Extended dust emission around nearby Asymptotic Giant Branch stars

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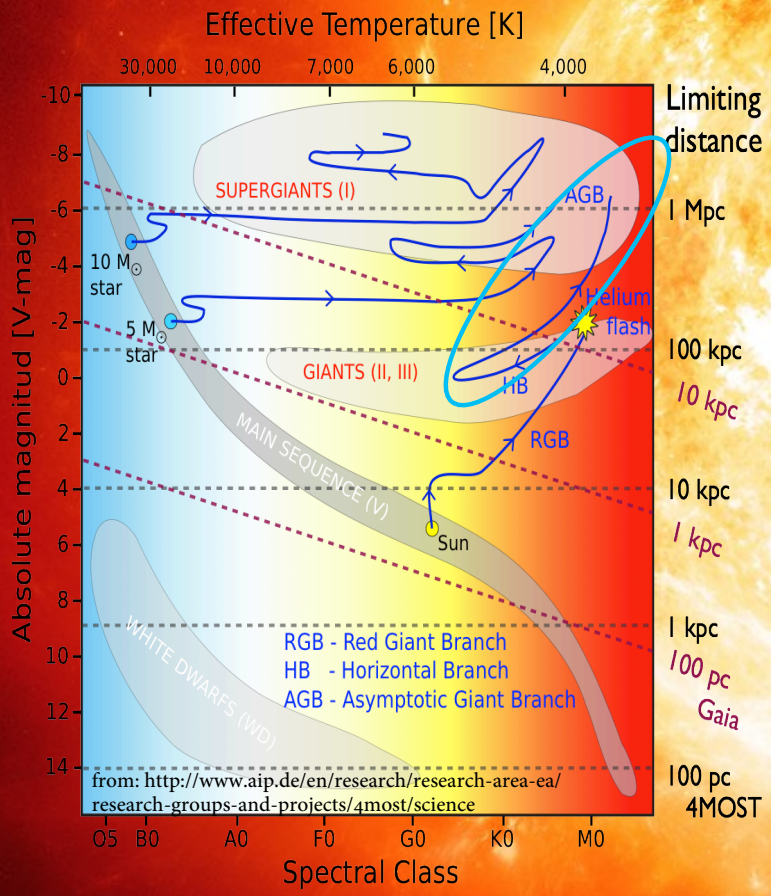
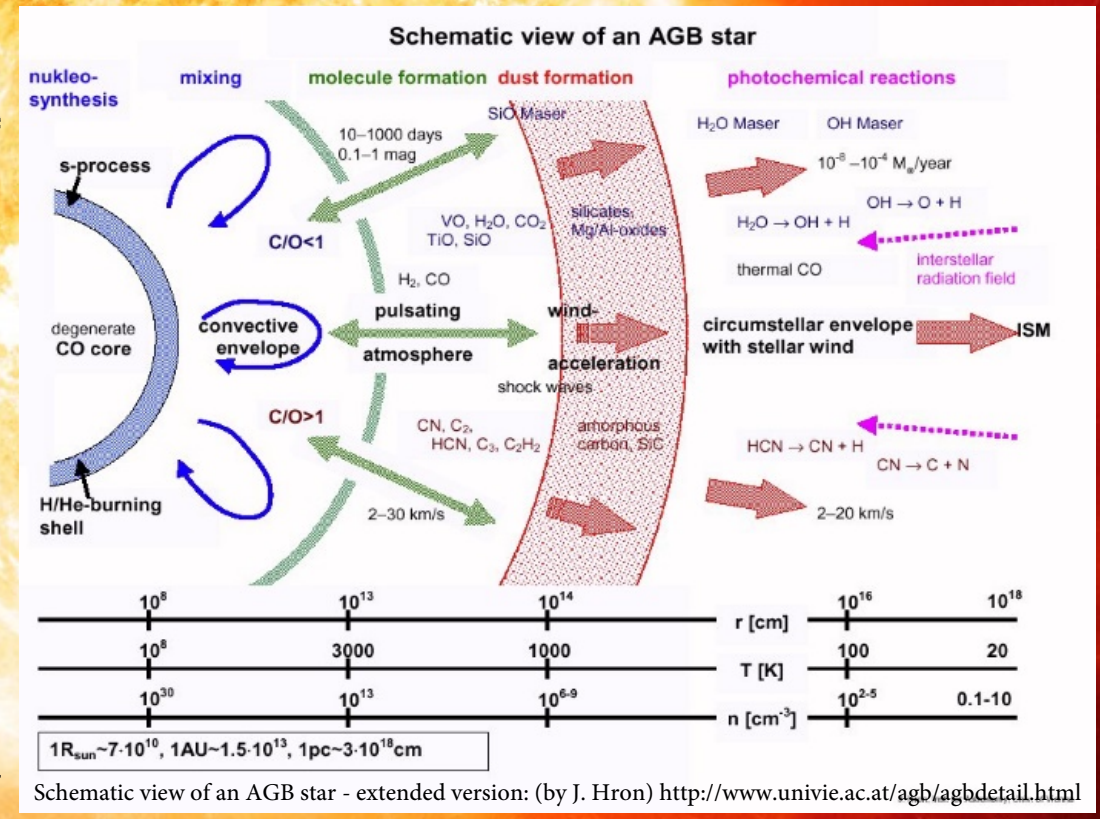
Asymptotic Giant Branch (AGB) Stars

