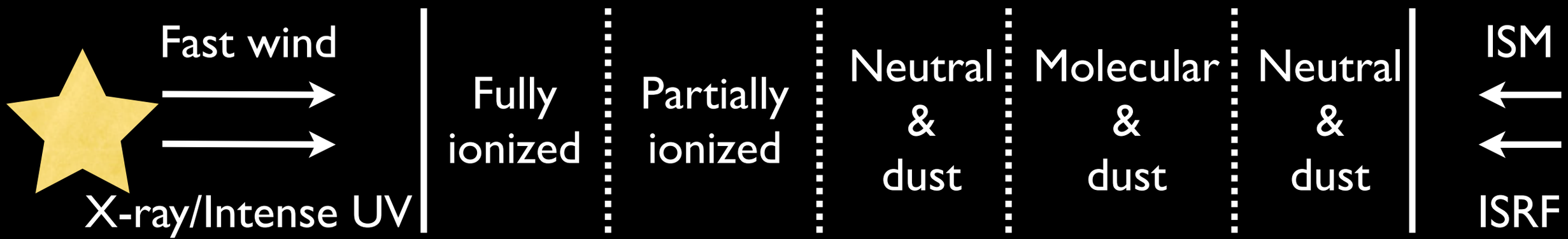
UNIVERSITY OF DENVER

HerPlaNS: a tale of mass-loss from Planetary Nebulae

Djazia Ladjal
& the HerPlaNS consortium

DSLG Santiago 09/04/2013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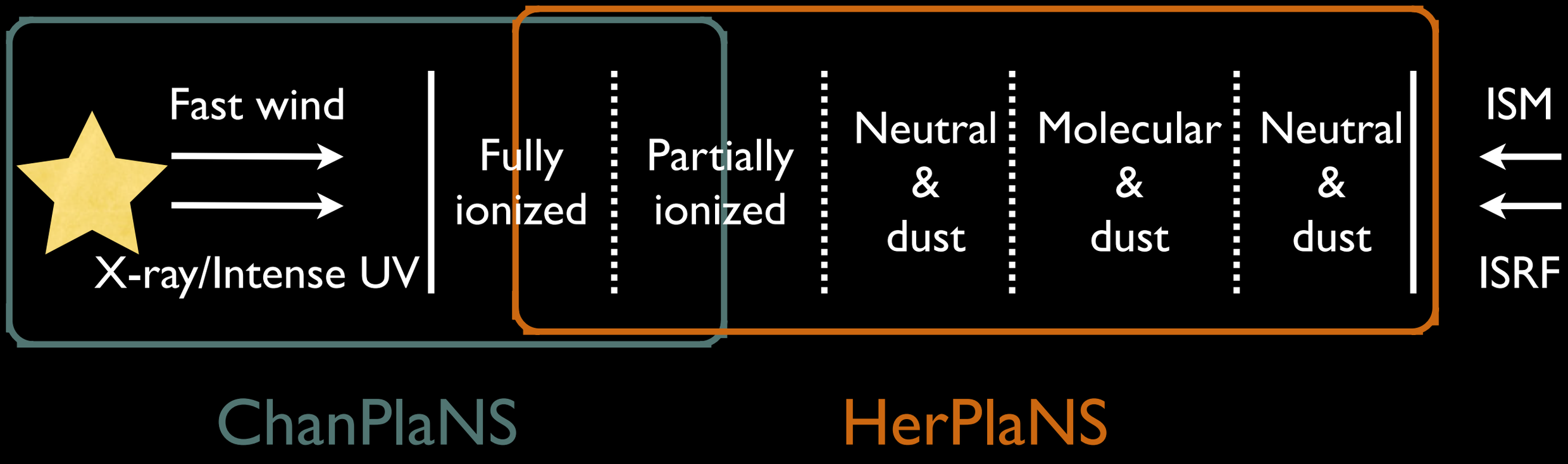
X-ray/Intense UV
Fully ionized
Partially ionized
Neutral & dust
Molecular & dust
Neutral & dust
ISM
ISRF


Fast wind
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ChanPlaNS
HerPlaNS

Near and Mid-IR

Optical

Fast wind

X-ray/Intense UV

Fully ionized

Partially ionized

Neutral & dust

Molecular & dust

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ISM

ISRF

ChanPlaNS

HerPlaNS

Near and Mid-IR

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Fully ionized

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Neutral & dust

Molecular & dust

Neutral & dust

ISM

ISRF

ChanPlaNS

HerPlaNS

FIR

Behind HerPlaNS

PI: T. Ueta (U. of Denver)

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HerPlaNS observing strategy

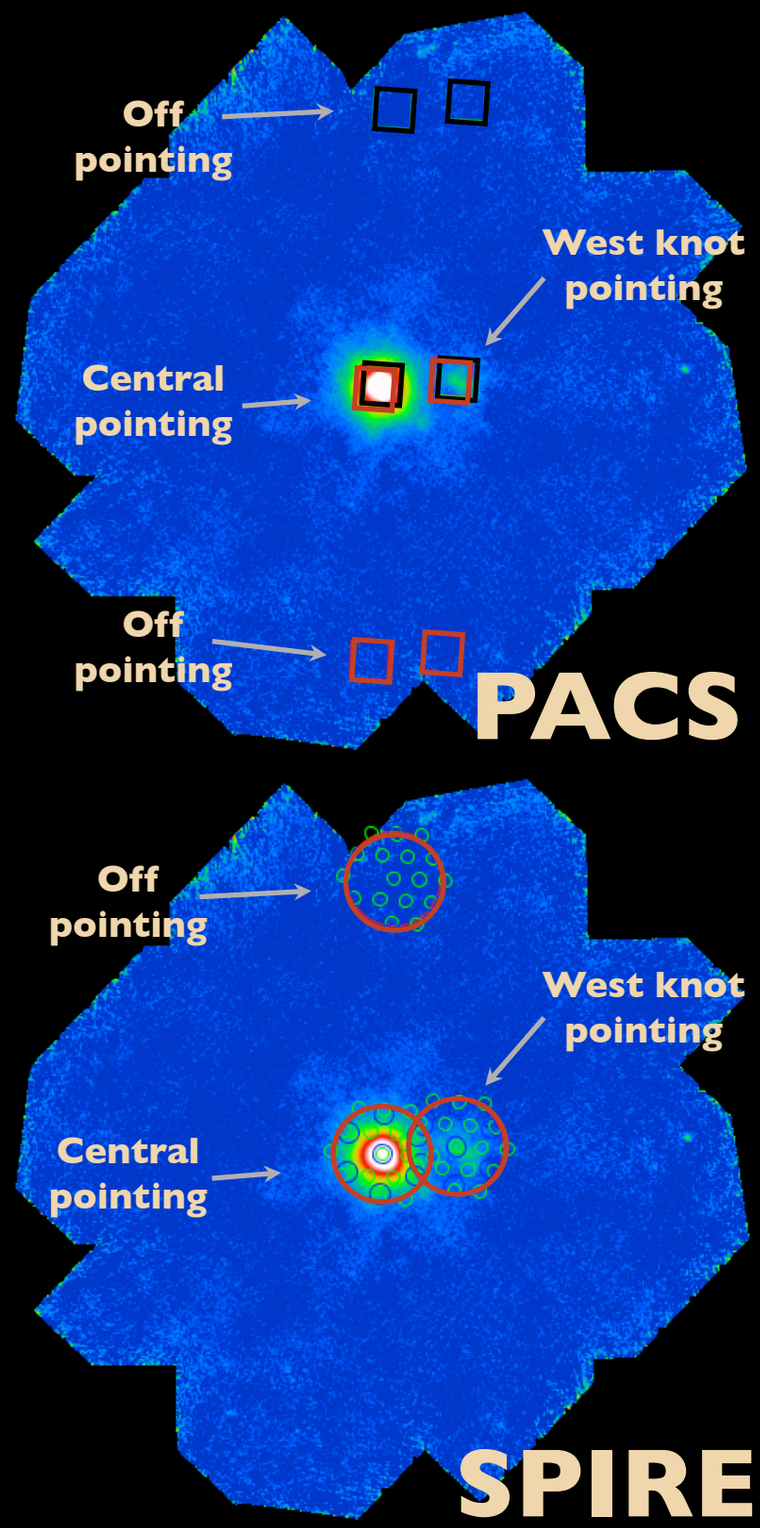
- Investigating a sample of 11 PNs using Herschel (~200 hours of observing time). Program completed!

- Use of the full capabilities of PACS and SPIRE instruments:

  - Photometry maps in 5 bands PACS+SPIRE (70um, 160um, 250um, 350um and 500um). Data fully reduced.

  - Full range spectroscopy covering a wavelength range from 51um to 670um (PACS+SPIRE). Second data reduction iteration done. Still need some improvement.

  - Spectral line maps (only with PACS and for two PNs) around 7 emission lines: [NII] 57um, [OI] 63um, [OIII] 88um, [NII] 122um, [OI] 146um, [CII] 157um and [NII] 205um.



Main HerPlaNS goals

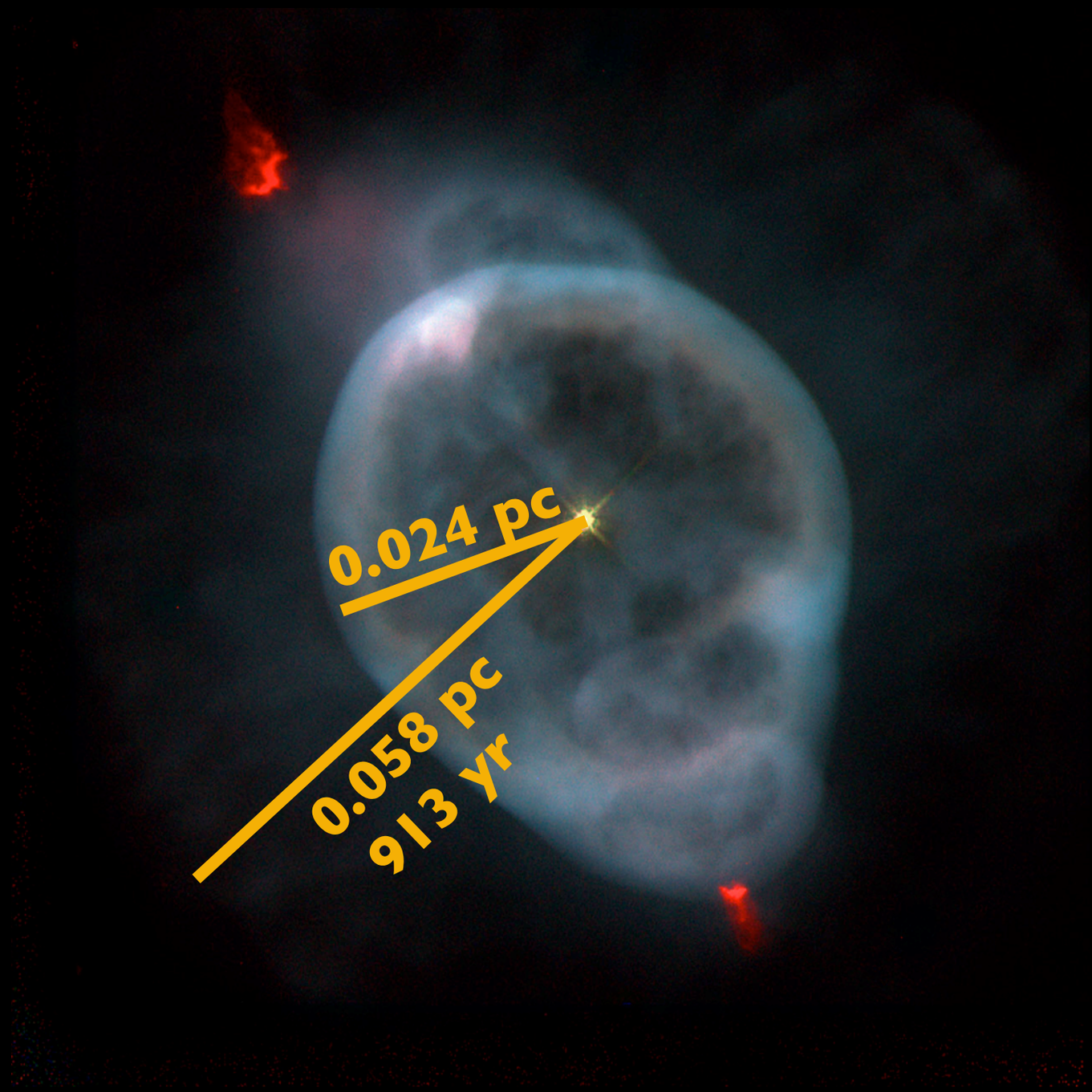
- Investigate the spatial distribution of the ionized gas, molecular gas and dust in the FIR.
- Estimate in a consistent way the gas-to-dust ratio.
- Constrain the older mass loss history in terms of total mass loss and chemistry.
- Check if there is any correlation between the X-ray properties of the CSPN and the FIR emission of the nebulae.

The case of NGC 3242

NGC 3242 (AKA Ghost of Jupiter)

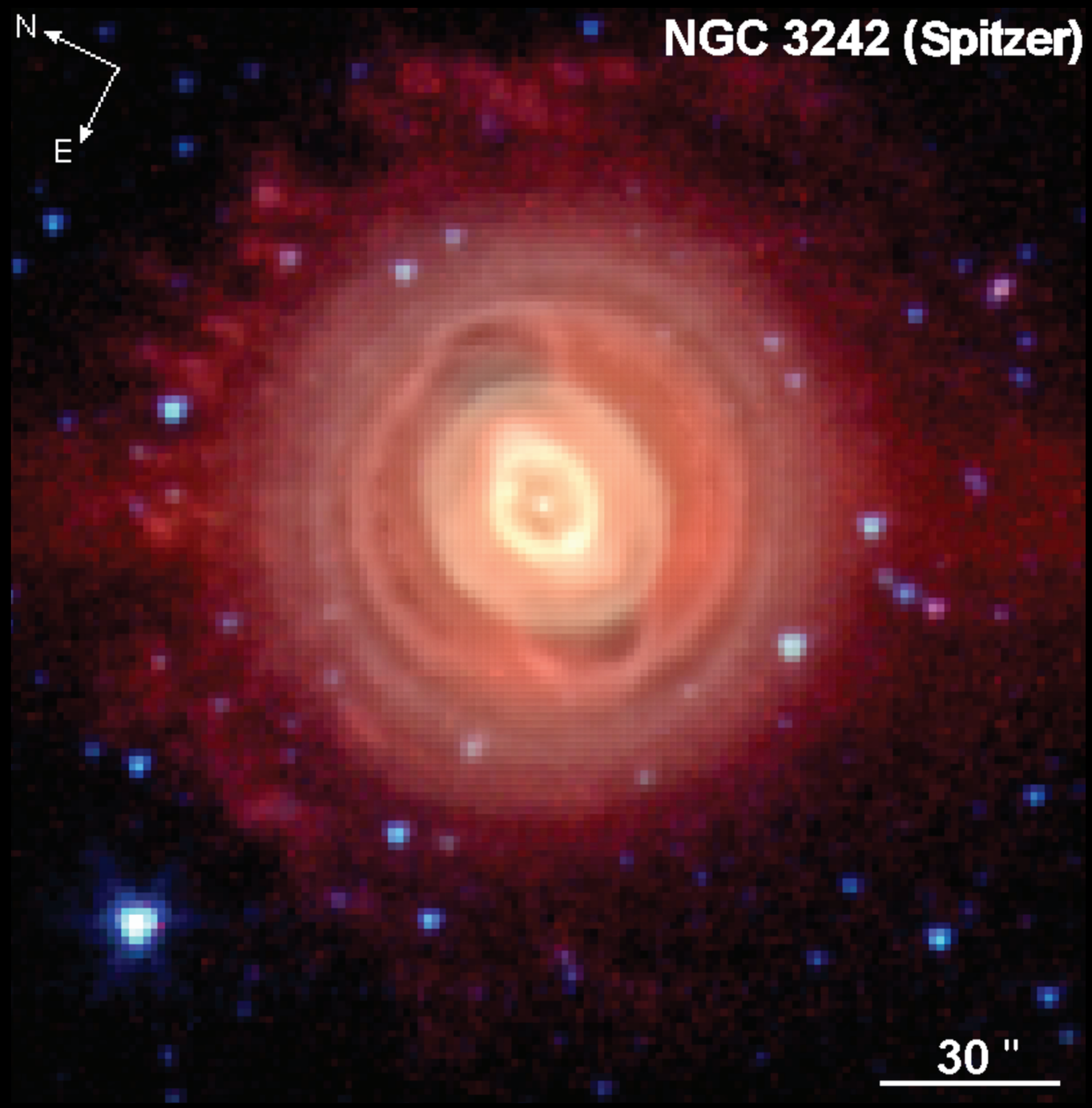
Danny LaCrue & the ESA/ESO/NASA FITS Liberator

