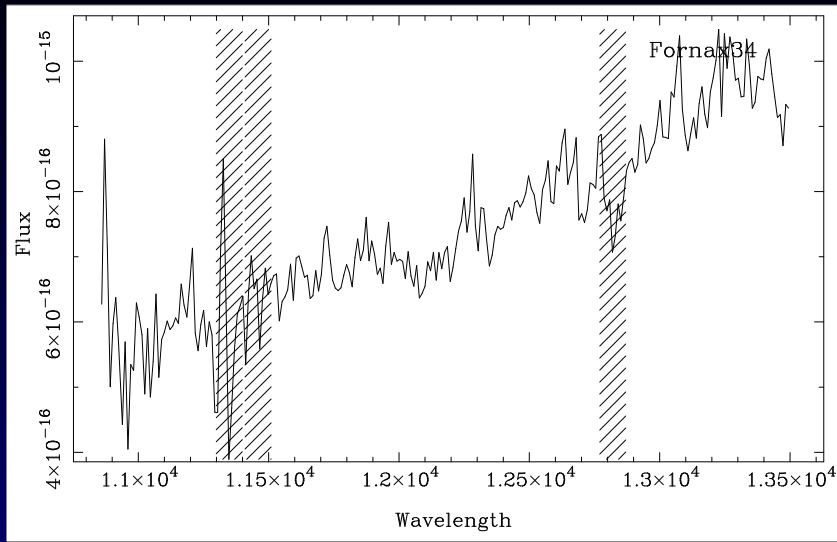




S-stars: Plez et al. 2003, IAU Symp. 210

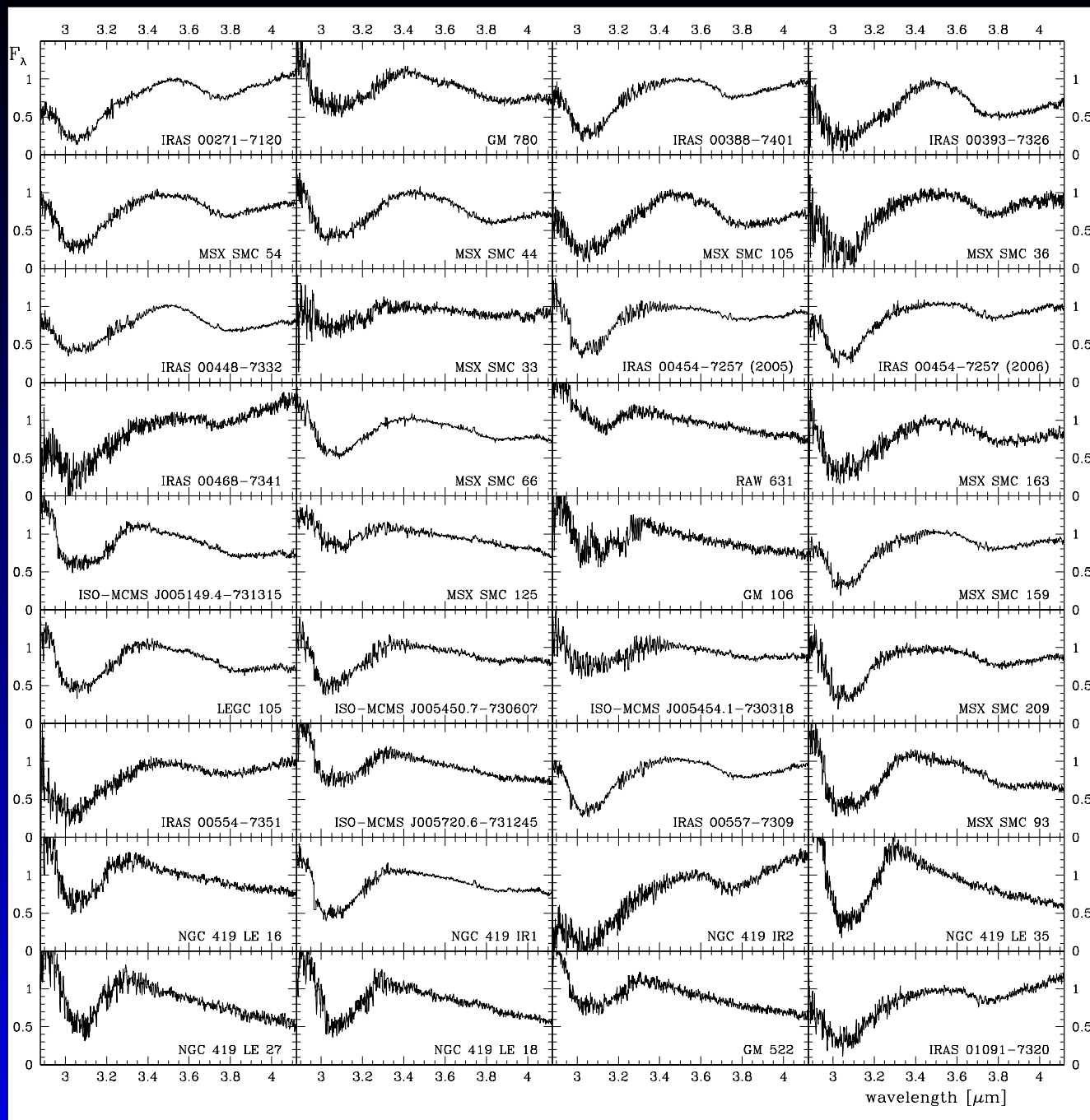


C-stars: Aringer et al. 2009, in press



Carbon stars in Fornax DSph

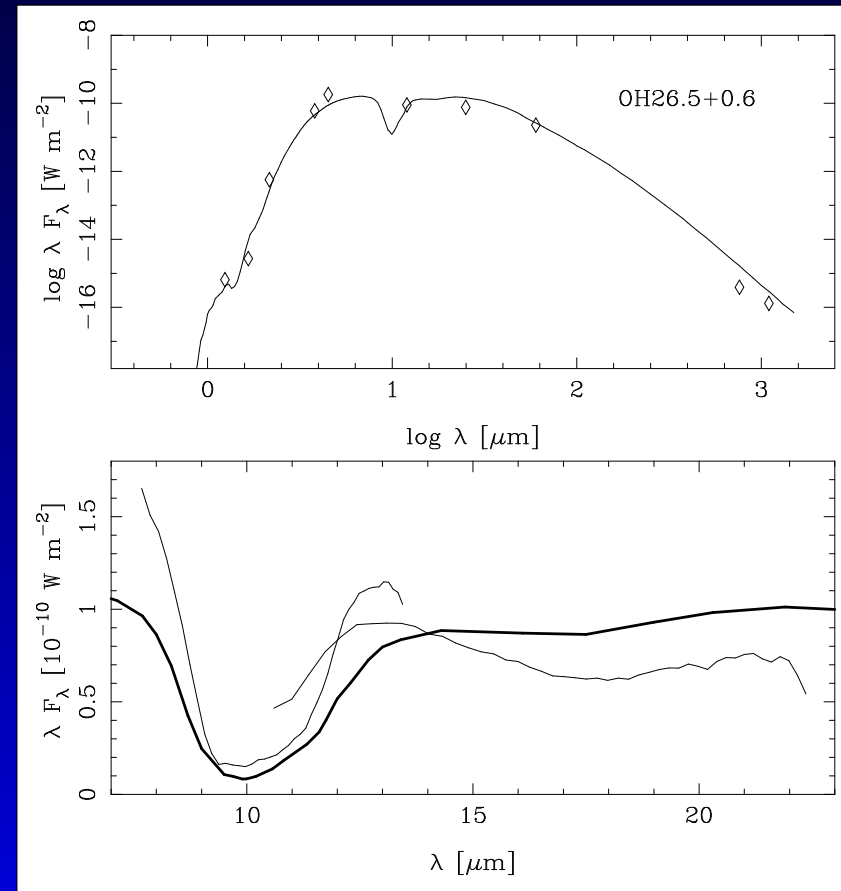
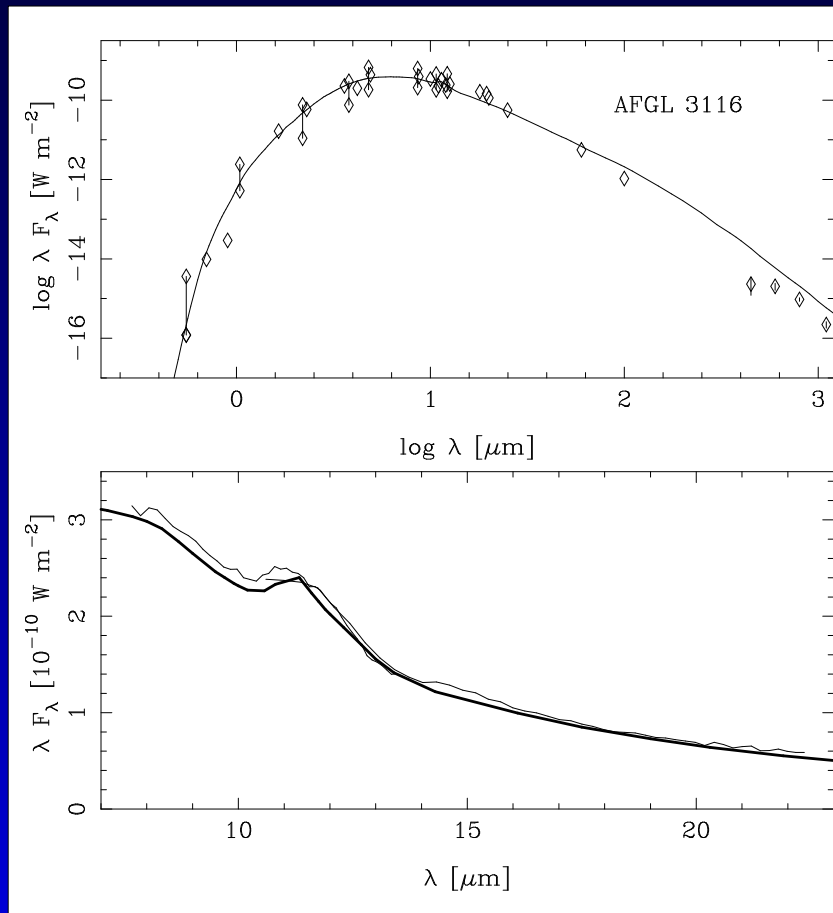
Groenewegen, Lançon & Marescaux (2009)



ISAAC 3 μm spectra of C-stars (van Loon et al. 2008)

The Mid-IR

Mass-loss / SED modelling / dust spectral features



Groenewegen (1995) for our Galaxy

Spitzer IRS program

200 (P.I. J. Houck), Sloan et al. (2008)