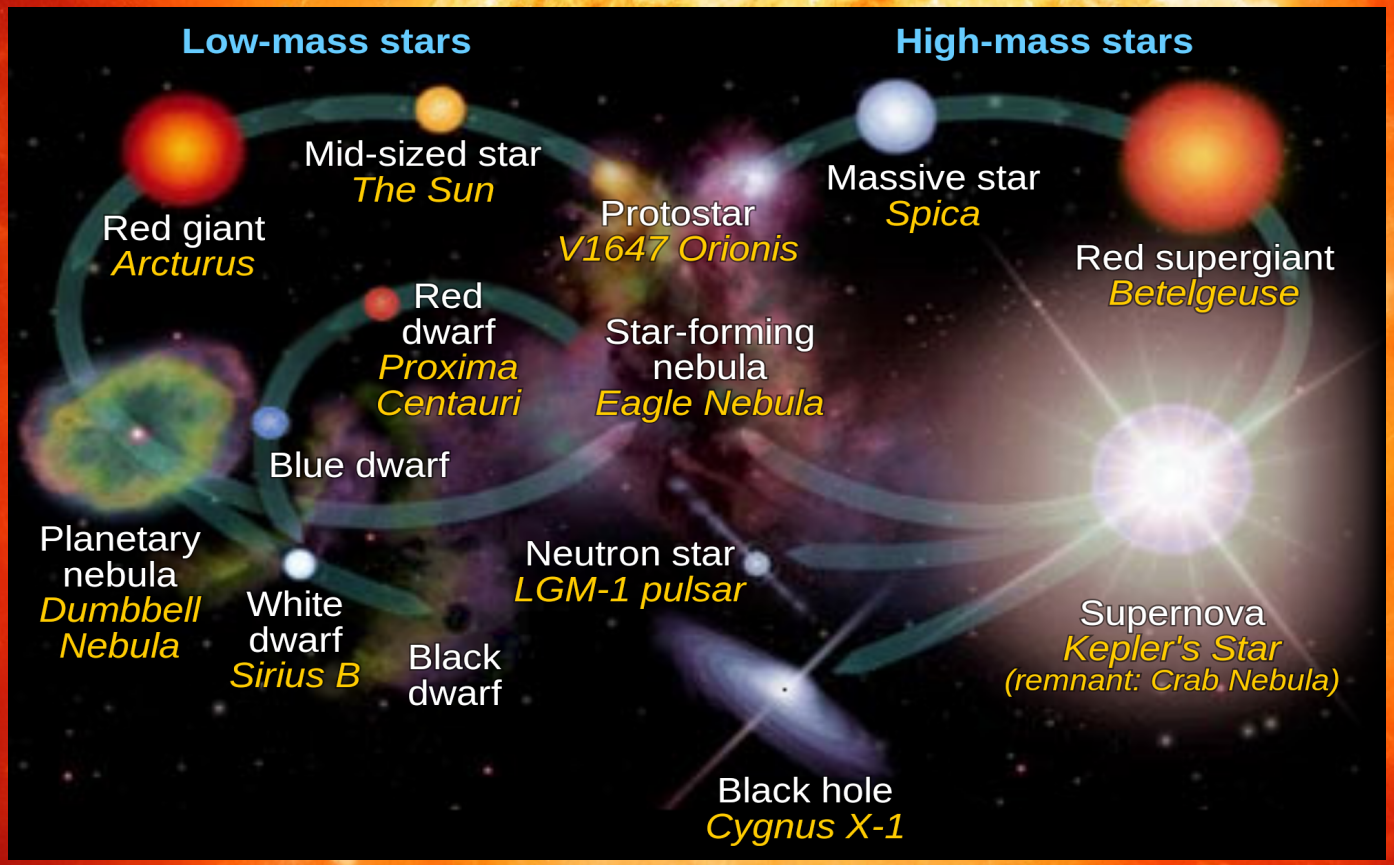


from: http://www.aip.de/en/research/research-area-ea/research-groups-and-projects/4most/science



Schematic view of an AGB star - extended version: (by J. Hron) http://www.univie.ac.at/agb/agbdetail.html