NGC 3242 (AKA Ghost of Jupiter)



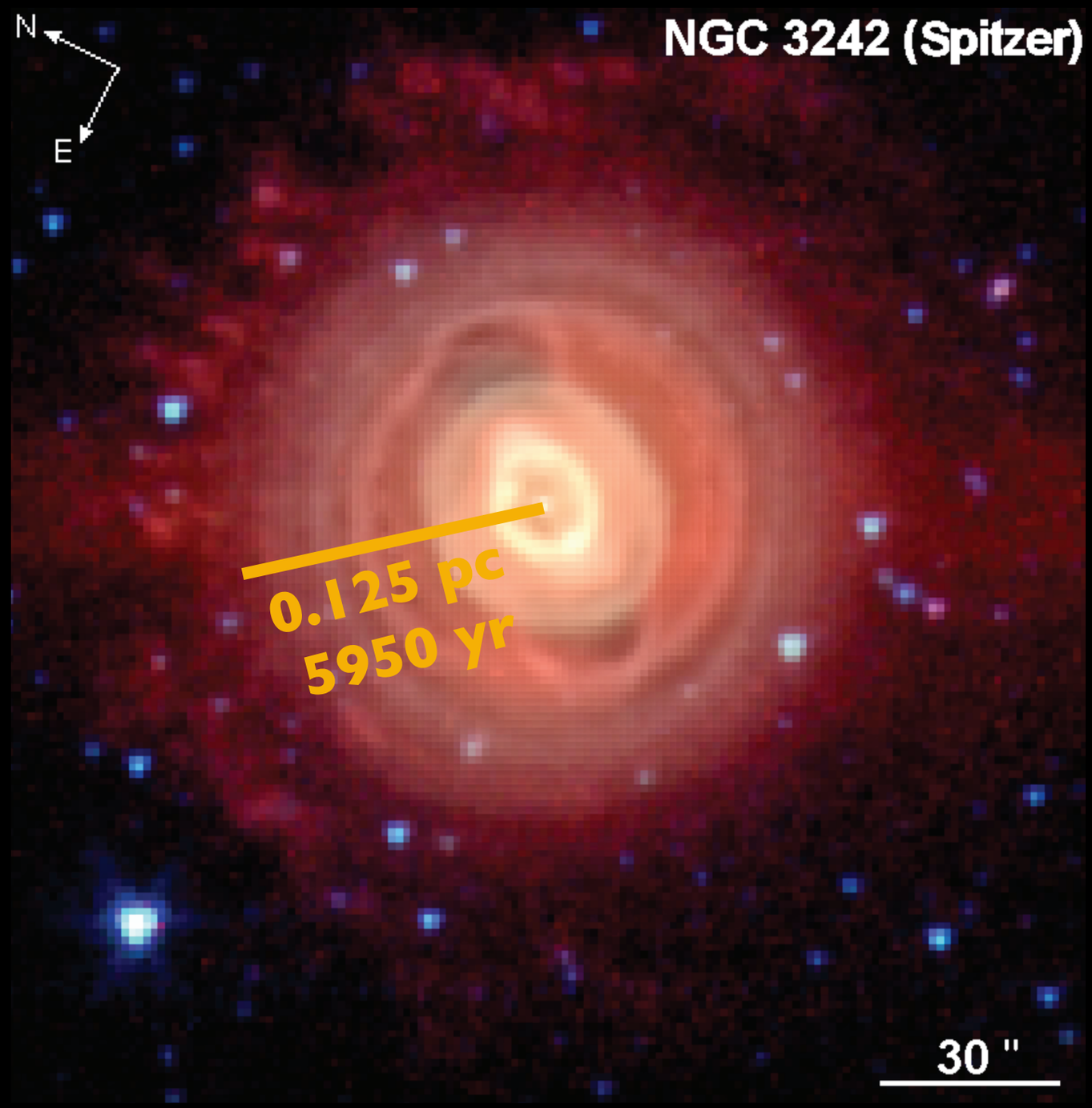
HST image. Credit: Danny LaCrue & the ESA/ESO/NASA FITS Liberator

NGC 3242 (AKA Ghost of Jupiter)



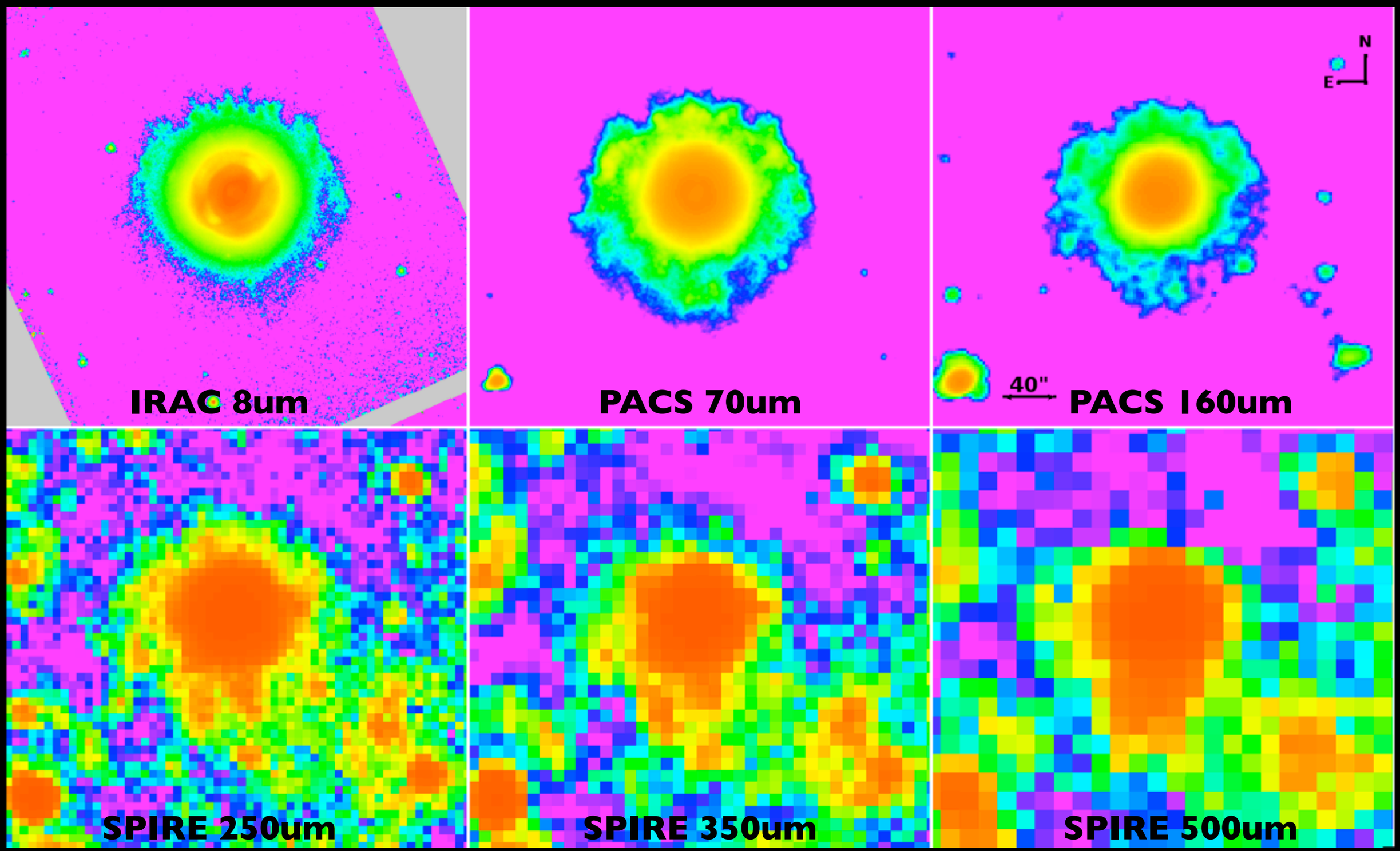
J. P. Phillips et al. (2009)

NGC 3242 (AKA Ghost of Jupiter)