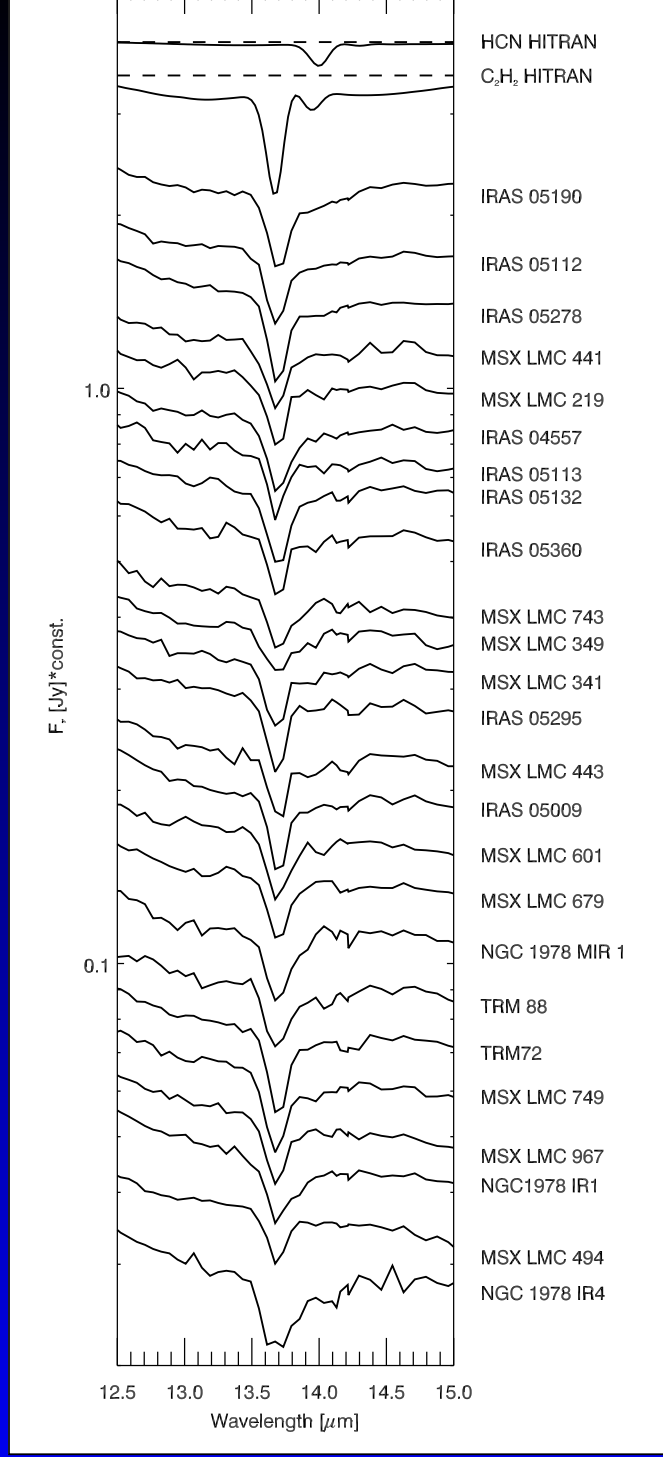
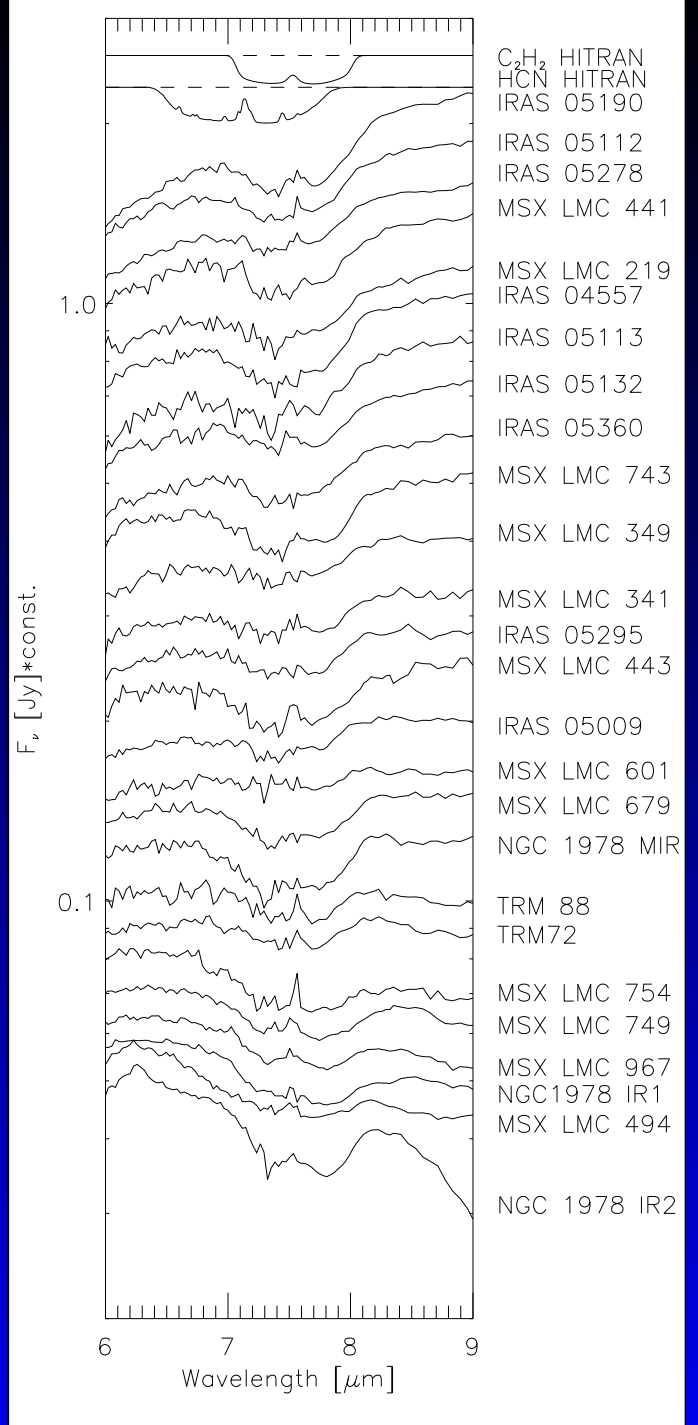
3277 (P.I. M. Egan), Sloan et al. (2006)

3426 (P.I. J. Kastner), Buchanan et al. (2006)

3505 (P.I. P. Wood), Zijlstra et al. (2006) and Lagadec et al. (2006)

3591 (P.I. F. Kemper), Leisenring et al. (2008)