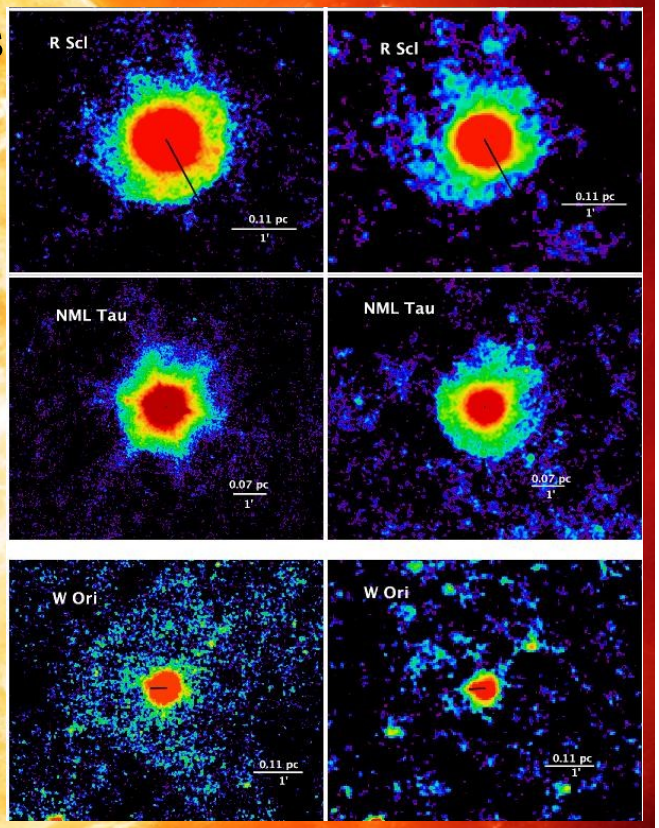
What makes AGB stars and their winds important to Galaxies?



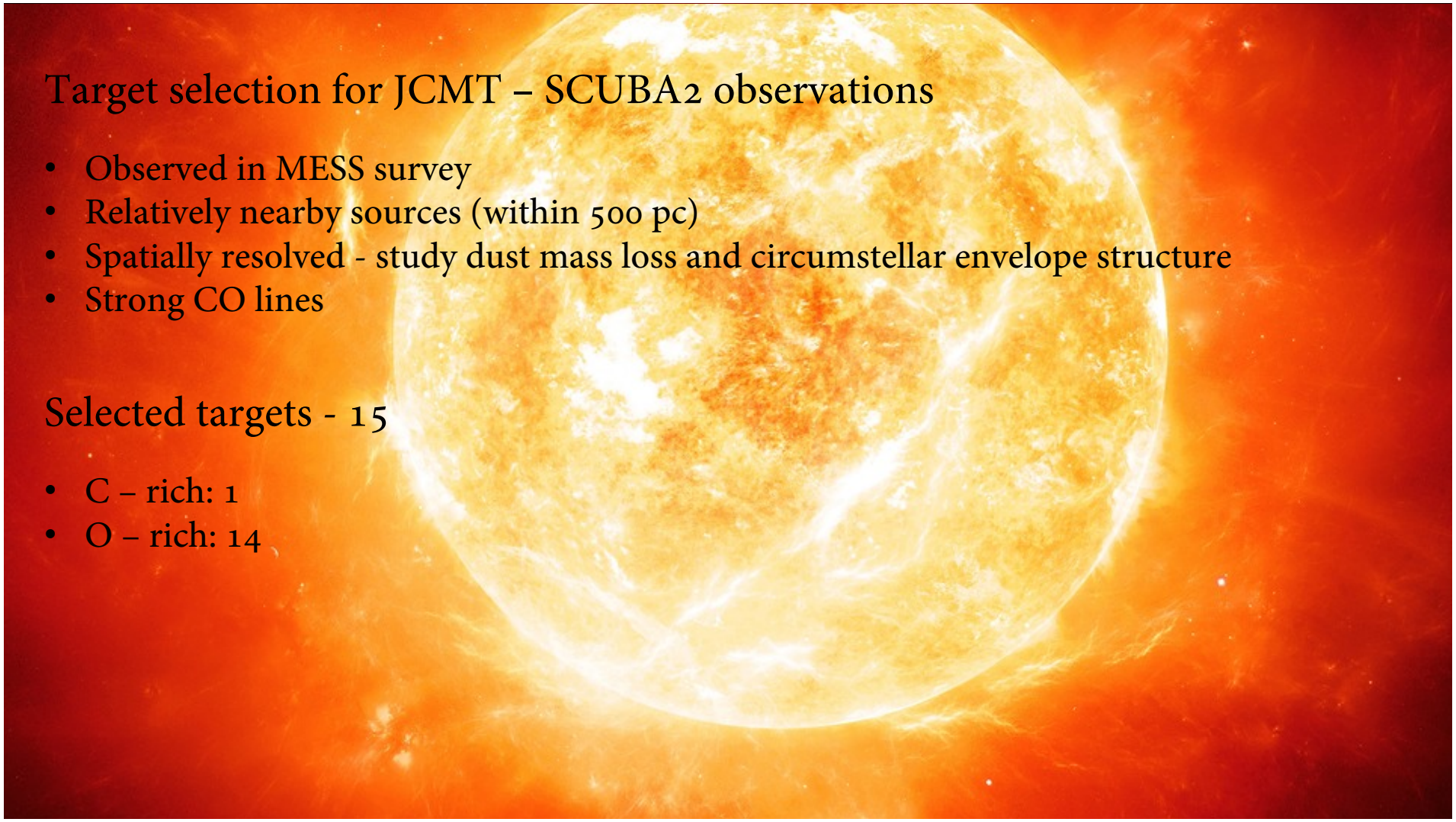
http://imagine.gsfc.nasa.gov/teachers/lessons/xray_spectra/images/life_cycles.jpg by NASA's Goddard Space Flight Center.