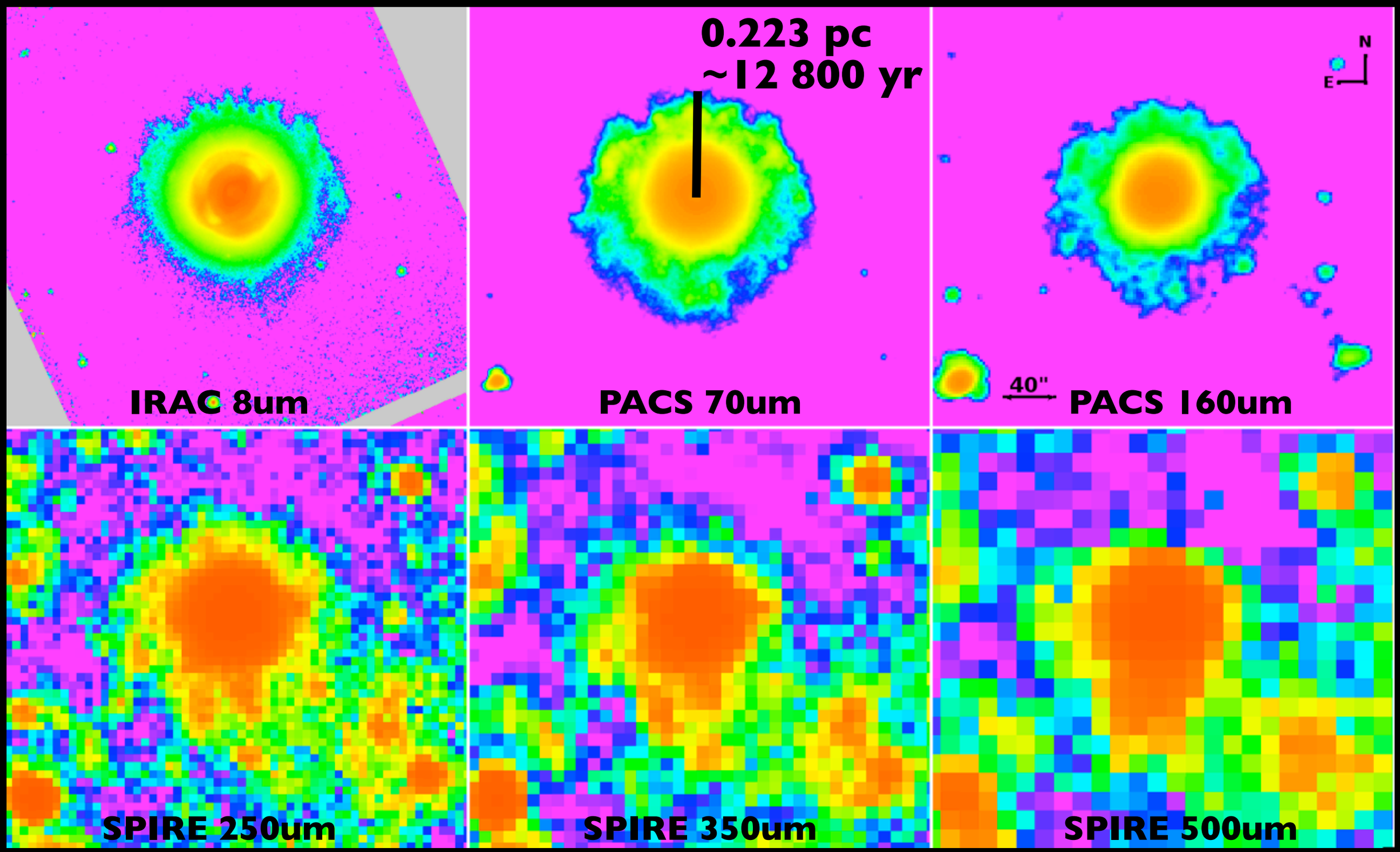


J. P. Phillips et al. (2009)

HerPlaNS photometry of NGC 3242



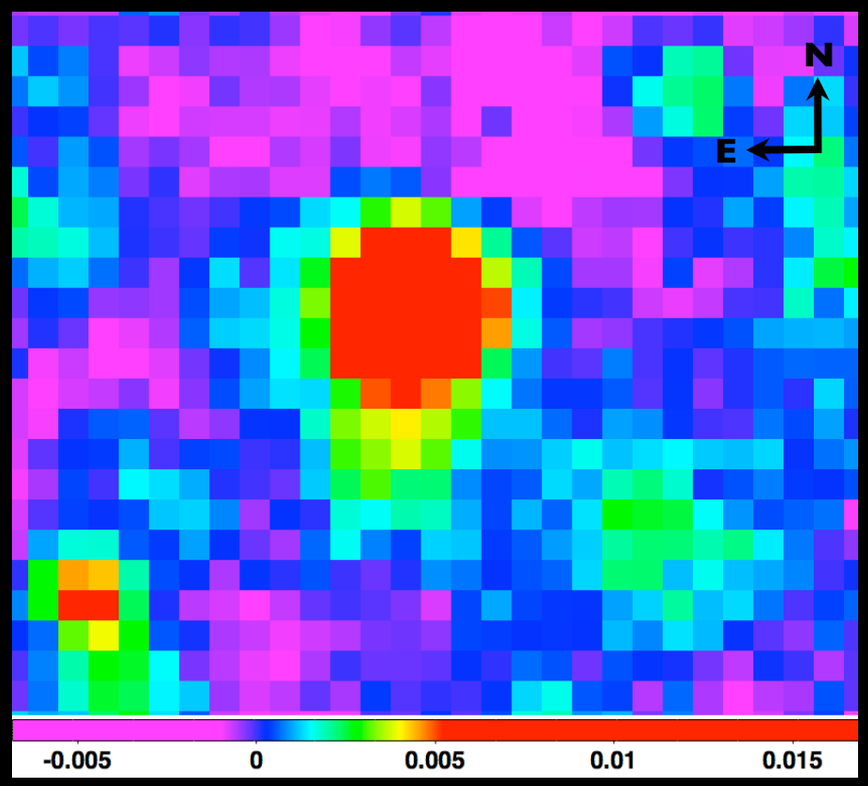
HerPlaNS photometry of NGC 3242

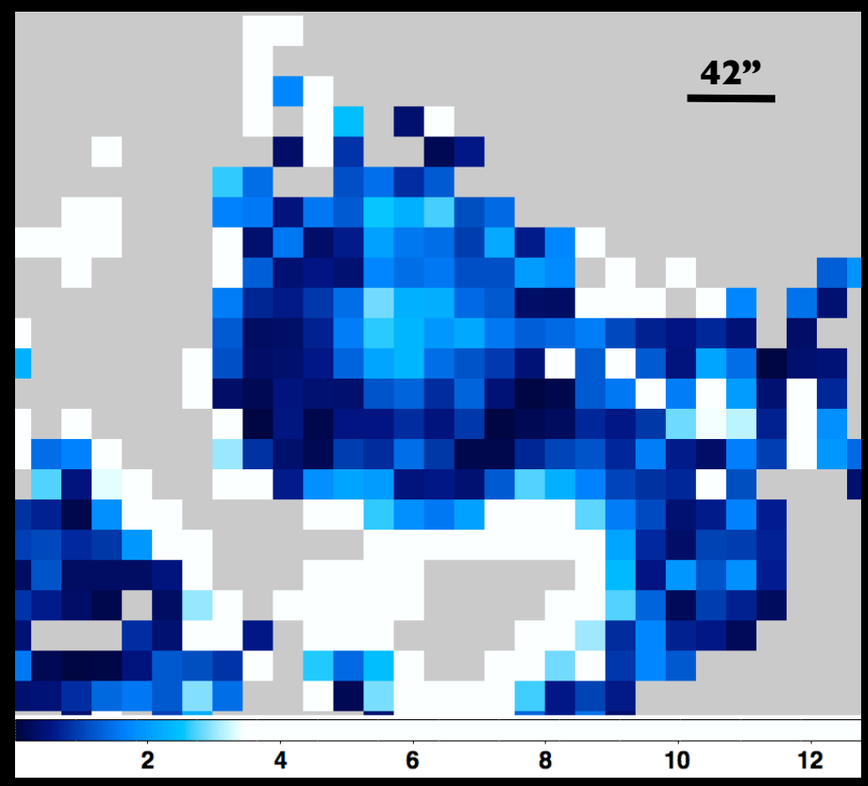


Temperature maps

Temperature map of NGC 3242

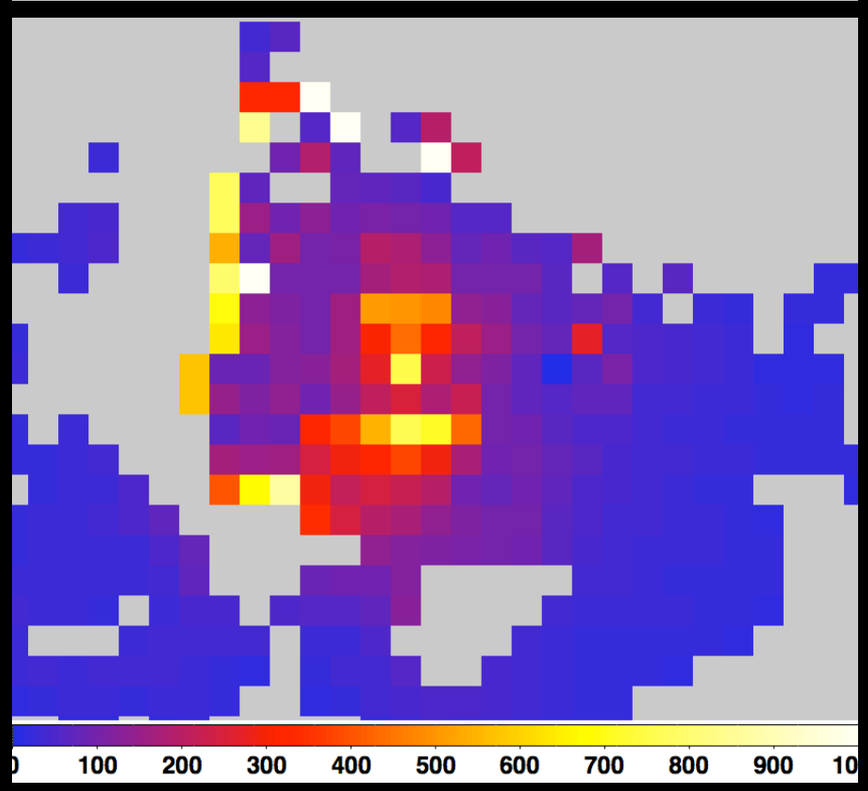
PACS 70um

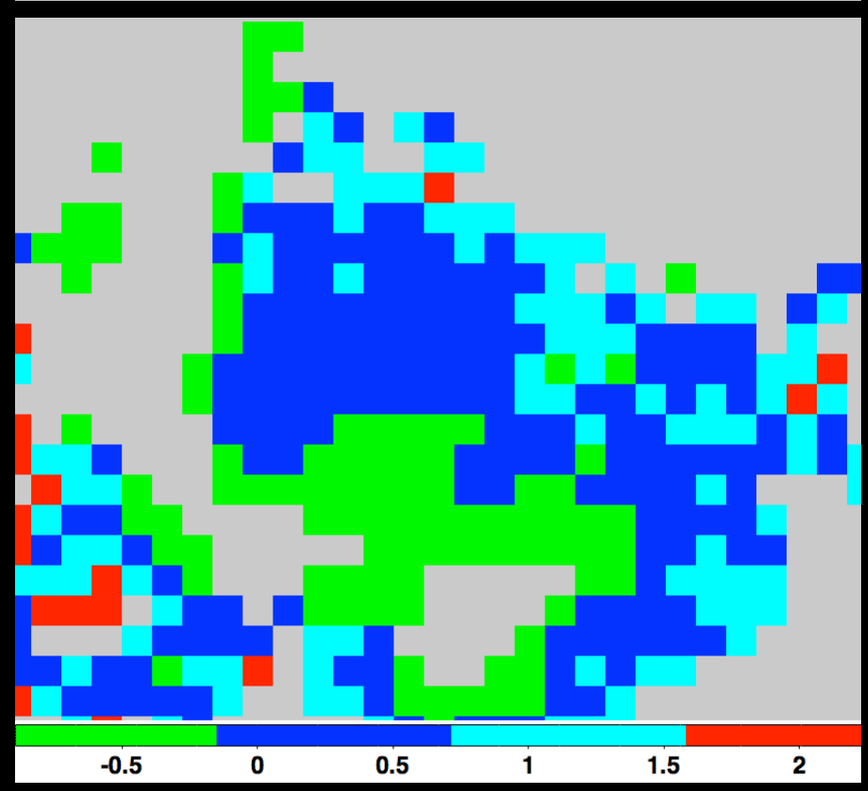




Chi^2 map

Temperature map

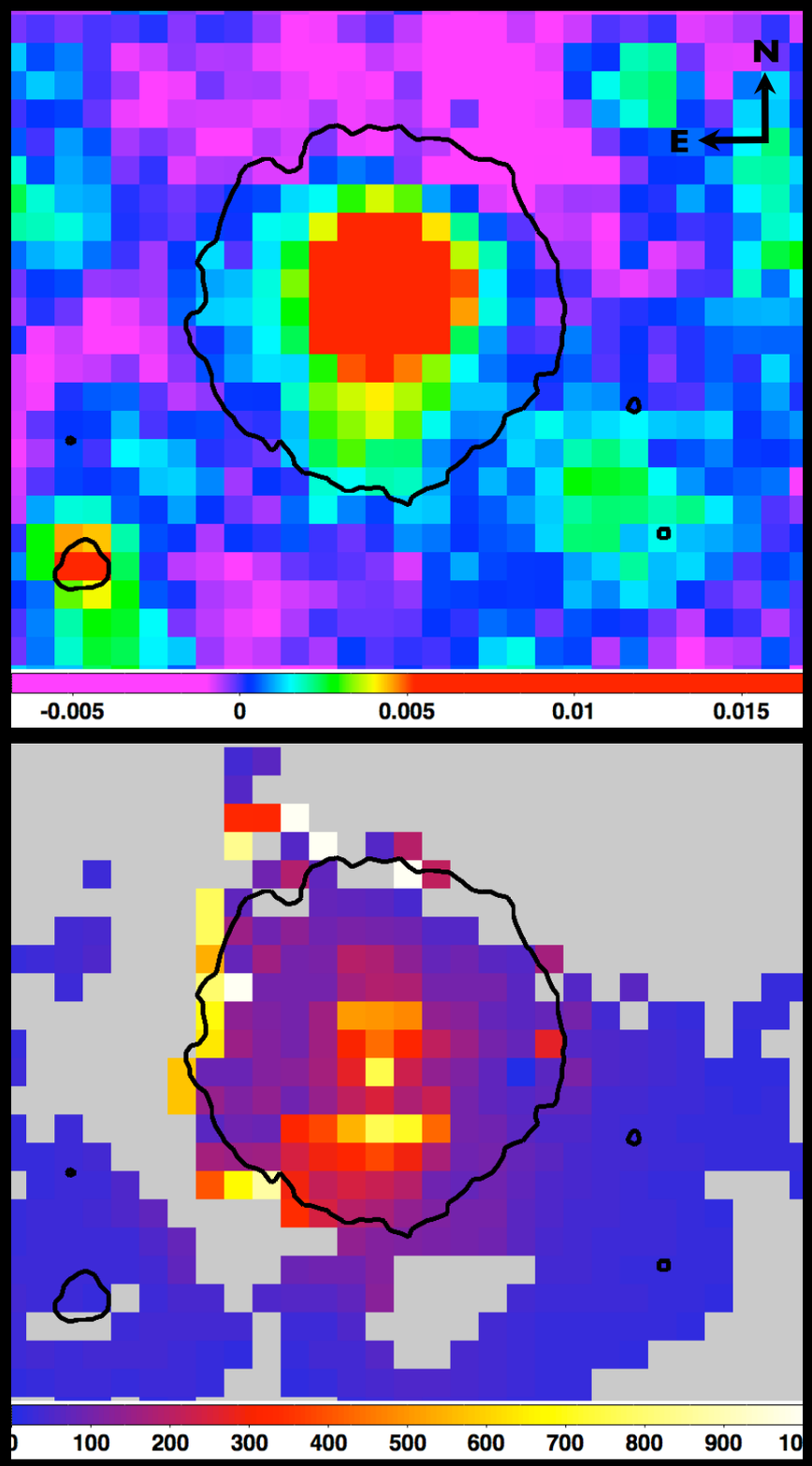


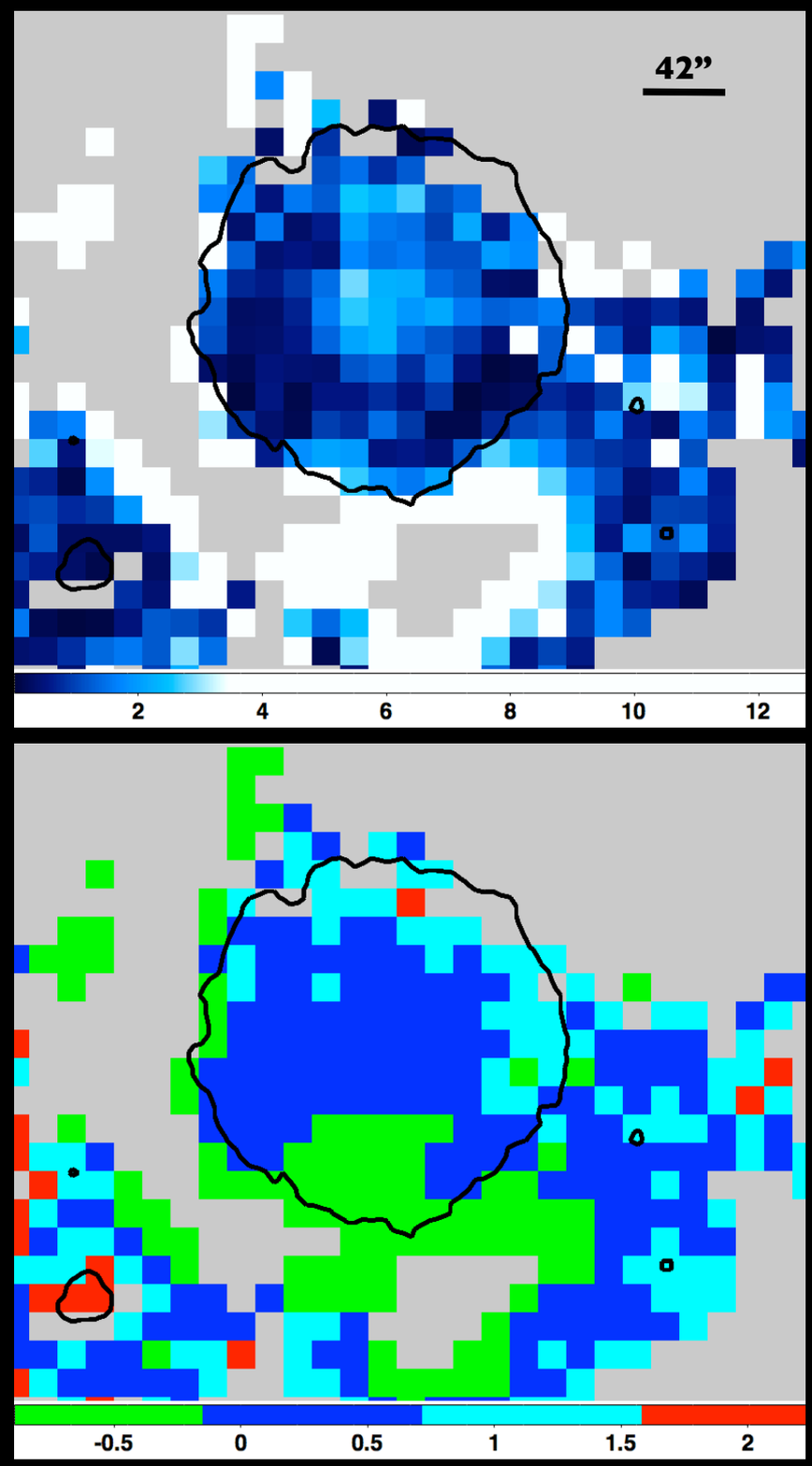


Beta map

Temperature map of NGC 3242

PACS 70um