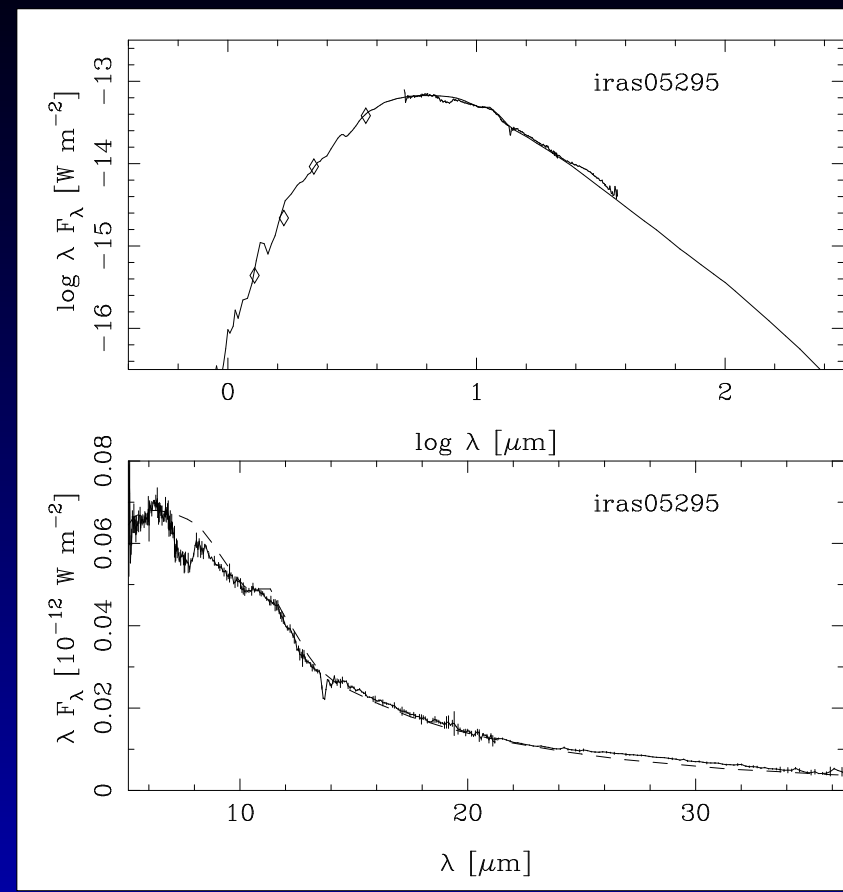
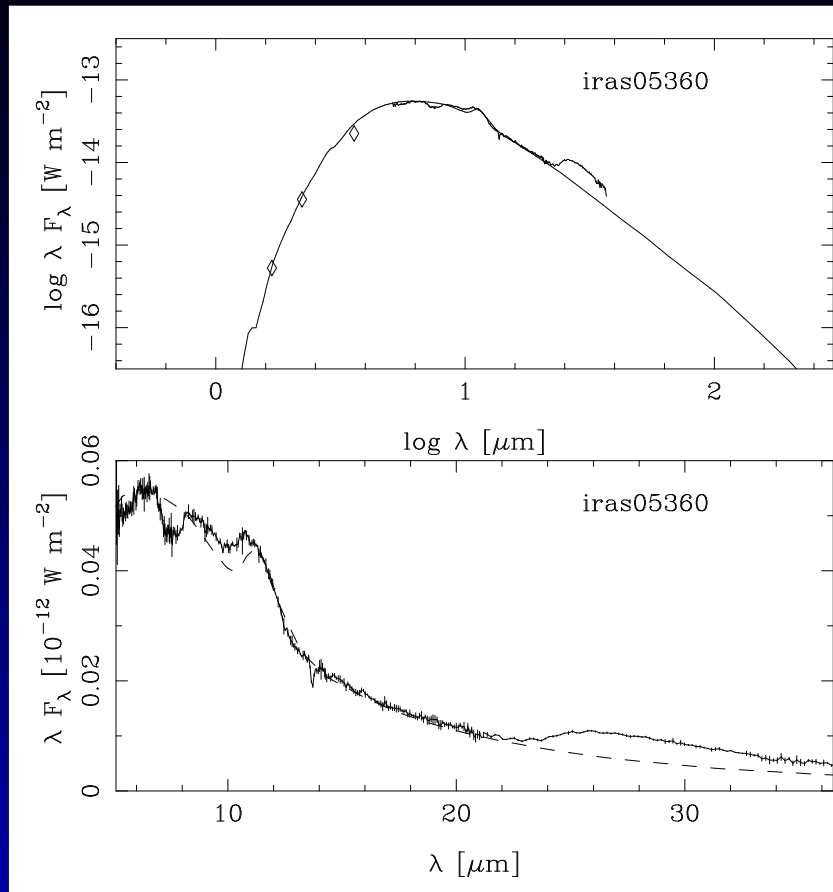
+ others ongoing



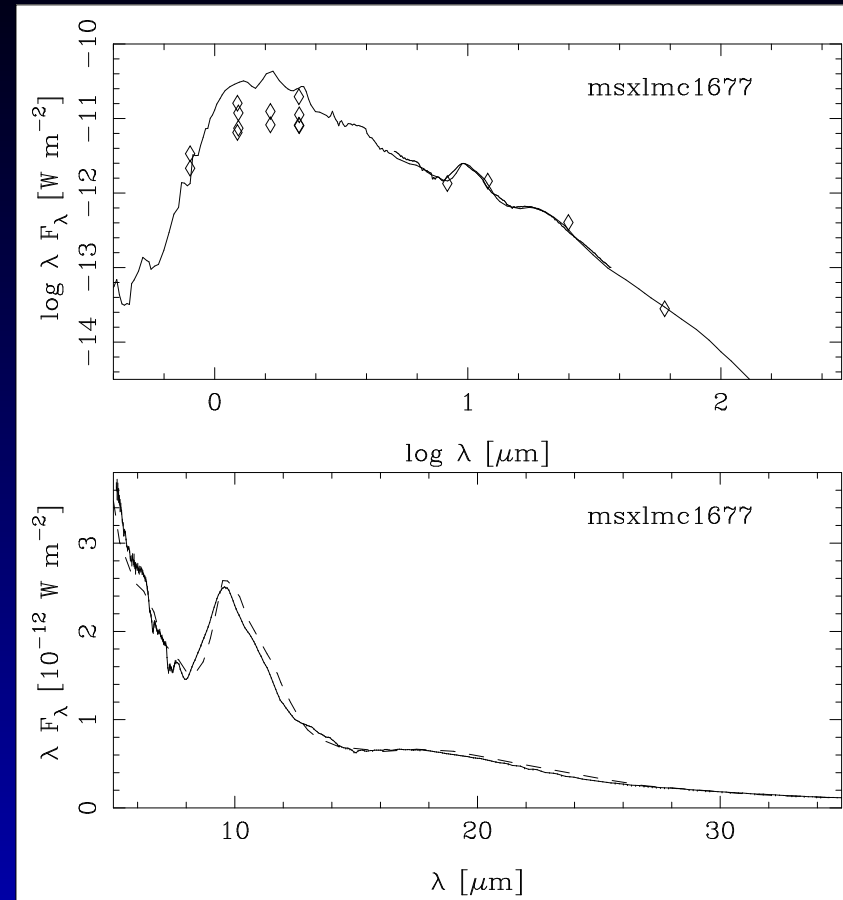
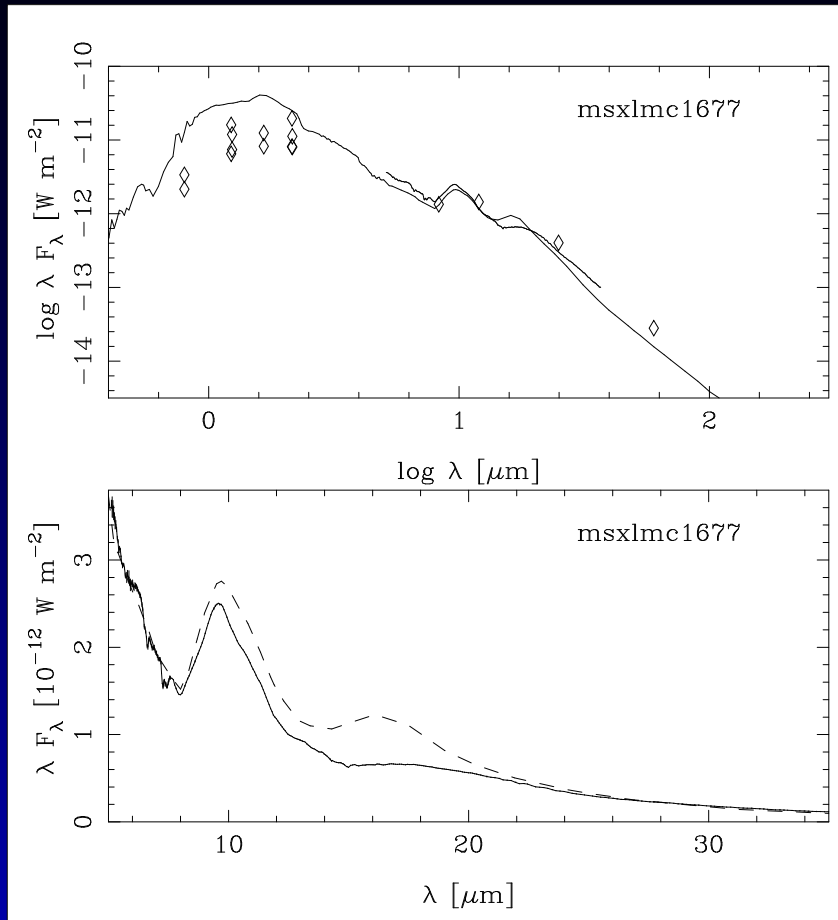
Matsuura et al. 2006 (Spitzer IRS)