Long overdue need for a study of nearby AGB stars

- The Herschel Mass-loss of Evolved StarS (MESS) survey - extended emission for nearby AGB stars up to radii ~1´-2´ at 70 μm and 160 μm (Cox et al., 2012) using the PACS instrument.
- Most sub-mm observations for AGB star - often limited to central position pointings - lacking spatial information.
- JCMT can overcome this - low resolution large scale maps.
- SCUBA2: Study thermal dust component of the stellar winds.
  850 μm beam size – 13″
  450 μm beam size – 7.9″
- Combined with the Herschel PACS maps - derive dust mass loss histories.



Herchel MESS observations. Left: PACS 70 μm, Right: PACS 160 μm (right). Cox et al., 2012.



Target selection for JCMT – SCUBA2 observations

- Observed in MESS survey
- Relatively nearby sources (within 500 pc)
- Spatially resolved - study dust mass loss and circumstellar envelope structure
- Strong CO lines

Selected targets - 15

- C – rich: 1
- O – rich: 14

Thermal dust mass loss rates

- MESS survey maps using Herschel PACS at 70 μm and 160 μm.
- SCUBA2 Thermal dust emission maps at 450 μm and 850 μm.

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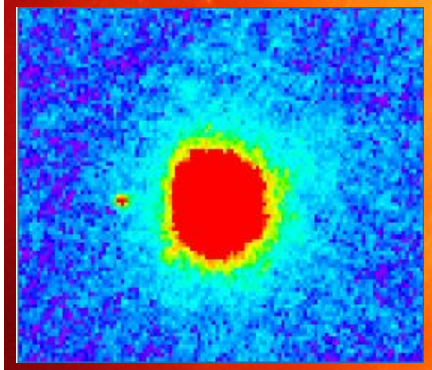
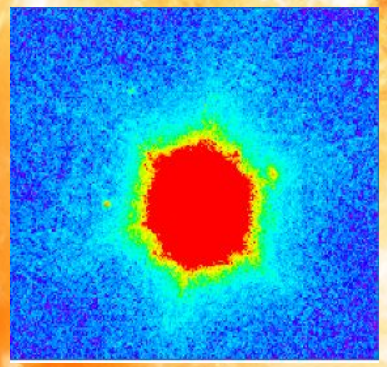


PACS 70μm
(1pix = 1.6 arcsec)



PACS 160μm
(1pix = 3.2 arcsec)

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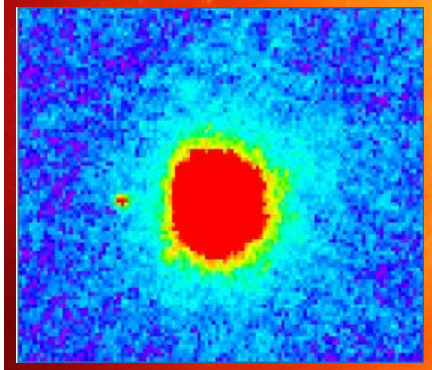

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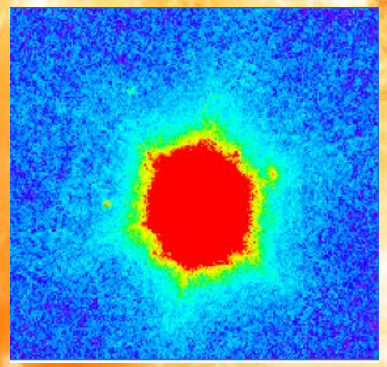