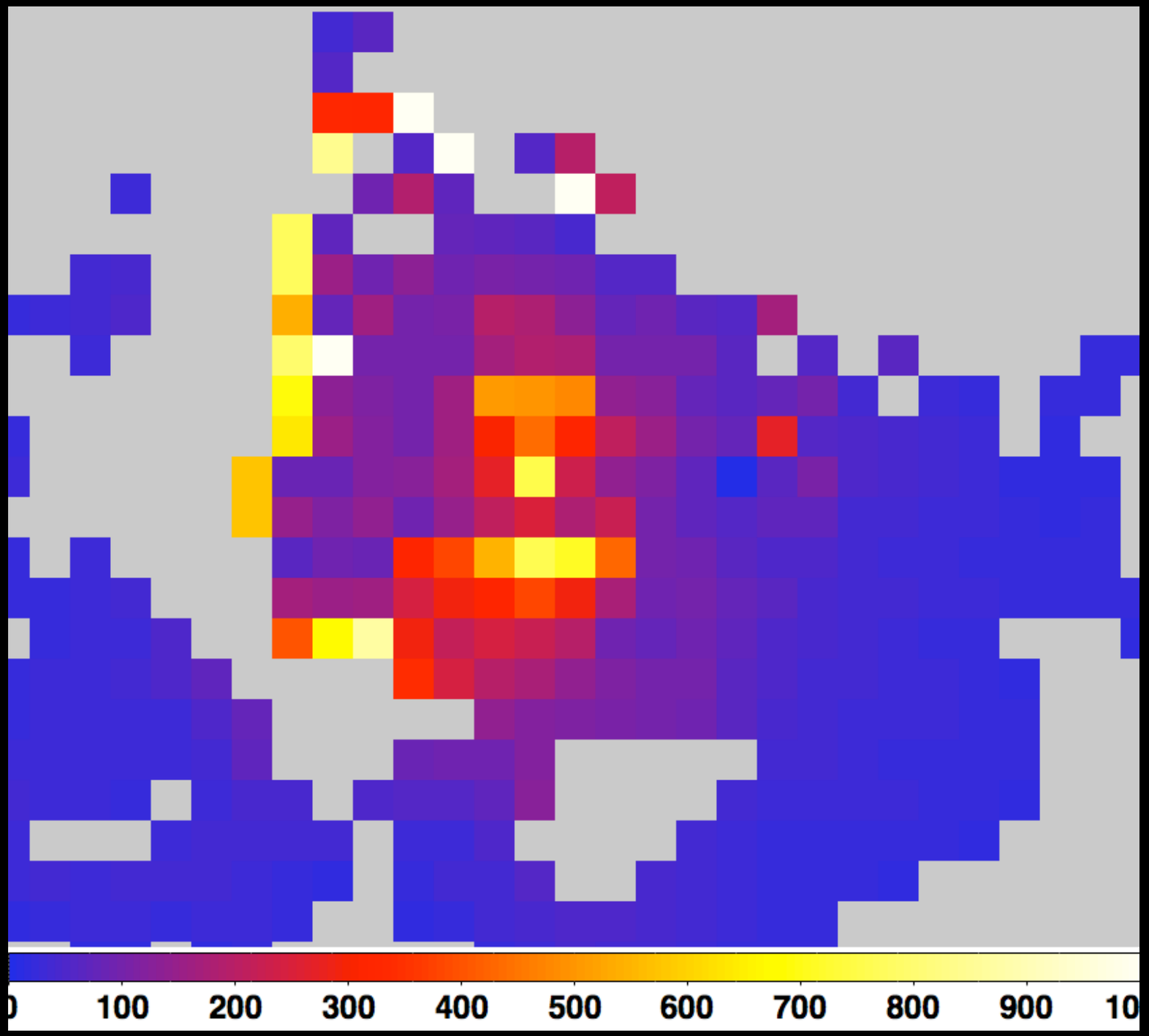


Chi^2 map

Temperature map

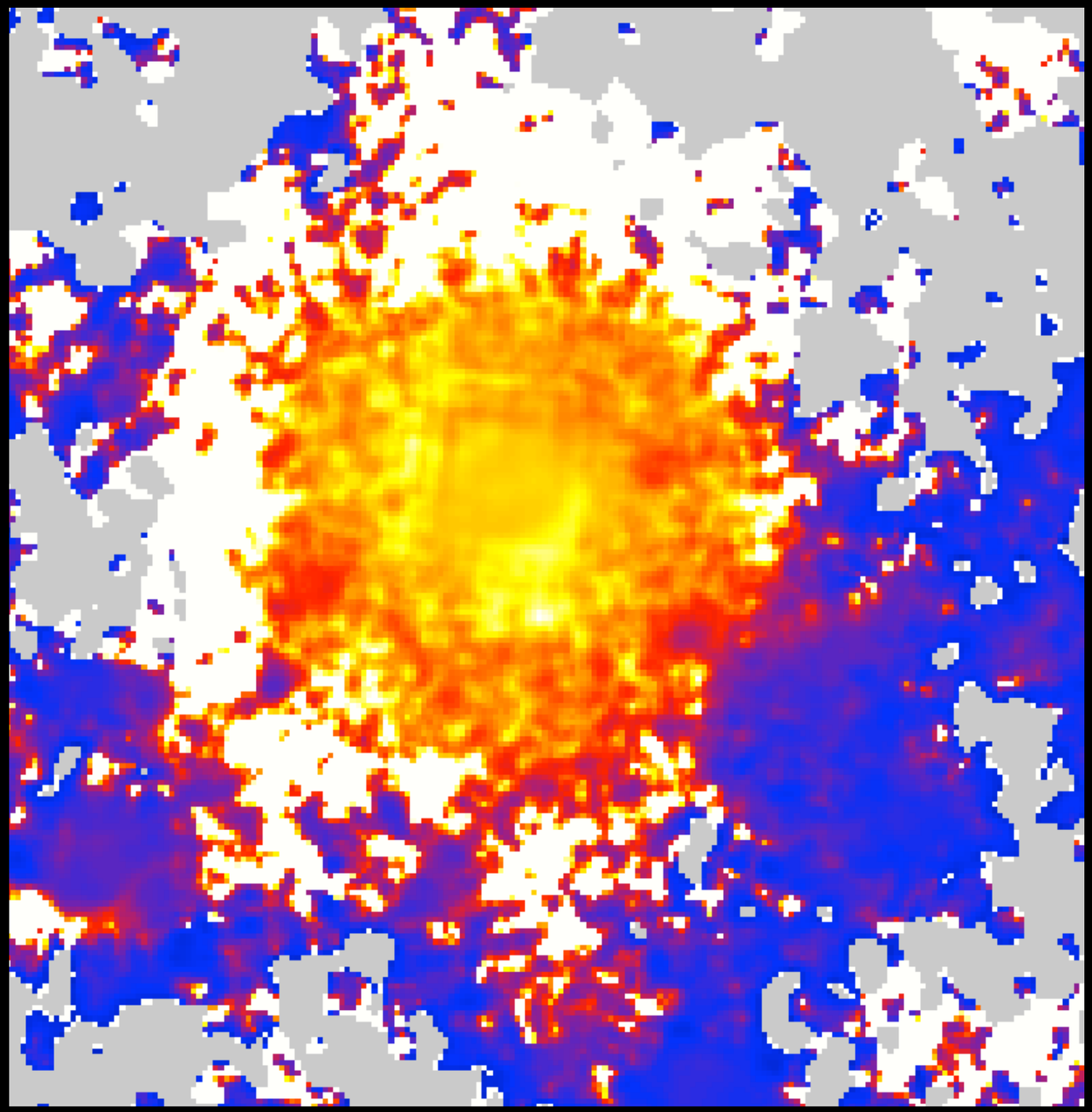
Beta map

Temperature map of NGC 3242



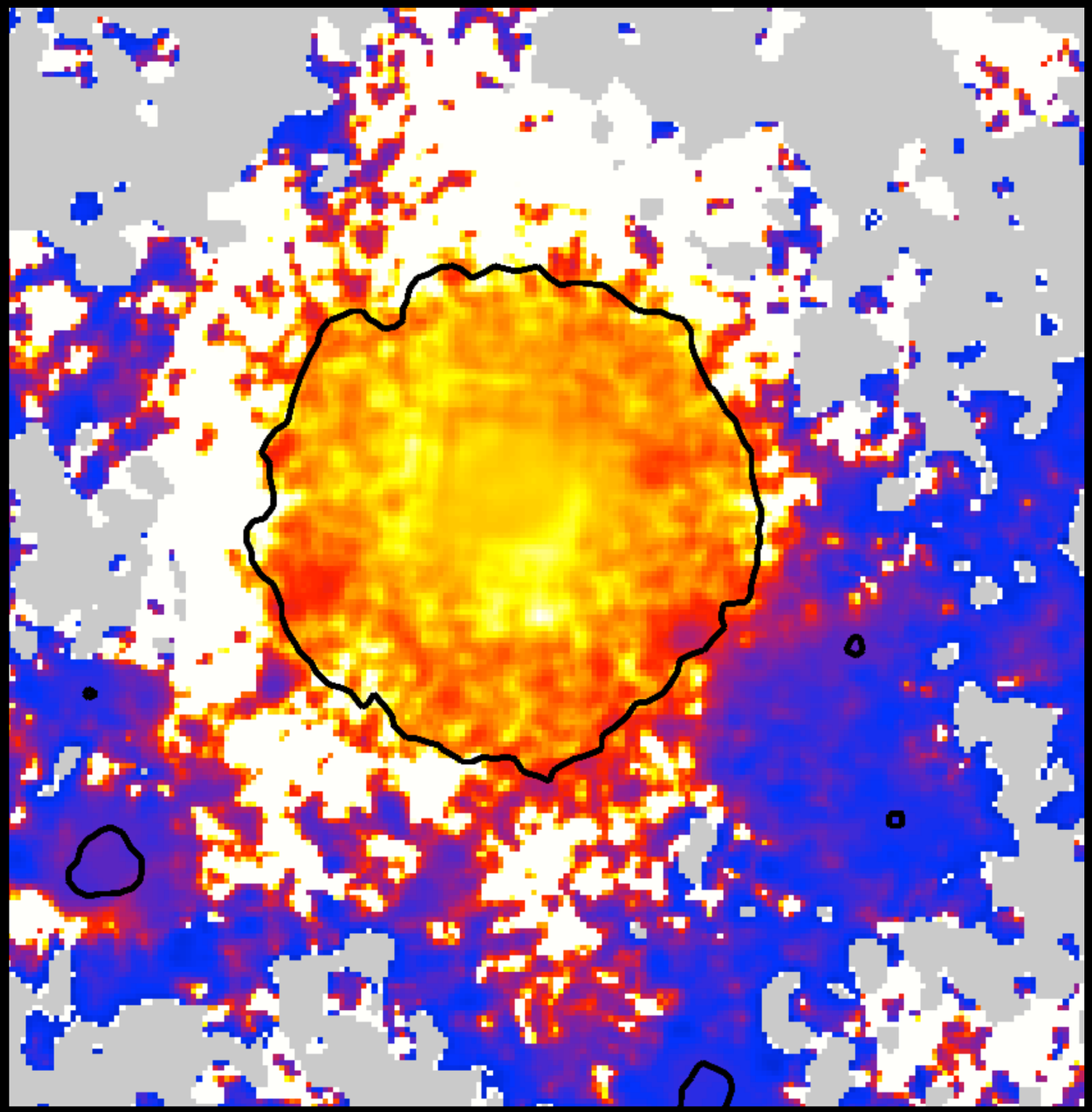
Temperature map with a ~ 37” PSF

Temperature map of NGC 3242



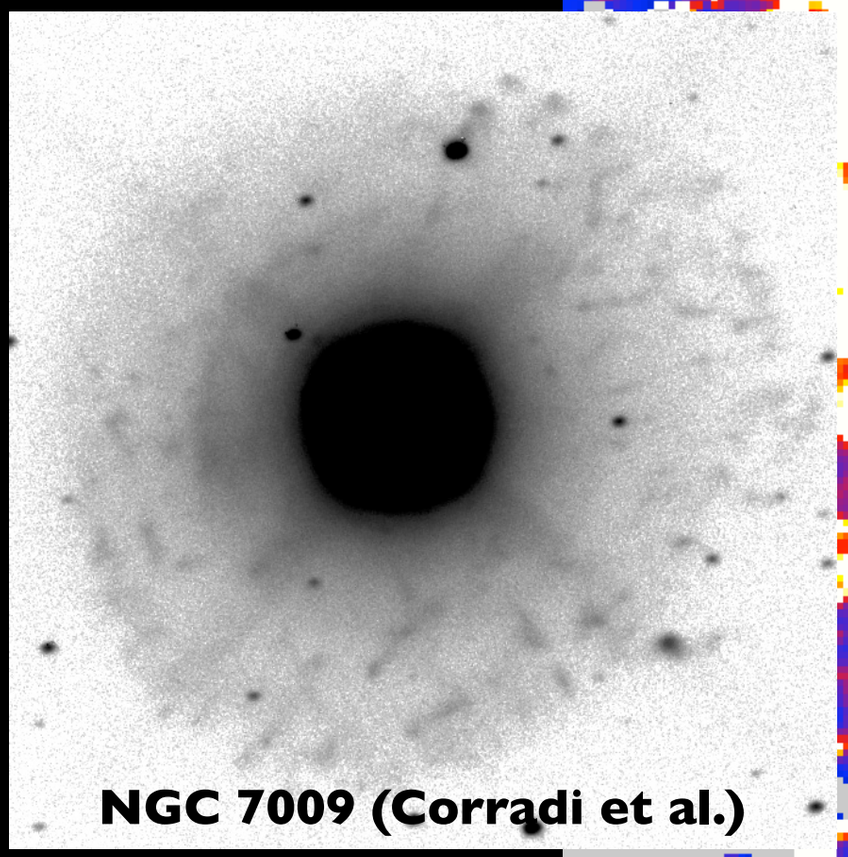
Temperature map with a ~ 12” PSF

Temperature map of NGC 3242

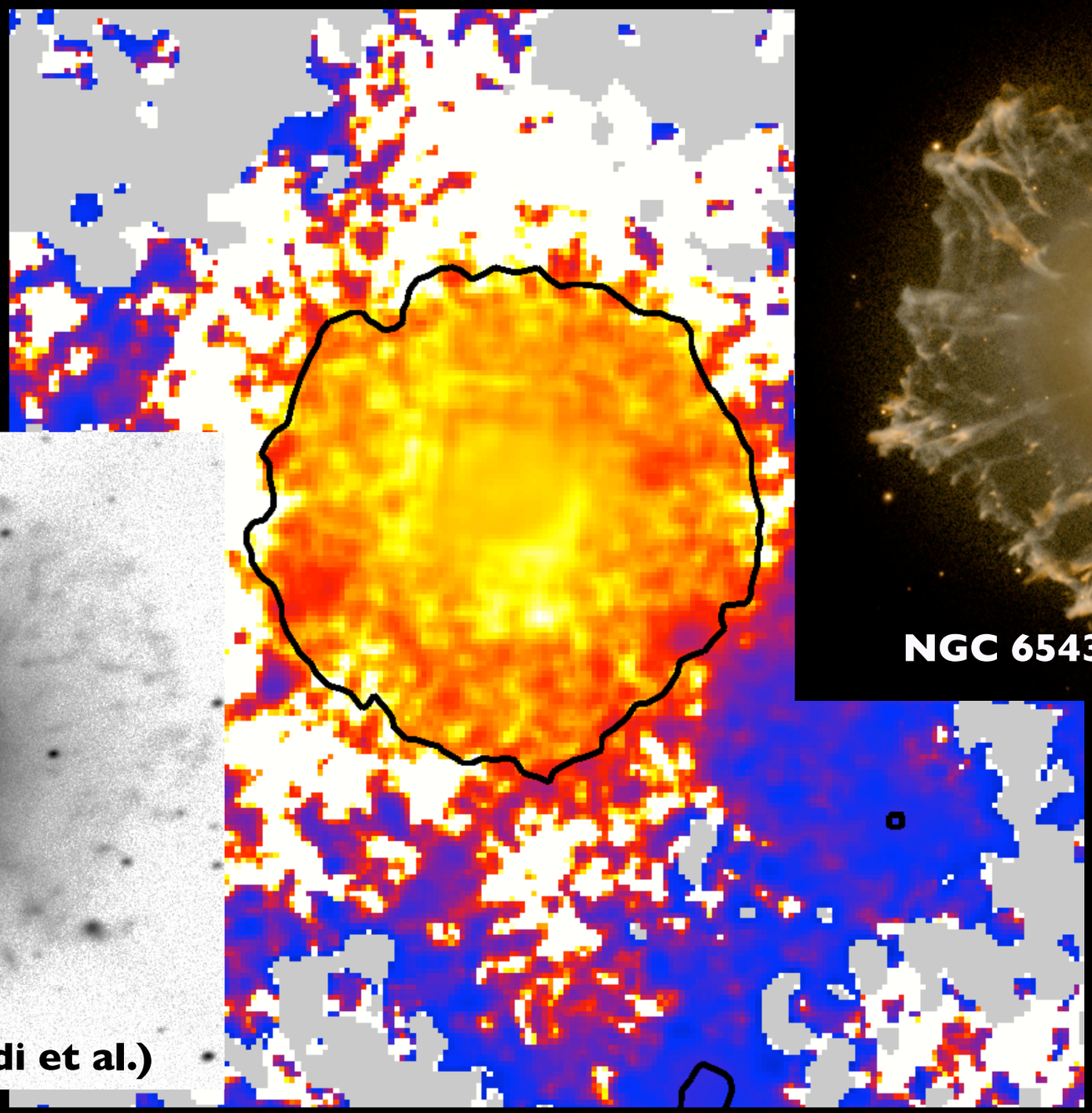


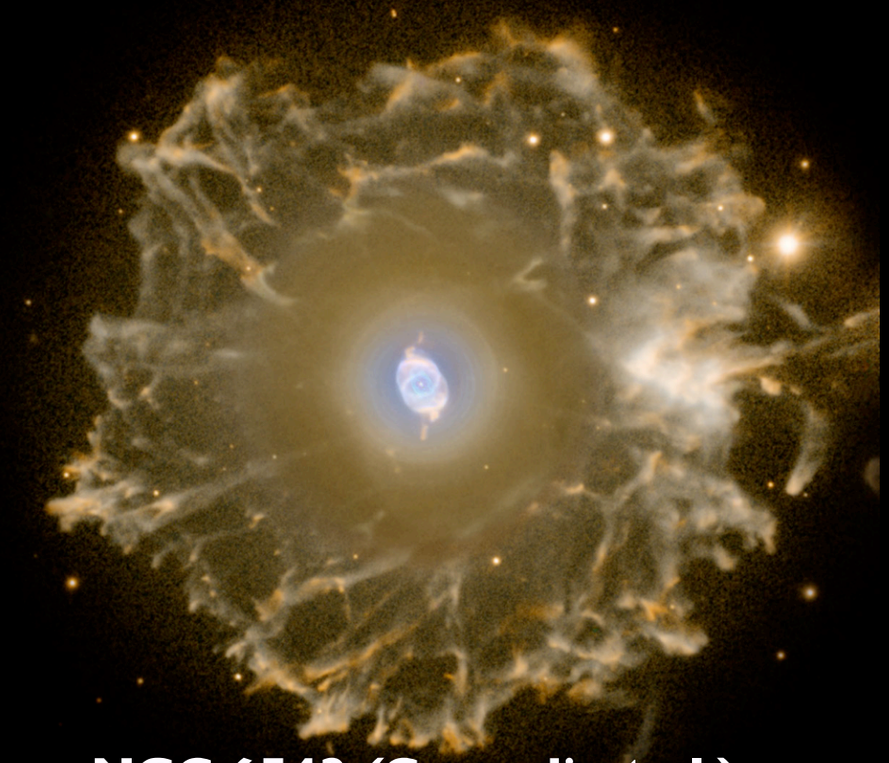
Temperature map with a ~ 12” PSF

Temperature map of NGC 3242



NGC 7009 (Corradi et al.)