SED fitting

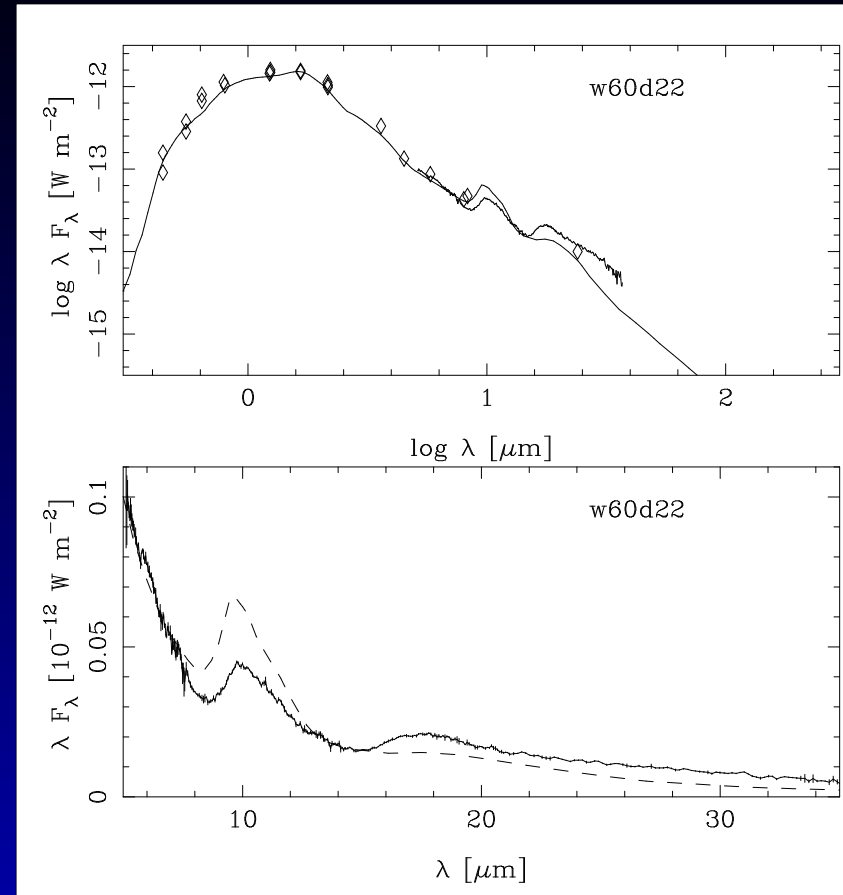
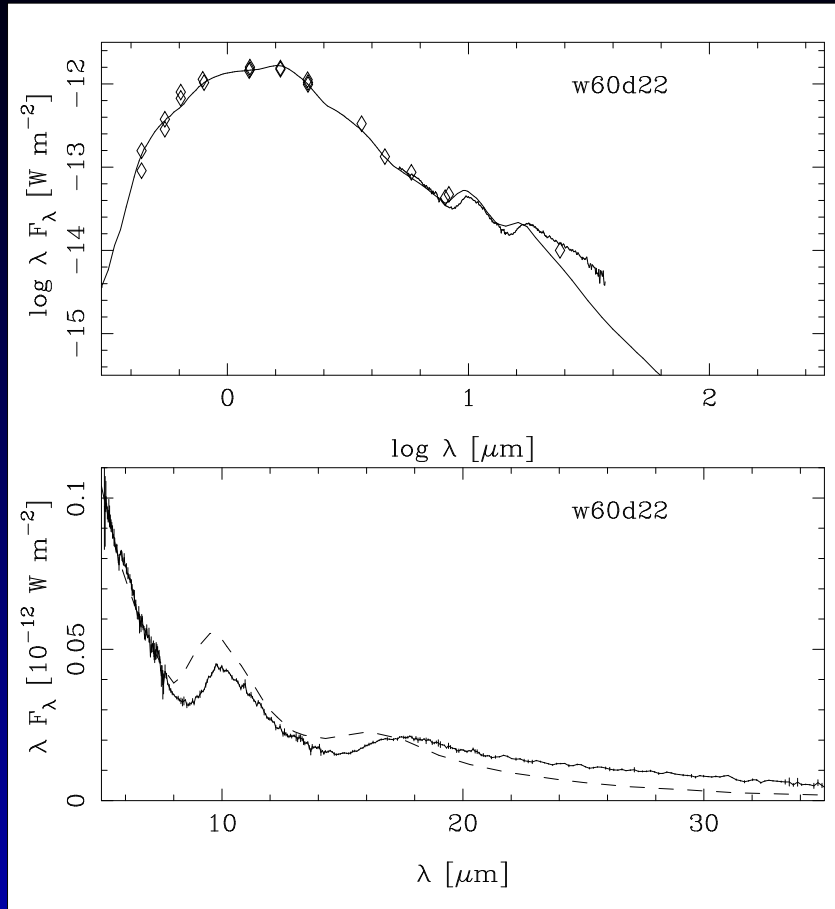
- 104 C-stars,
86 O-stars (10 FG, 42 RSG, 34 O-AGB)
- 1D dust radiative transfer model
(Groenewegen 1995)
- Included as subroutine in minimalisation routine
Runs on HPC \Rightarrow fits L, T_c, \dot{M}
- Model atmospheres:
Fluks et al. (M), Loidl et al. (C)
- Different types of dust
- Assumptions:
Dust-to-gas ratio of 0.005
Dust expansion velocity of 10 km/s