PACS 160μm
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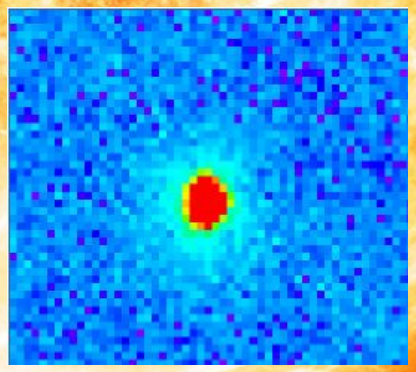
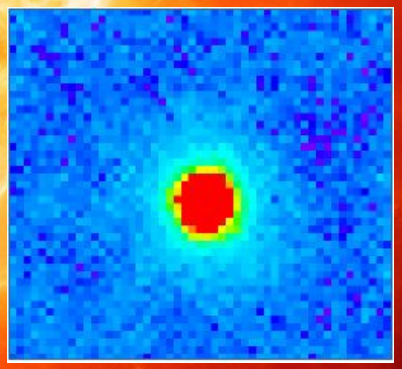
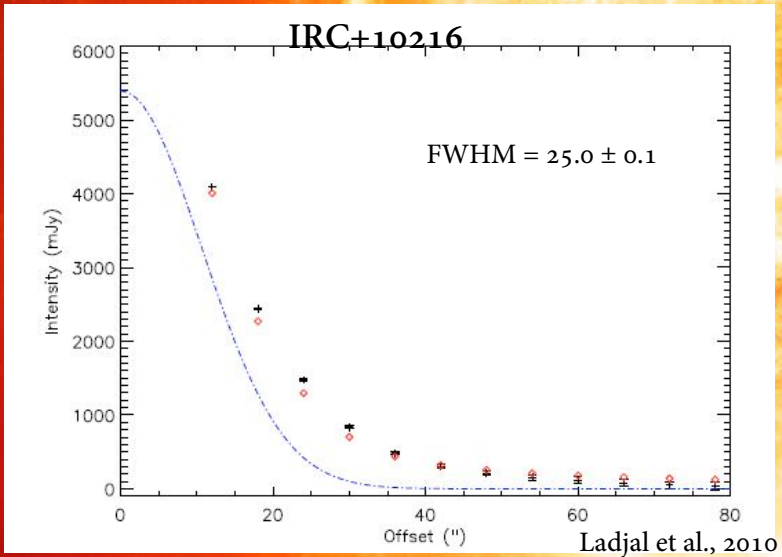


SCUBA2 450 μm
(1pix = 2 arcsec)

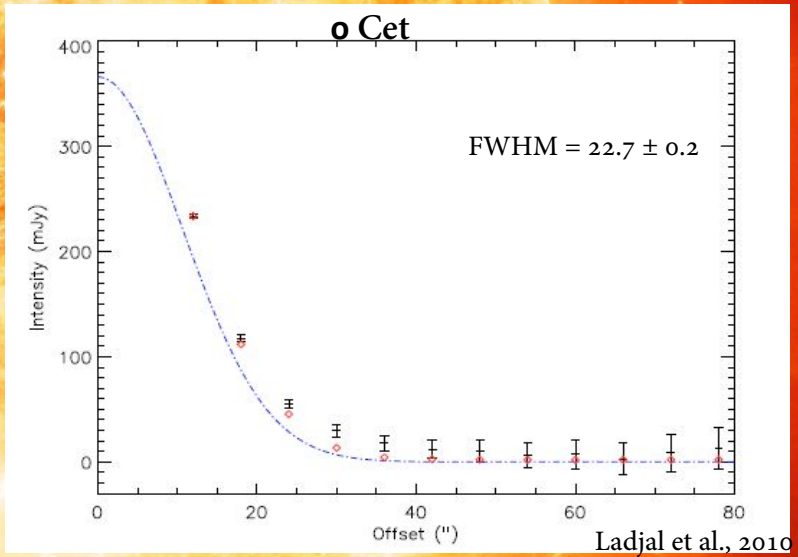


SCUBA2 850 μm
(1pix = 4 arcsec)

- APEX - LABOCA observations at 870 μm of several southern AGB stars showed extended emissions up to FWHM of ~20″-25 (Ladjal et al., 2010).
- Similar wavelengths to SCUBA2 – good comparison.