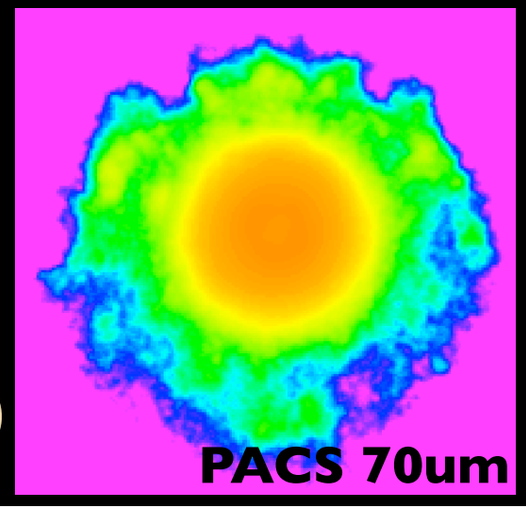


NGC 6543 (Corradi et al.)

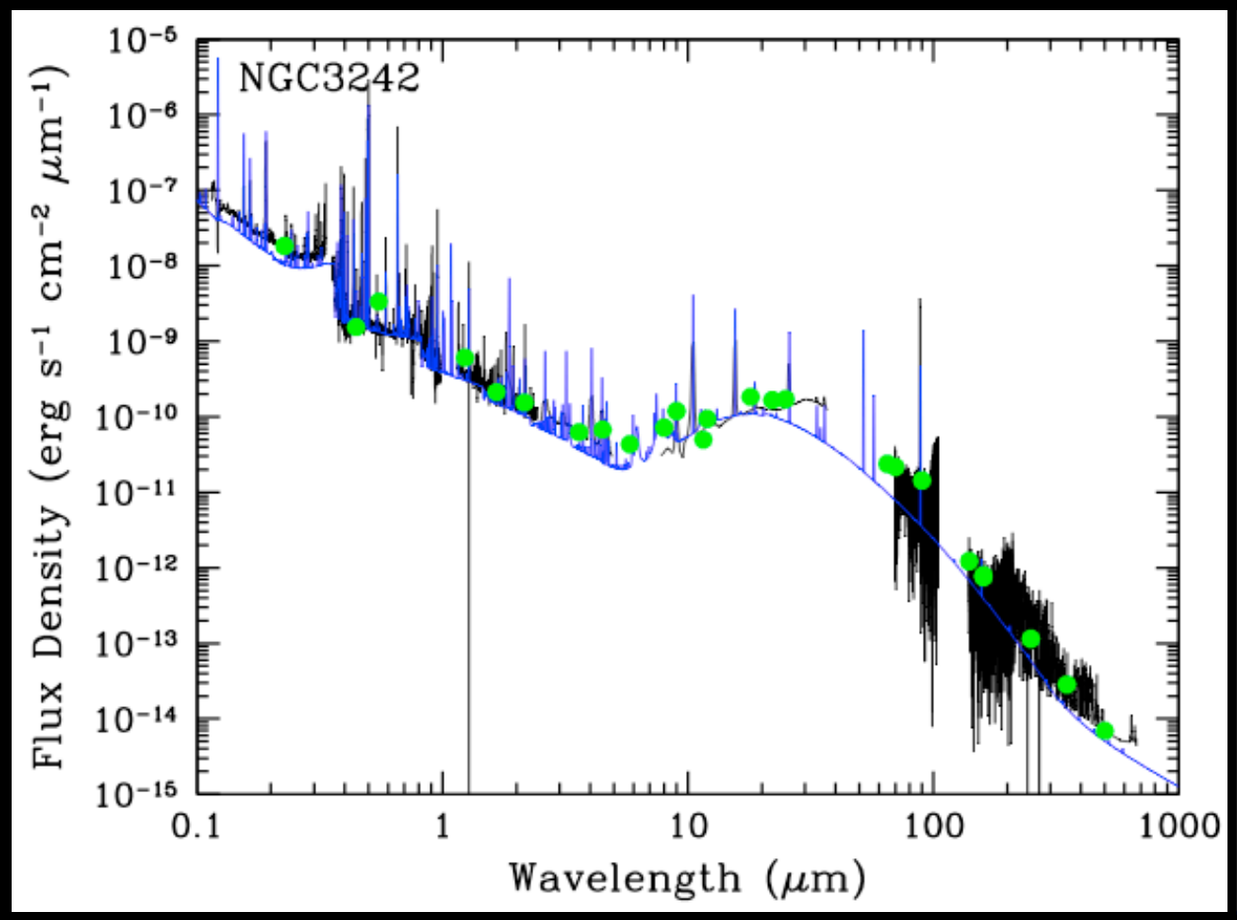
Temperature map with a ~ 12” PSF

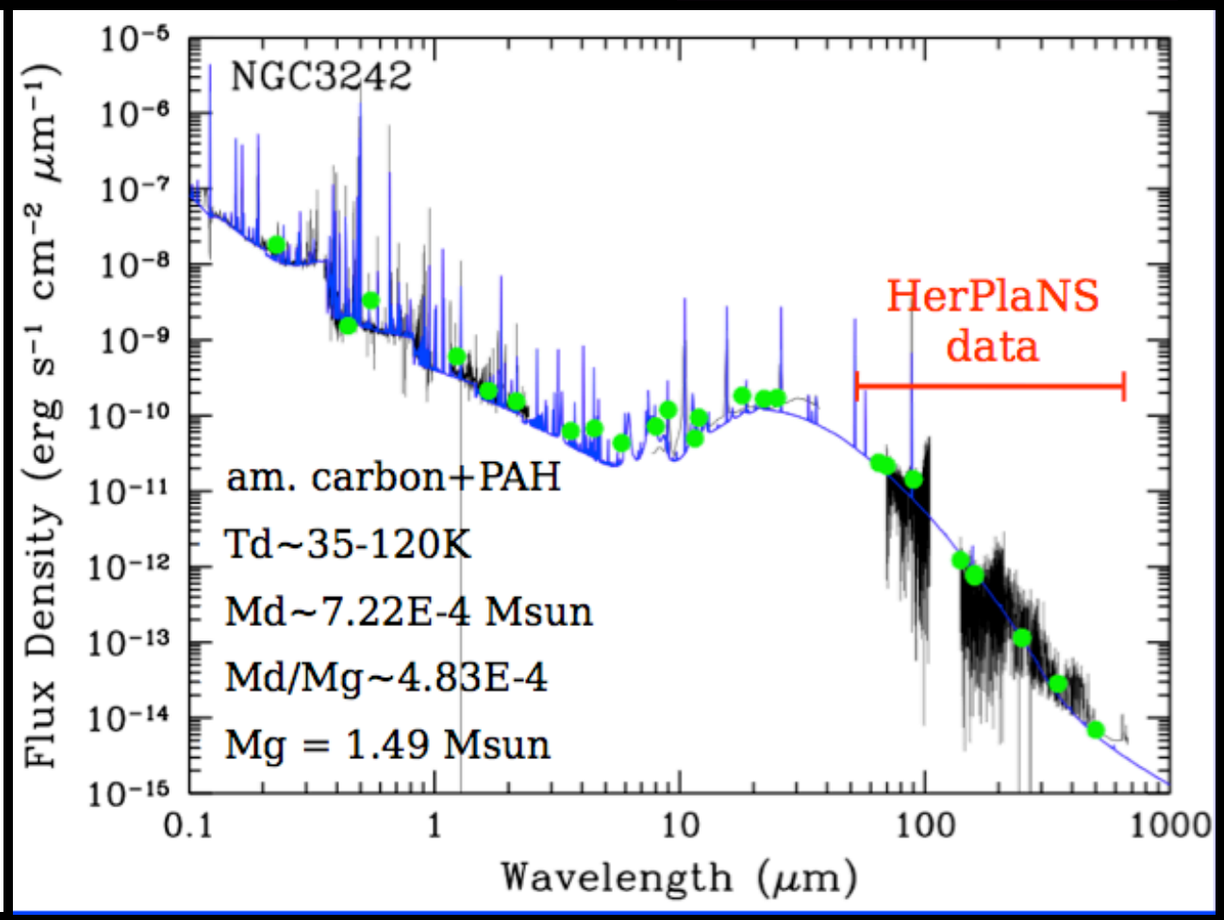
How much dust is out there?

HerPlaNS preliminary results

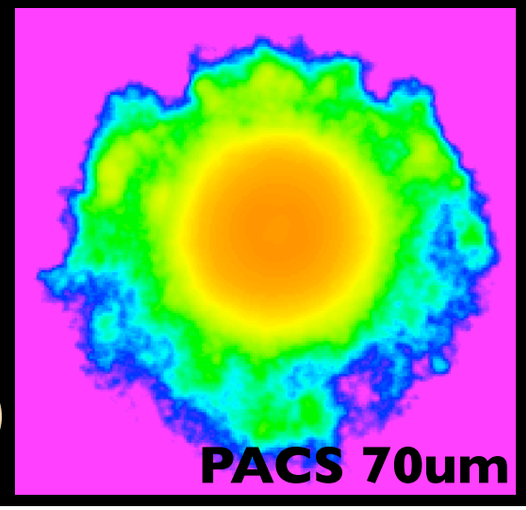


Cloudy dust+gas modelling of NGC 3242 (by M. Otsuka)