Groenewegen et al. (2007, 2009) for MCs



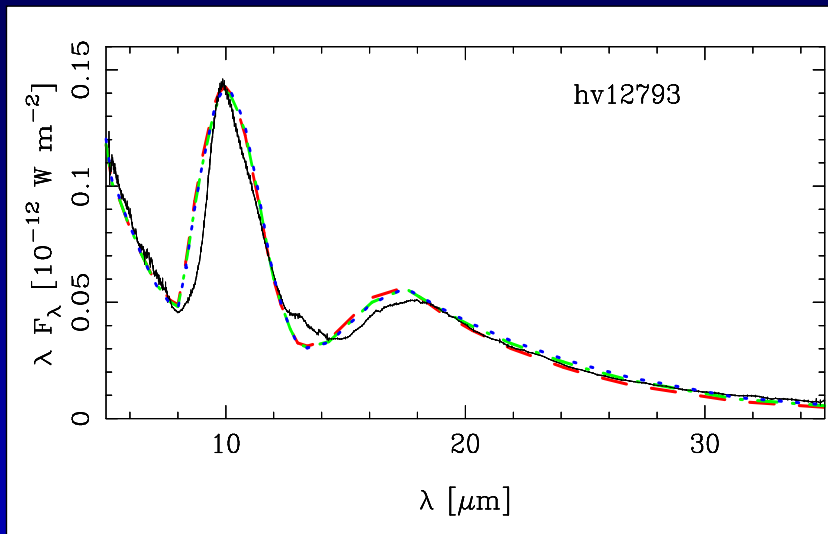
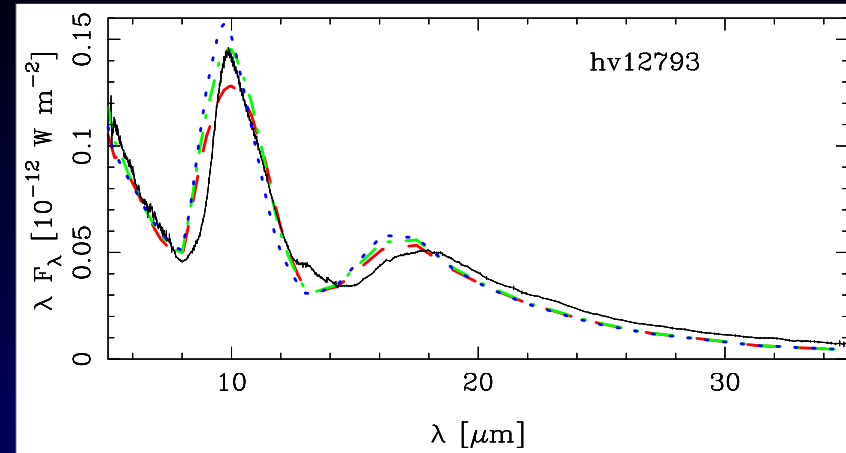
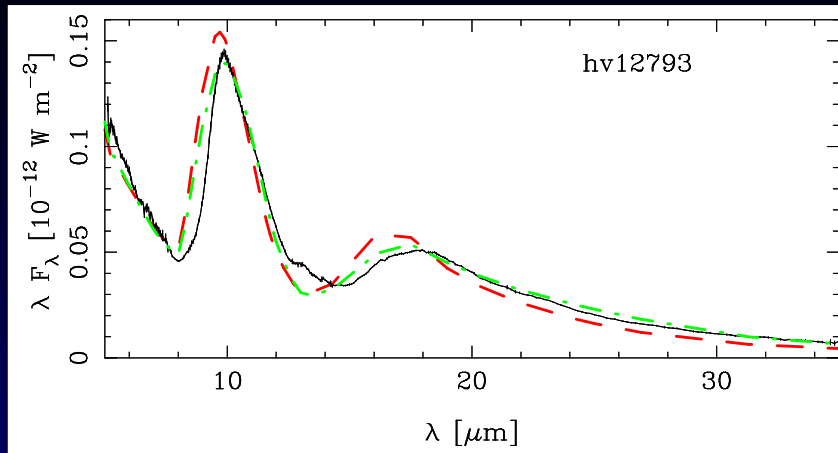
Example O-stars. Lab versus Astronomical silicates



Example O-stars. Lab versus Astronomical silicates

Astronomical Silicates typically fit better.

Depends on assumptions in calculating Q from (n, k) CDE, or grains of order $1 \mu\text{m}$, show better results



Top Left: small spherical grains (red); CDS (green).
 Top Right: grain size 1.5 (red dashed line), 1.2 (green dot-dashed line) and 0.6 micron (blue dotted line).
 Below: DHS with $f_{\text{max}} = 0.4$ (red), 0.7 (green) and 0.9 (blue) for a grain size of 1.2 μm .