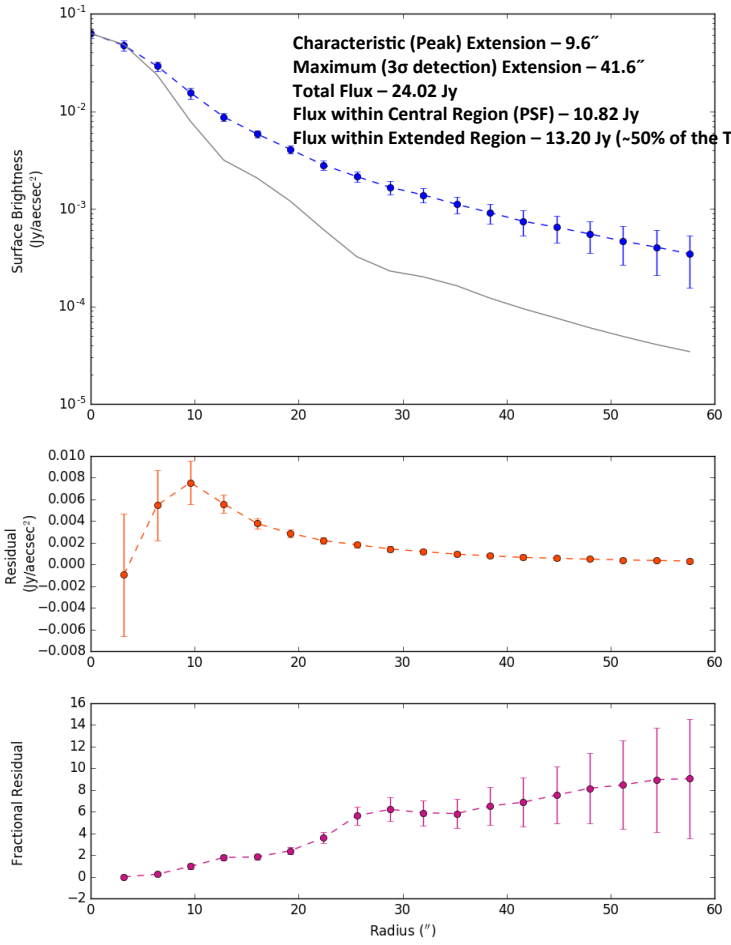
Ladjal et al., 2010



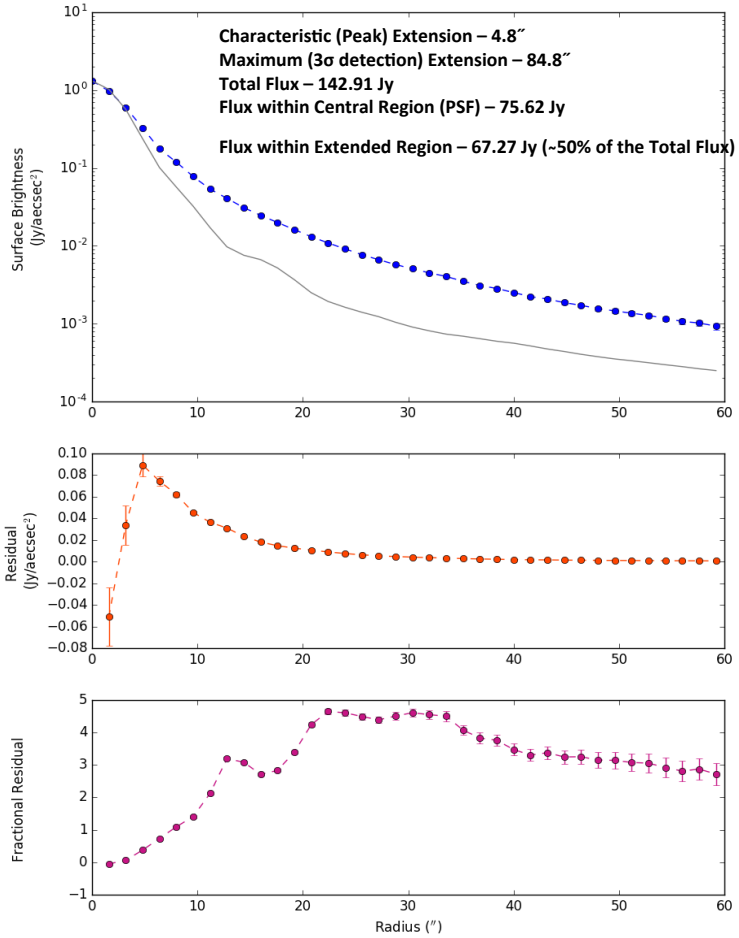
Ladjal et al., 2010

- Look deeper into the SCUBA2 observations.
- Generate radial profiles of surface brightness vs. radius at each wavelength for the SCUBA2 and PACS observations.