HerPlaNS preliminary results



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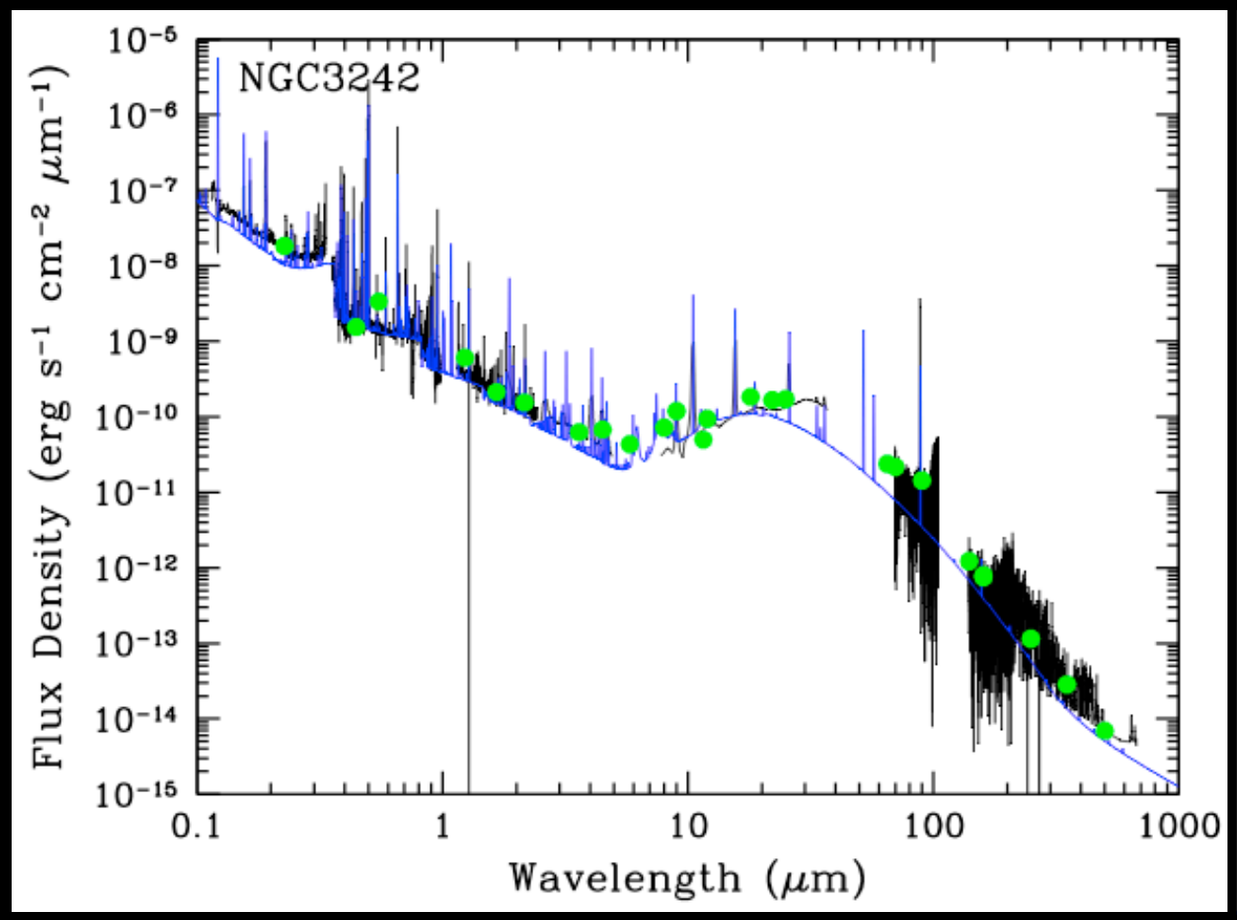
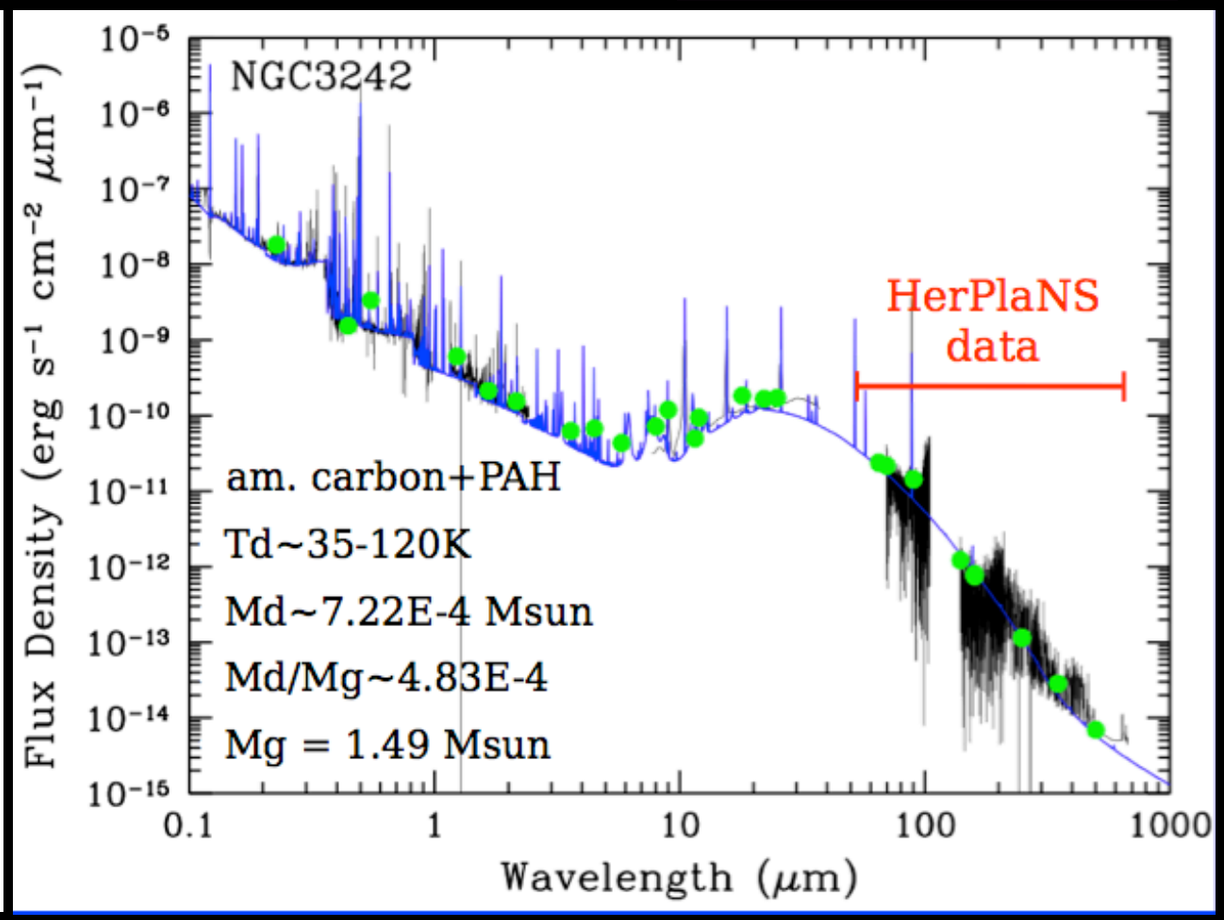
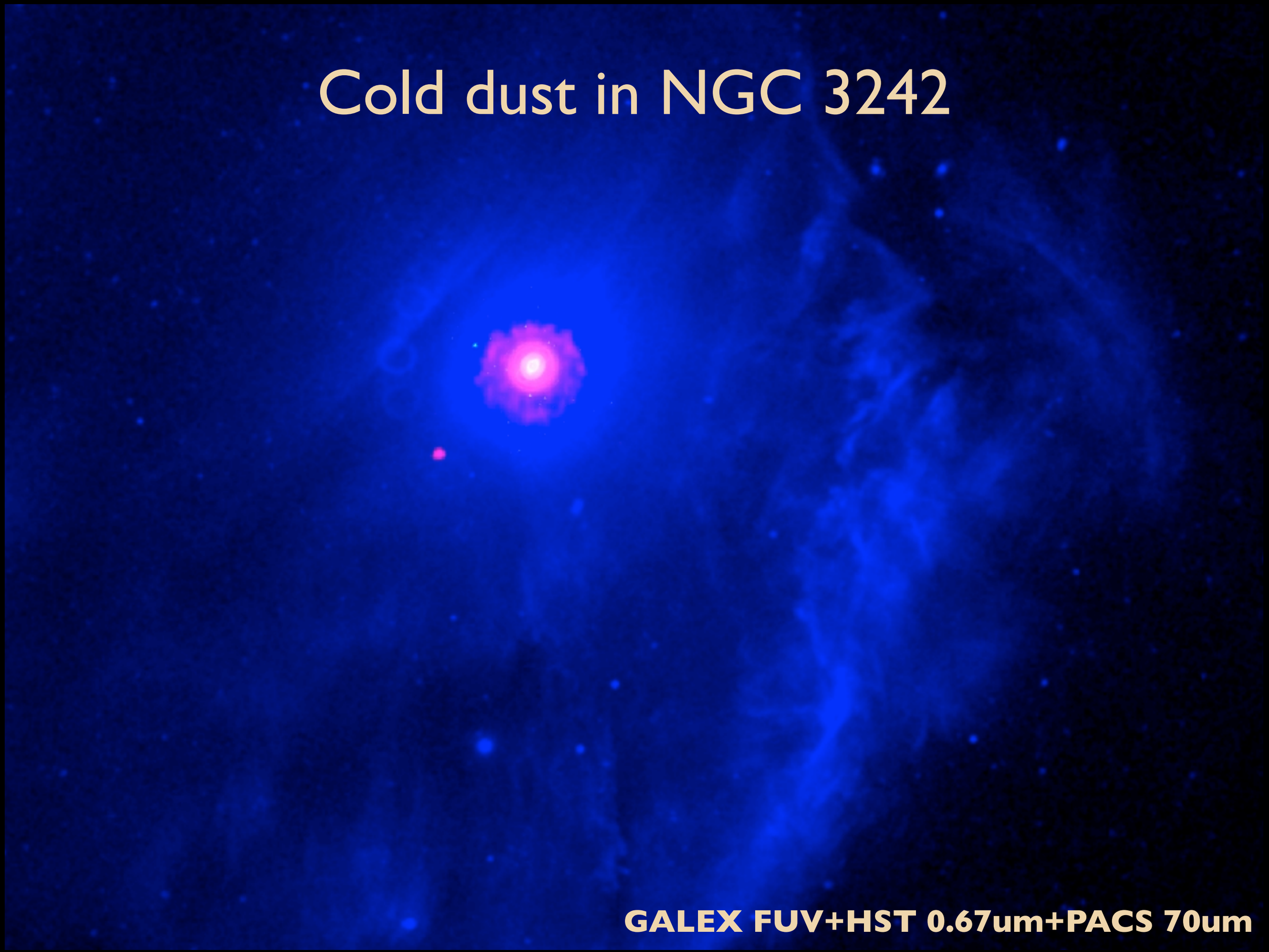


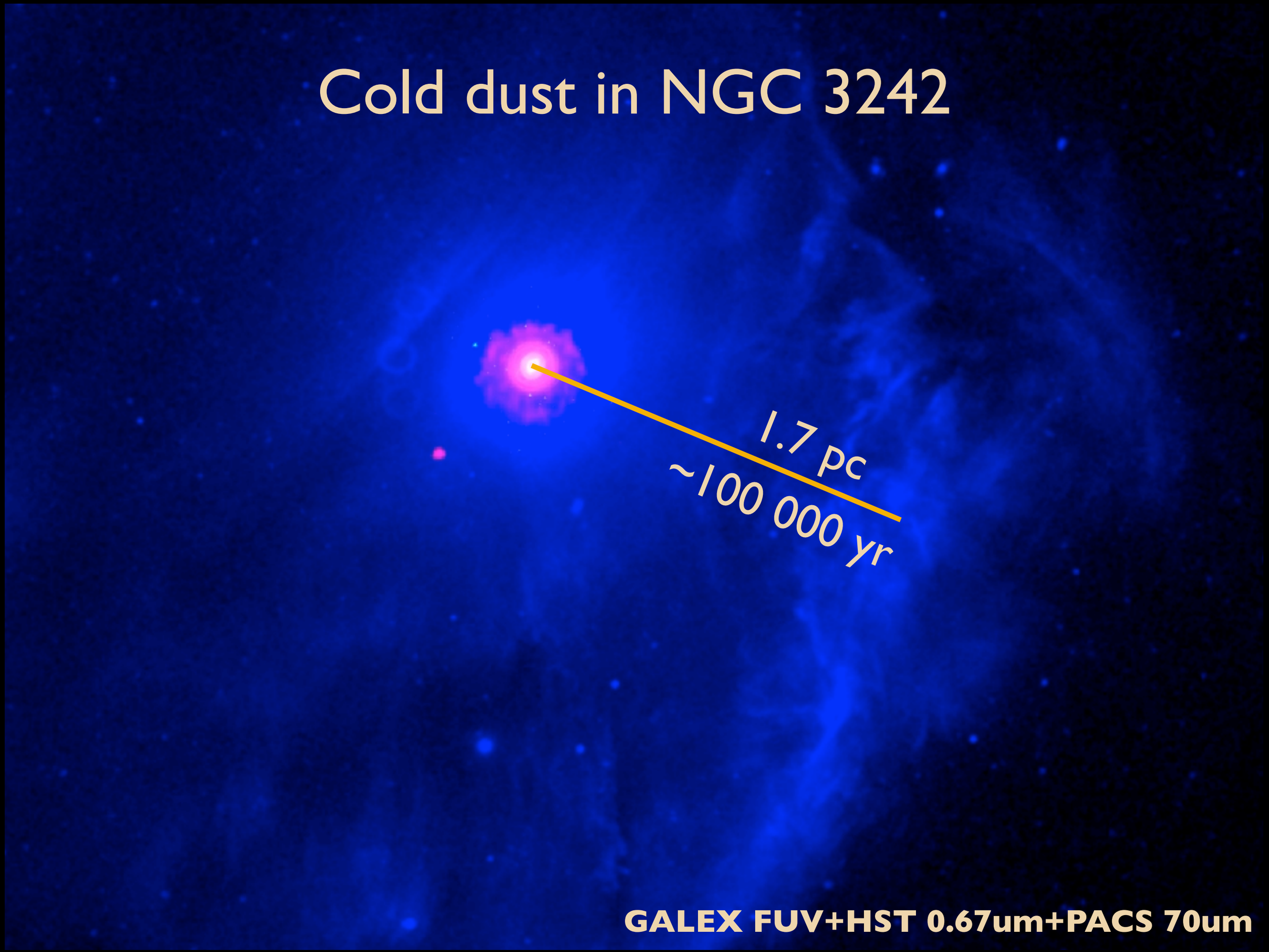


A factor 2.3 increase in the total dust mass when including FIR data!