The Far-IR

Launch Herschel: Tomorrow

MESS (Mass Loss of Evolved Stars) GTKP

<http://www.univie.ac.at/space/MESS/>

AGB, post-AGB, RSG, WR, LBV, SN

PI. Groenewegen

Belgium (Waelkens, PACS Co-PI)

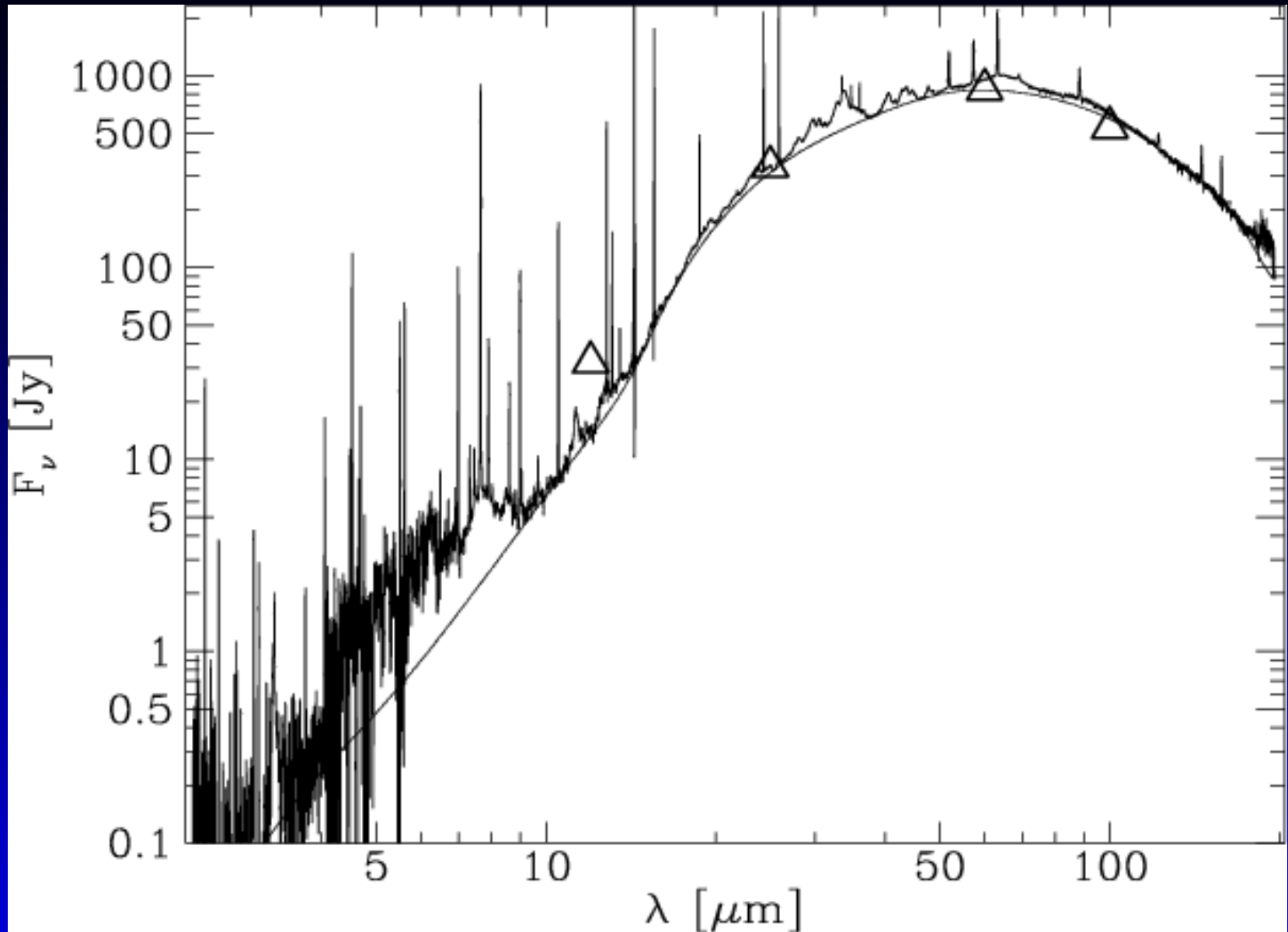
Austria, HSC, Heidelberg, SAG-6 (Barlow)

Mapping:

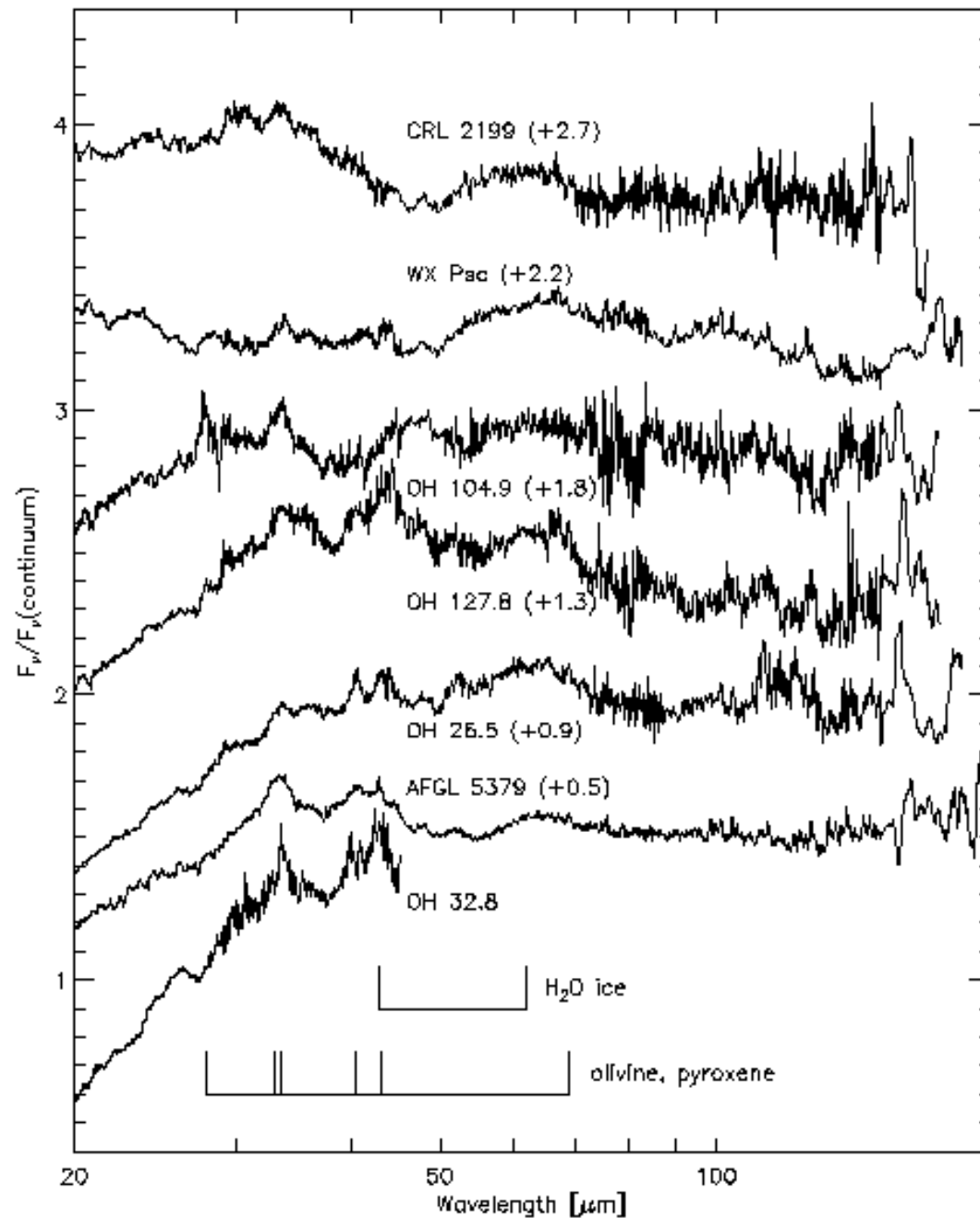
70, 170 (103 sources), 250, 350, 500 μm (32 sources)