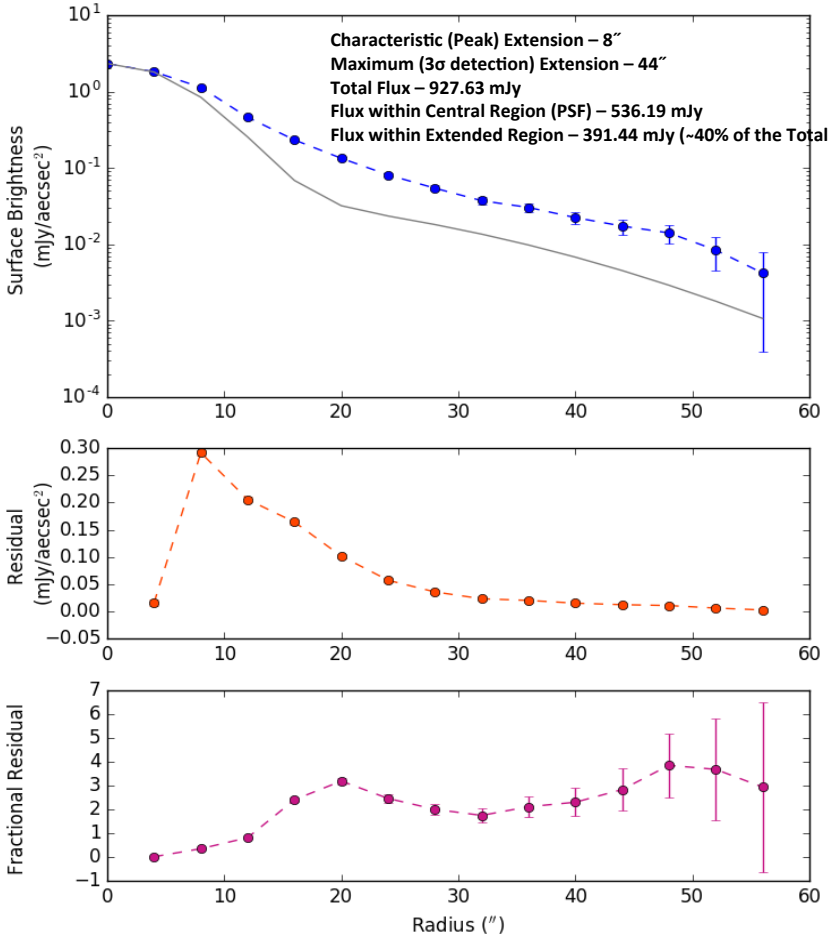
CIT 6 – PACS 160 µm



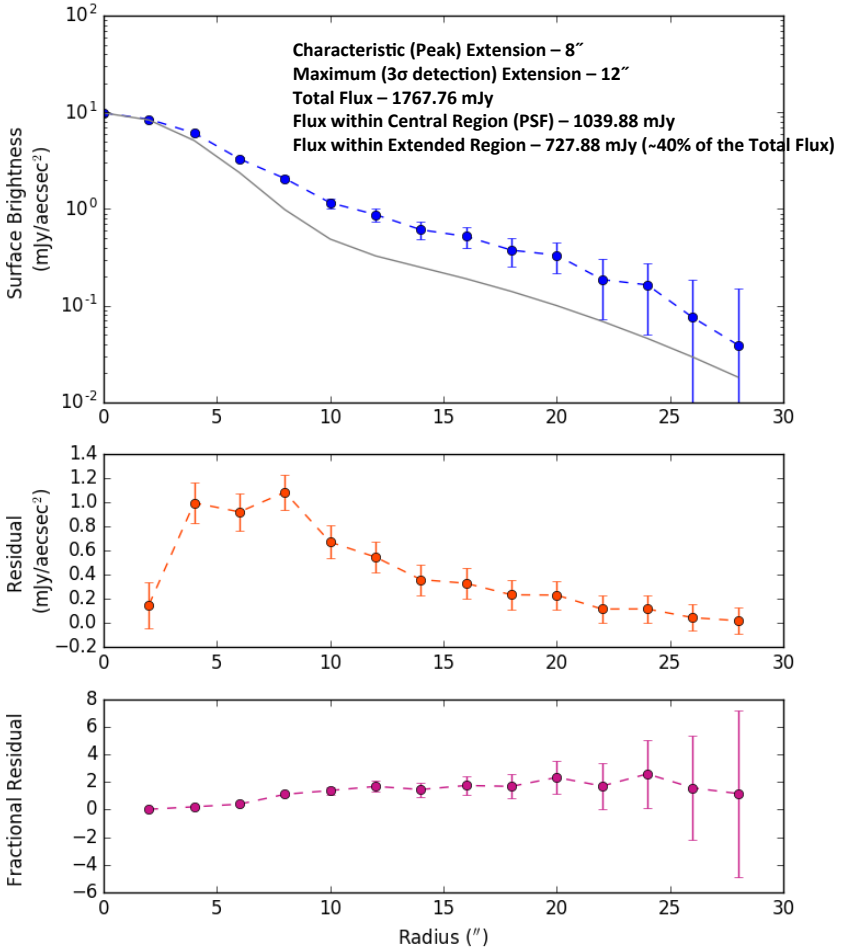
CIT 6 – PACS 70 µm



CIT 6 – SCUBA2 850 μm

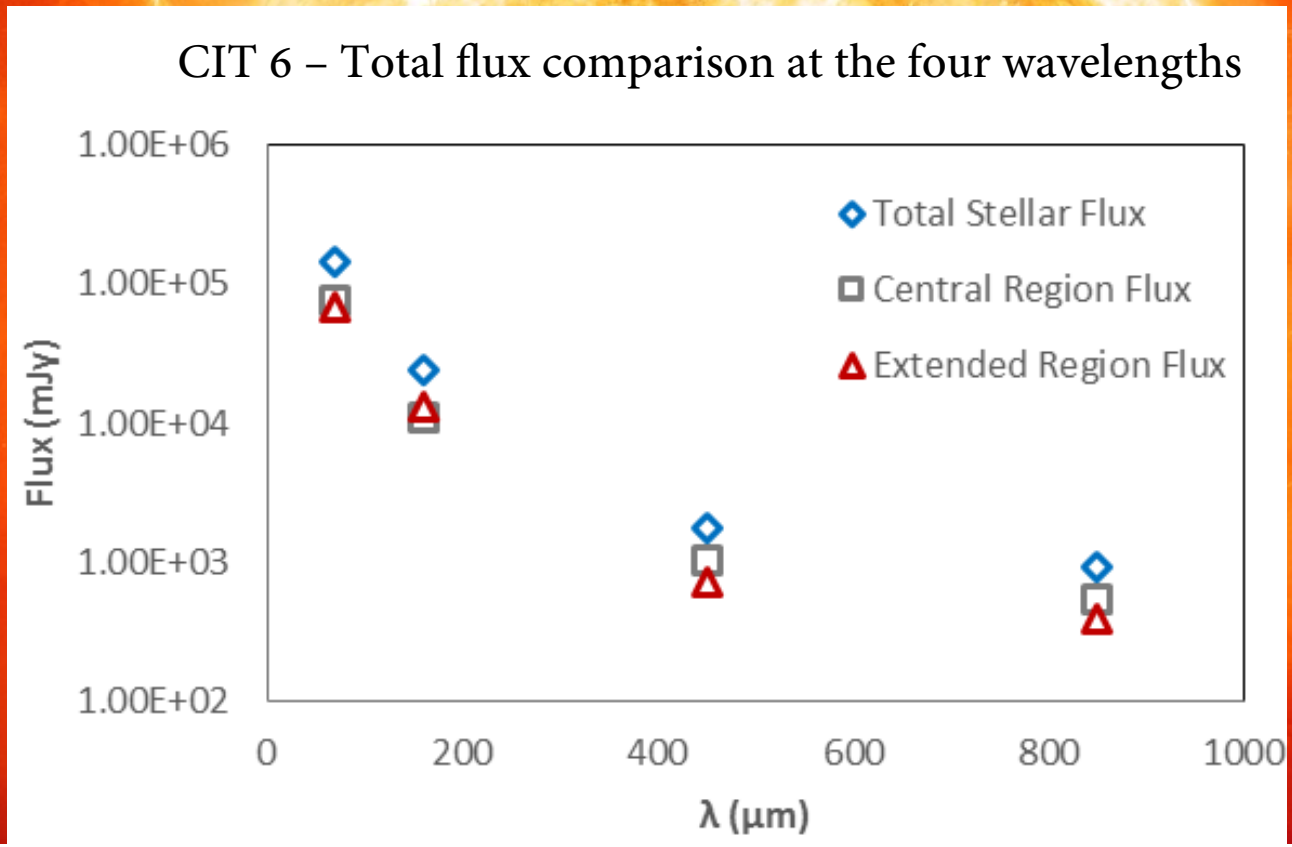


CIT 6 – SCUBA2 450 μm



Ongoing - Fitting SEDs

- Combine data from all four wavelengths:
  - SCUBA2 850 μm, 450 μm and PACS 160 μm, 70 μm.



- Fit a 4 point SED to a modified blackbody **at each radial point** .
- Determine Dust Temperature (T_{dust}), Spectral Index of the Dust Emissivity (β) and the Dust Mass (M_{dust}) (Gordon et al., 2010 methods).

$$F_\nu \propto \lambda^{-\beta} B_\nu(T_{\rm dust}).$$

Form of modified black body. (Gordon et al., 2010)

$$M_{\rm dust} = \frac{4}{3} \frac{a\rho d^2}{Q_{\rm em}(160)} \frac{F_{160}}{B_\nu(T_{\rm dust})}$$

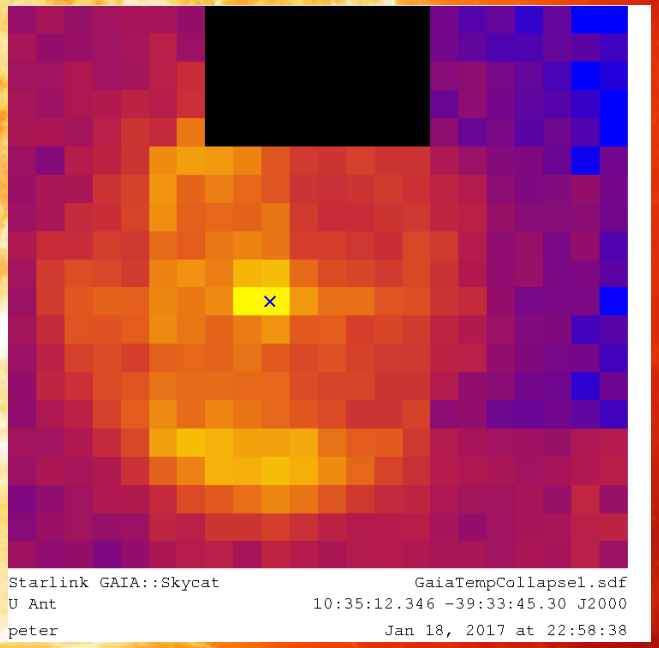
Dust Mass (a – grain radius). (Gordon et al., 2010)

The Nearby Evolved Star Survey – NESS

- Extend this study to a volume limited (300 pc) sample of AGB stars.

- Multi telescope data

JCMT – SCUB2 and HARP - S17A + 17B
APEX
SMA
ALMA



HARP observation of U Ant obtained in semester 17A as part of the NESS project

Summary

- We observe extended emission in a sample of 15 AGB stars using JCMT - SCUBA2 (450 μm and 850 μm) and Herschel PACS (70 μm and 160 μm) observations.
- Maximum extension with 3σ detection for SCUBA2 850 μm observations ~40 .
- Flux within the extended region up to ~40% for SCUBA2 observations and ~50% for PACS observations.
- Ongoing work – Fitting SEDs at each individual radial point and deriving radially dependent dust temperature, mass and beta profiles.