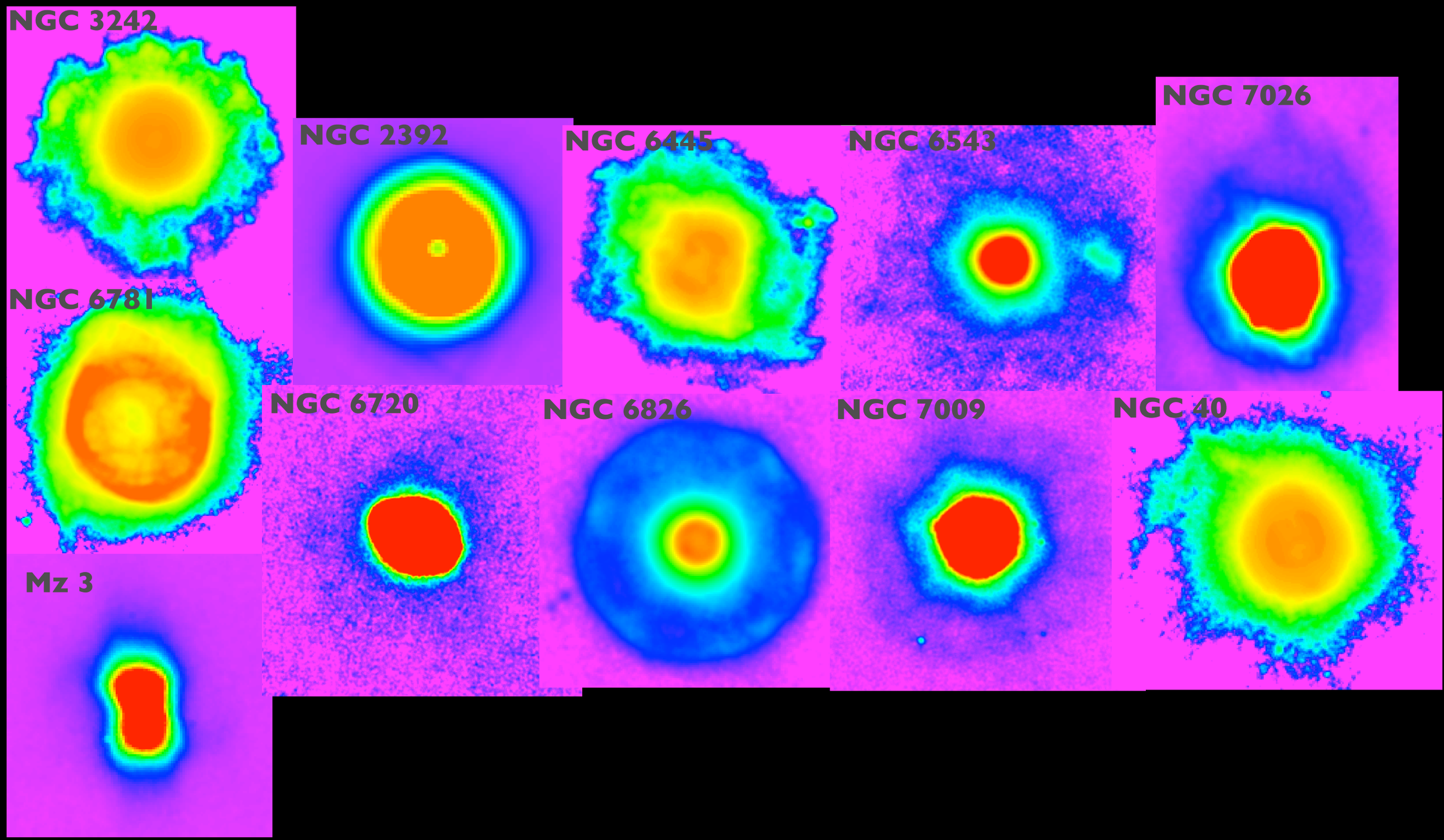
Cold dust in NGC 3242



Cold dust in NGC 3242

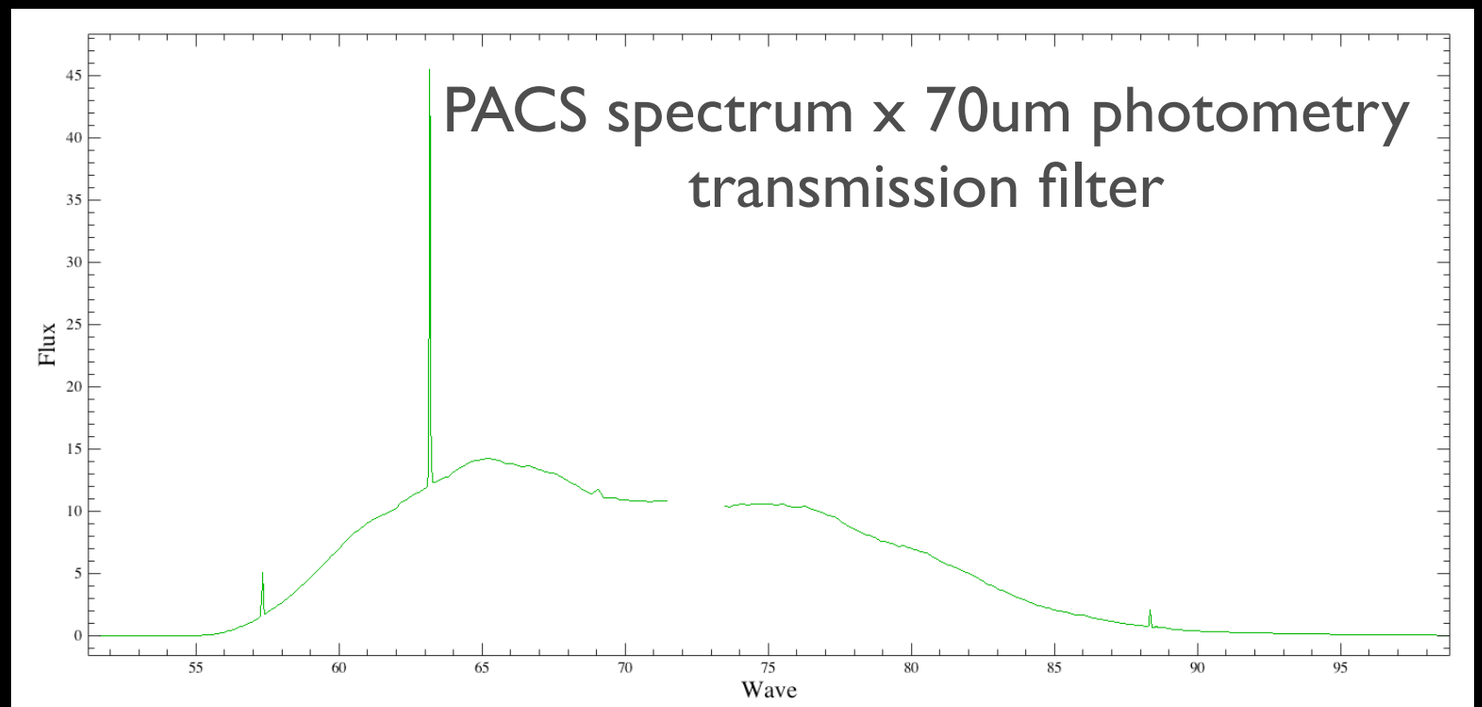


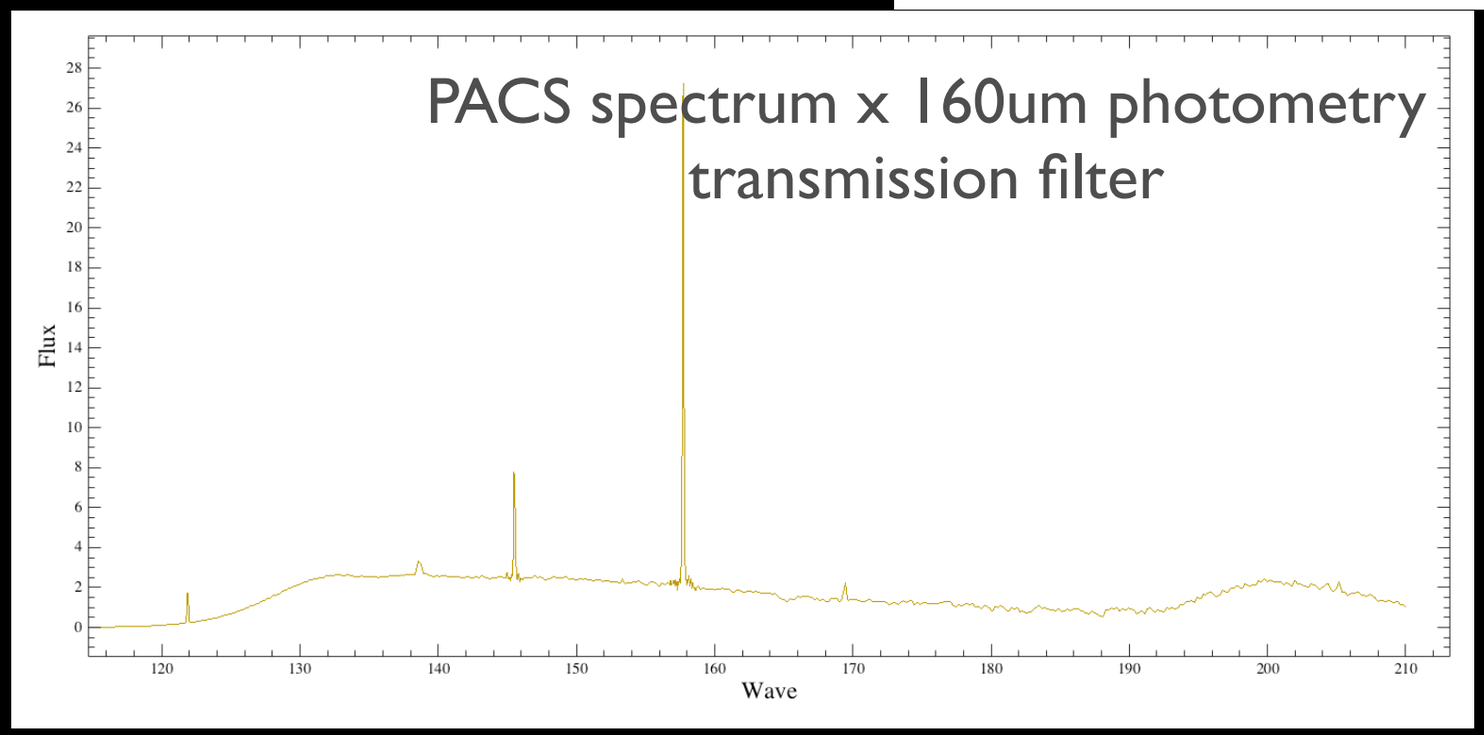
More to come!


NGC 3242
NGC 2392
NGC 6445
NGC 6543
NGC 7026
NGC 6781
NGC 6720
NGC 6826
NGC 7009
NGC 40
Mz 3

Line contamination

- We estimated the emission lines contamination in the photometry maps by making synthetic maps using the spectroscopy data.





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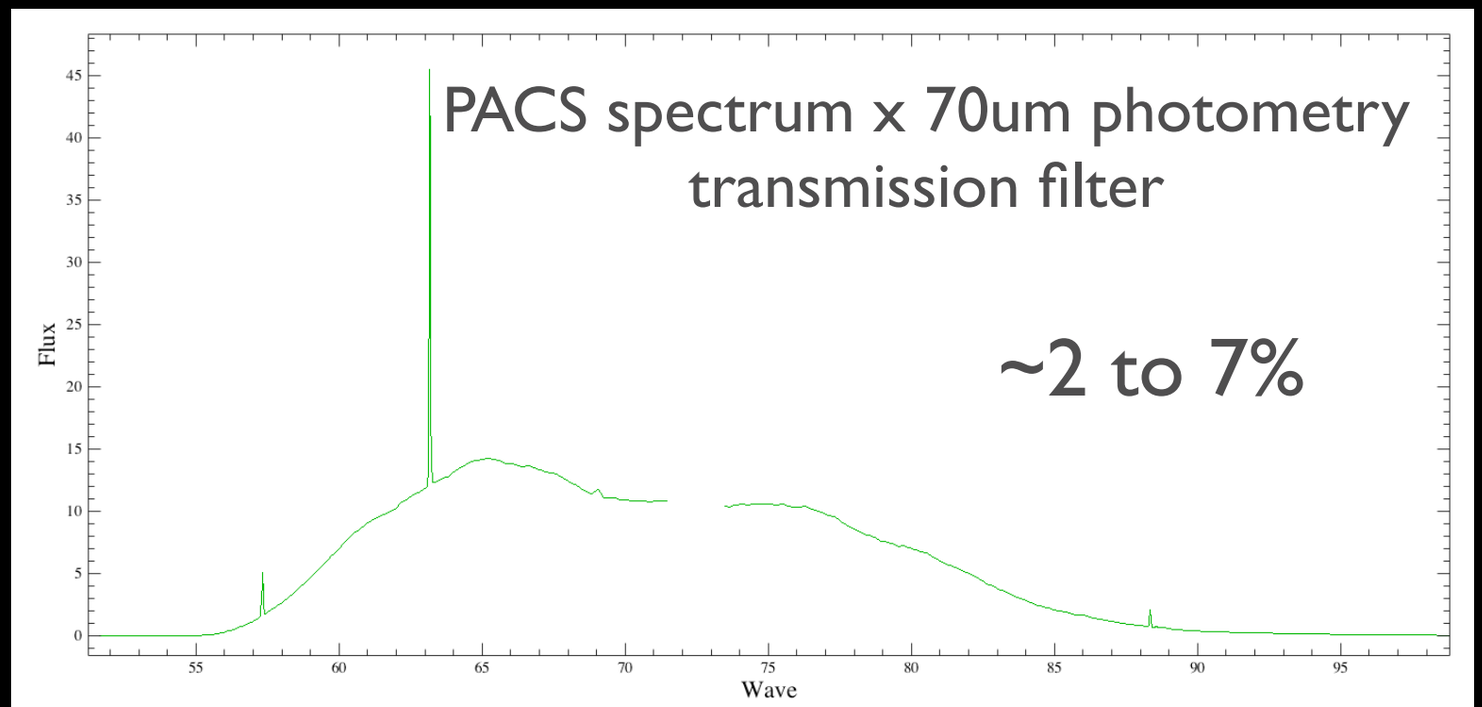
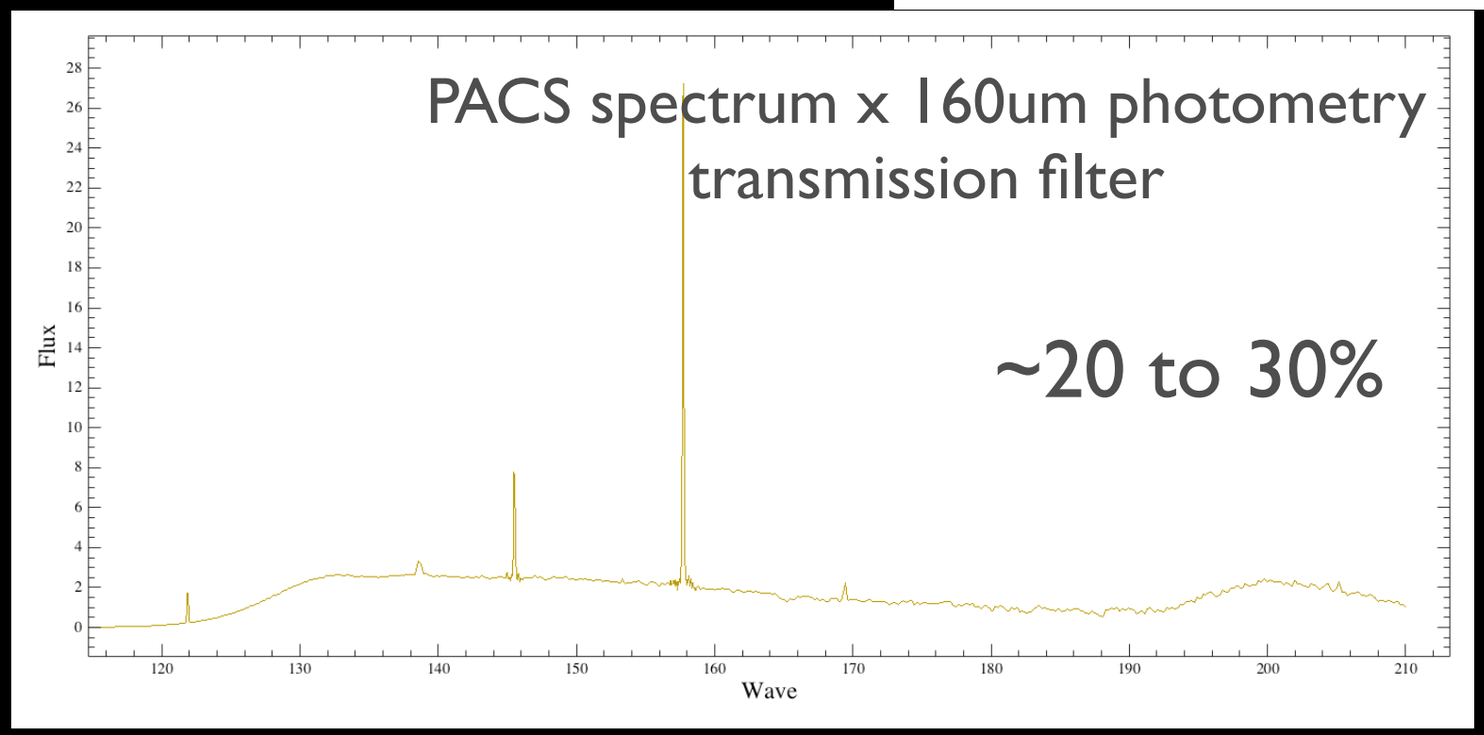
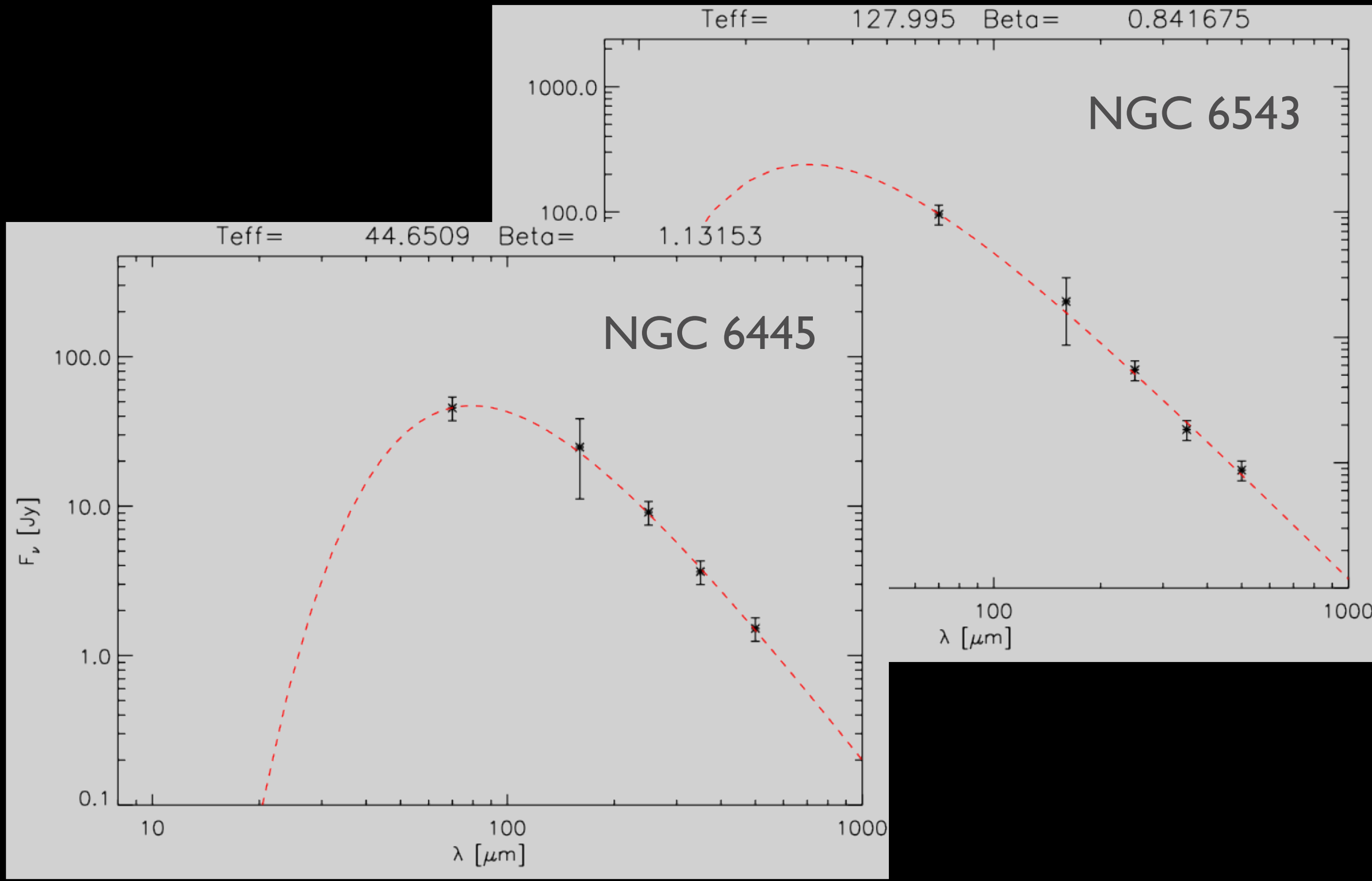
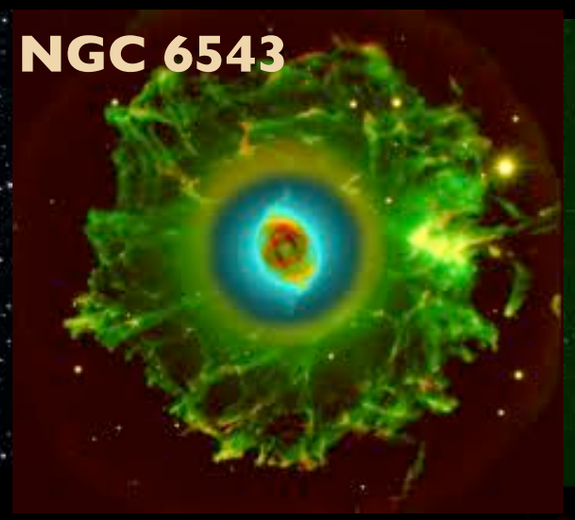