Spectroscopy:

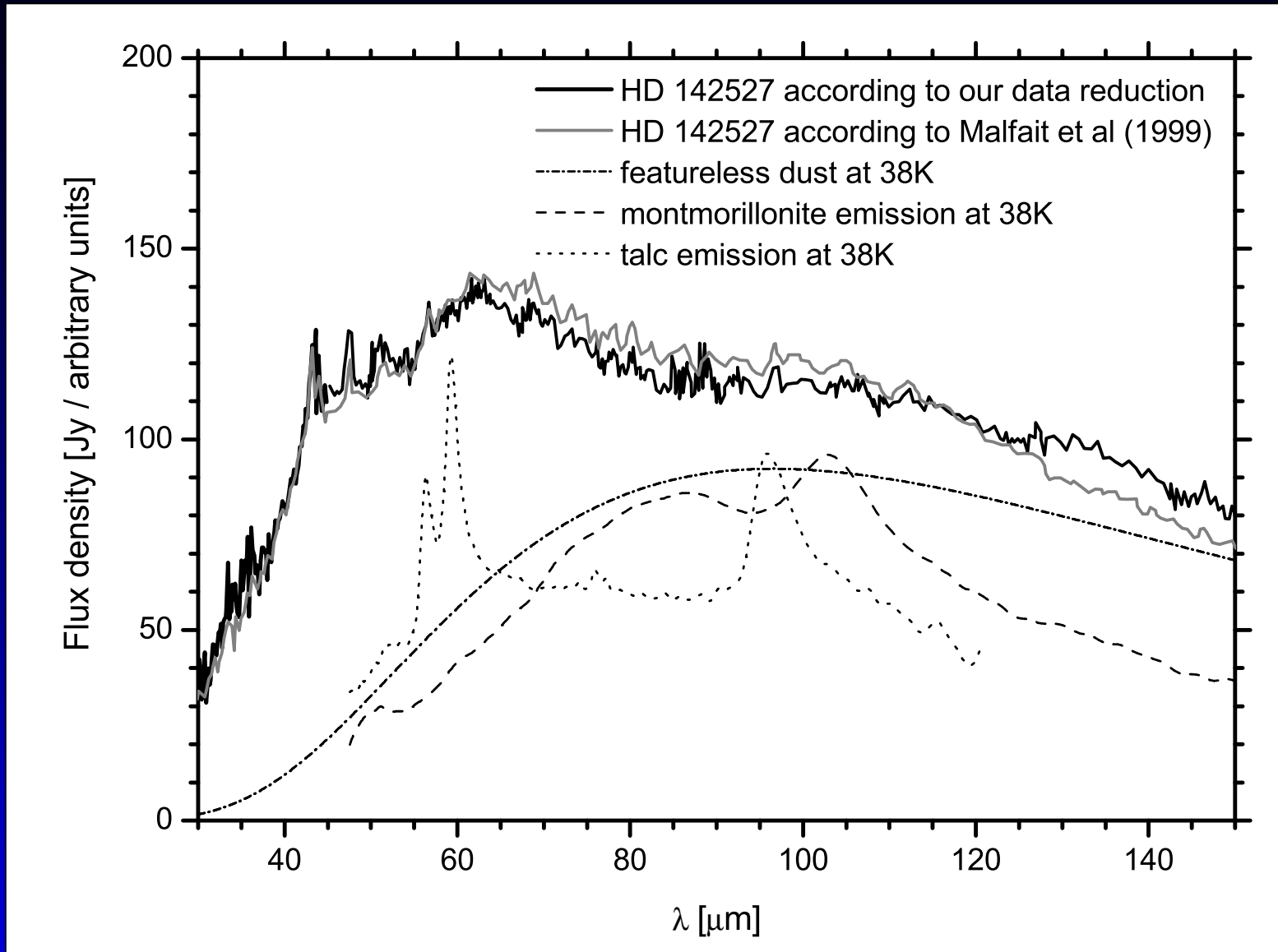
60-210 μm (55 sources), 190-670 μm (23 sources)



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



Sylvester et al. 1999; LWS spectra



Mutschke et al. 2008

The Future

Improved model atmospheres:
(MARCS; Gustafsson, Aringer, Plez)

X-shooter:
R= 5000-9000; 0.4-2.5 μm
(oversubscription for P84 on UT2 is 8!)

Herschel: PACS - SPIRE

THE END