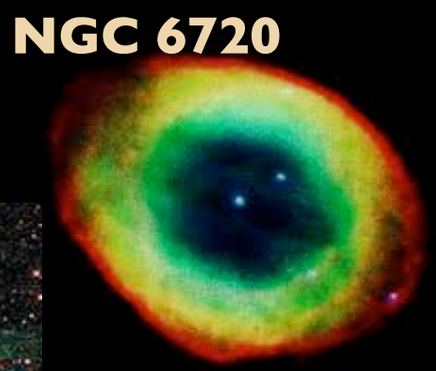


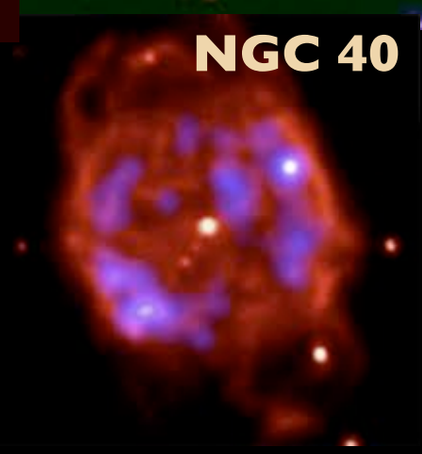
Line contamination



HerPlaNS sample list

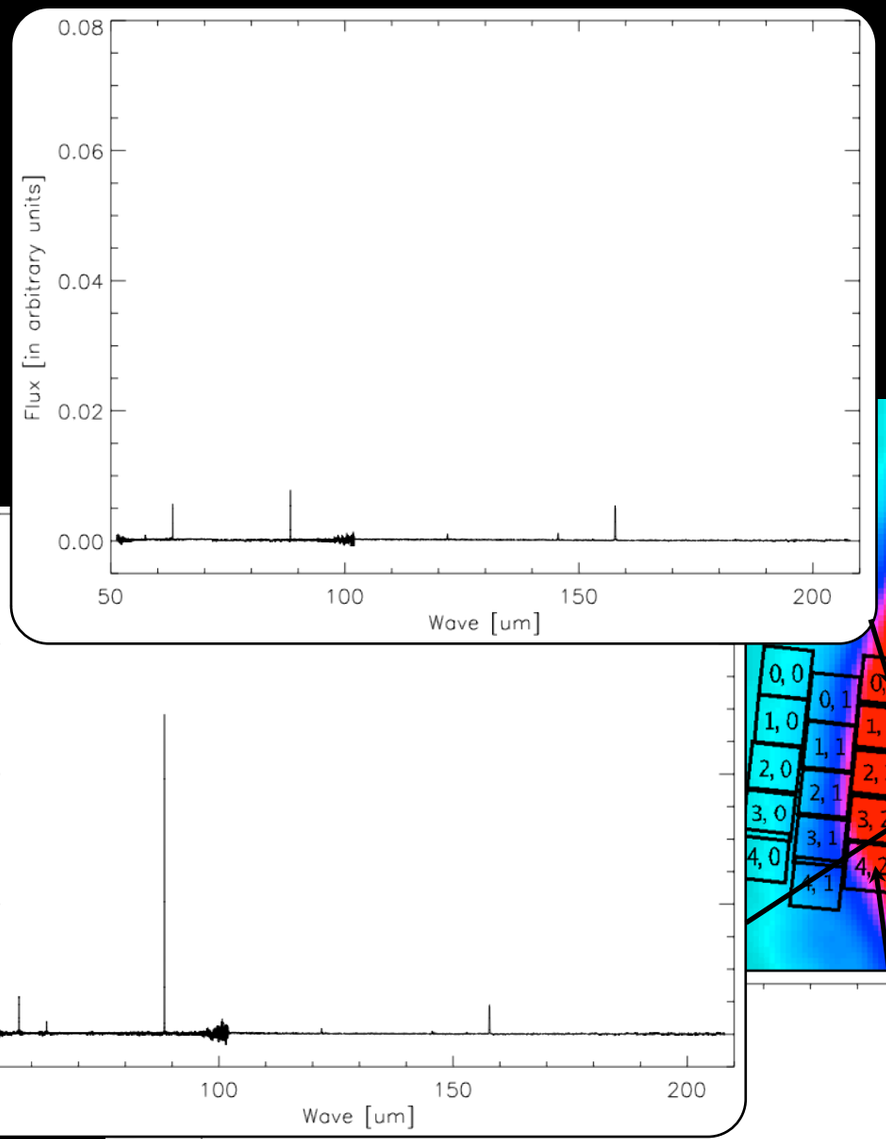


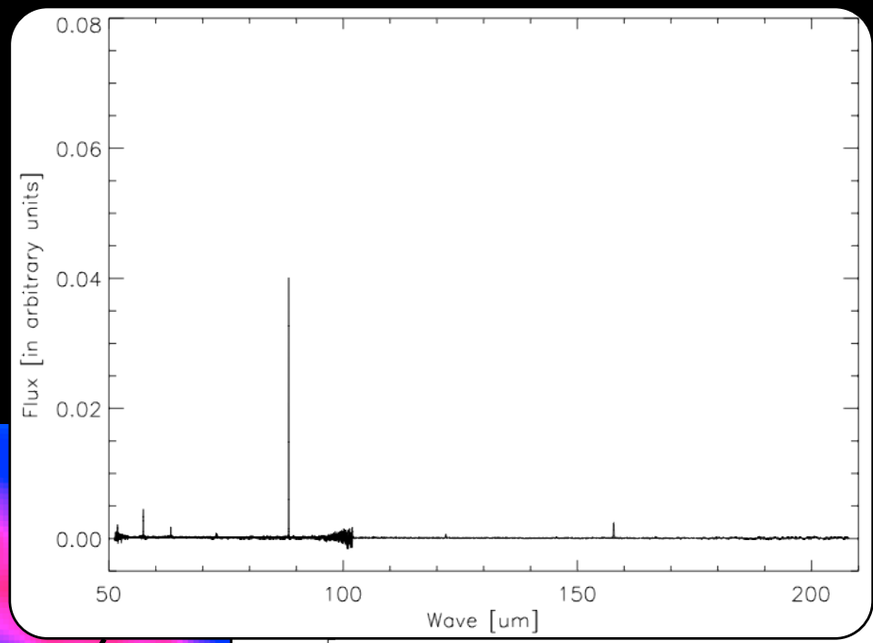


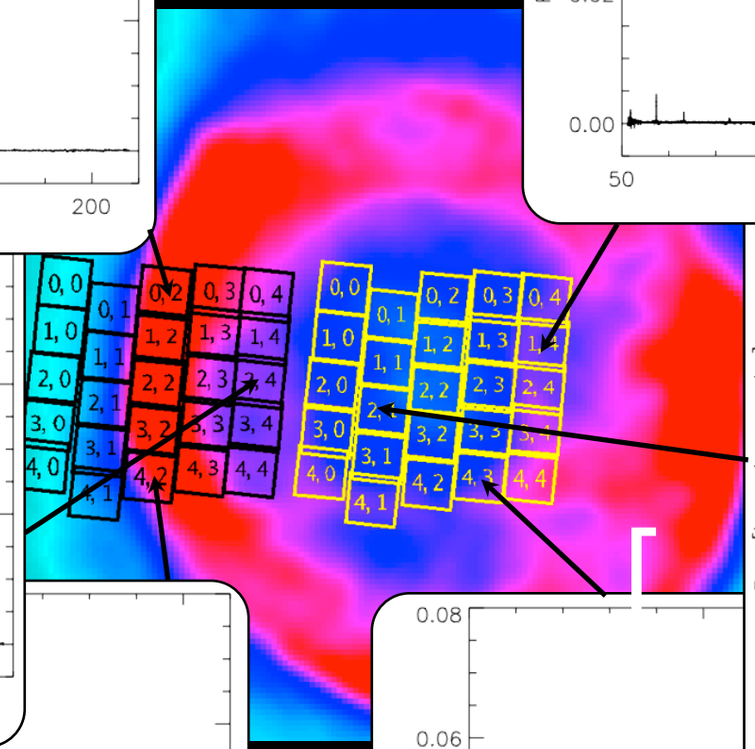


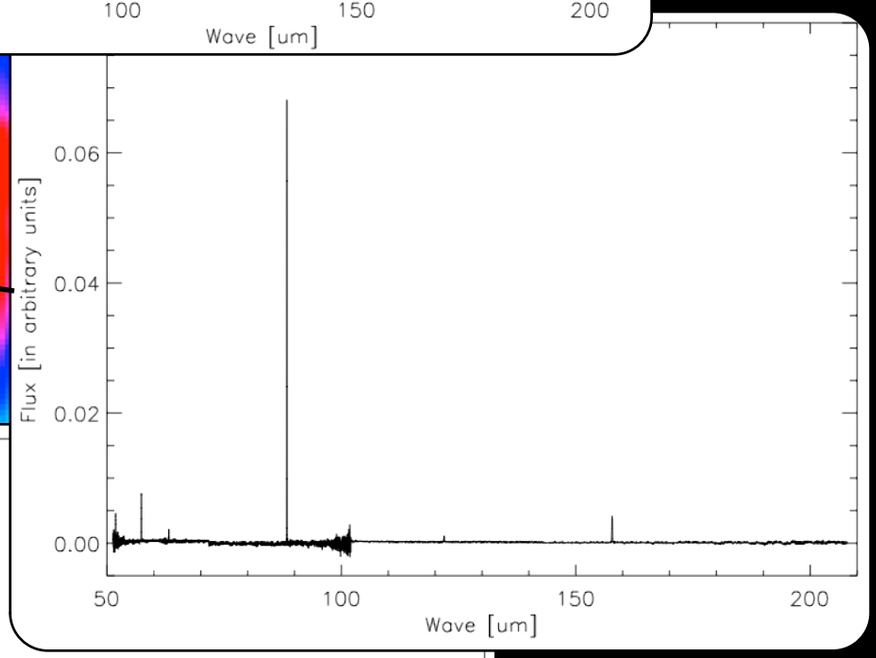
Images credits: X-ray: NASA/CXC/RIT/J.Kastner et al.; Optical: NASA/STScI/R.Corradi & D.Goncalves

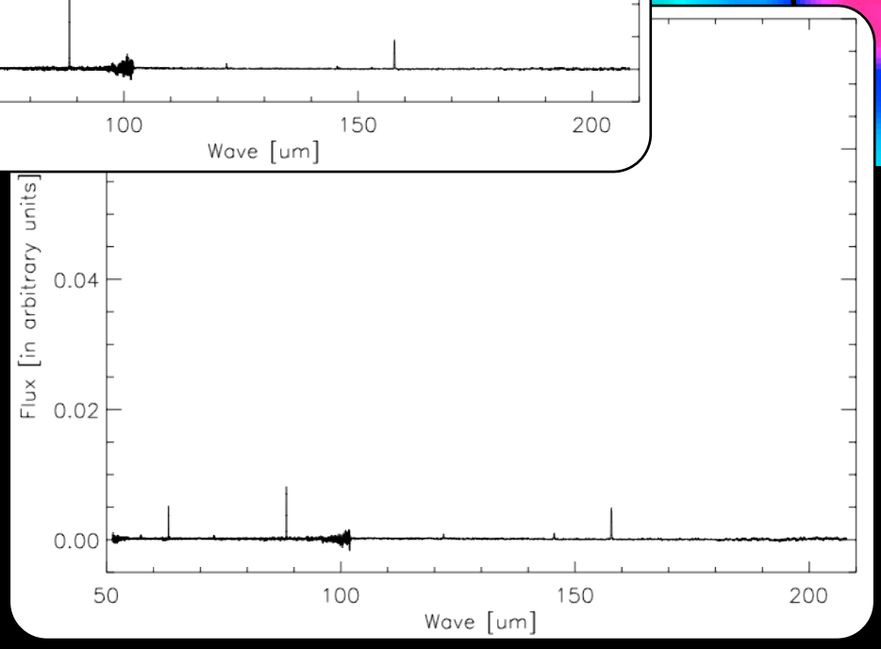
Preliminary: PACS spectroscopy of NGC 6781

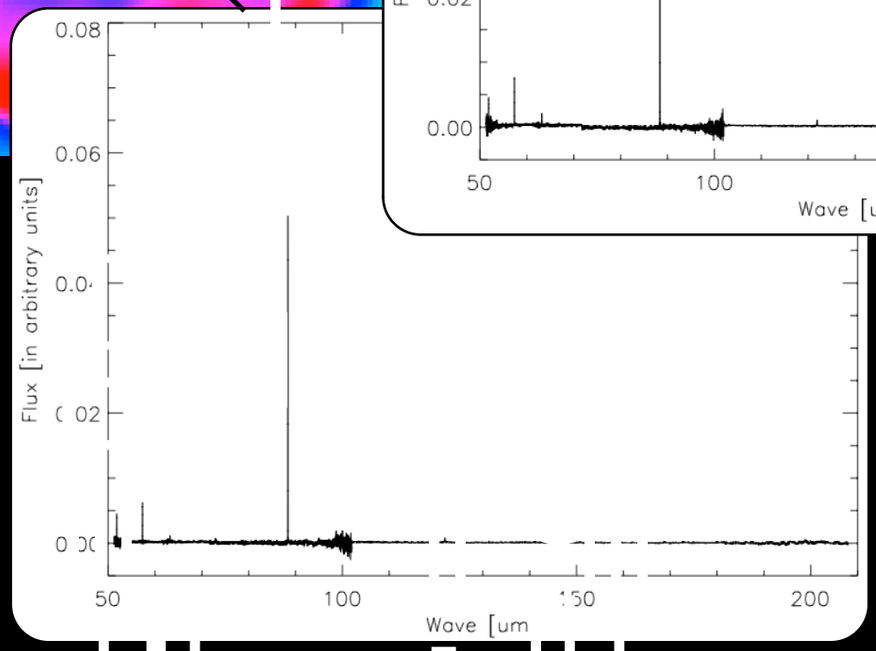












Preliminary: SPIRE spectroscopy of NGC 6781