First Results from the Very Nearby Galaxies Survey

Chris Wilson

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On behalf of the SPIRE consortium
(the SPIRE Nearby Galaxies Astronomy Group)

SPIRE Nearby Galaxies Astronomy Group

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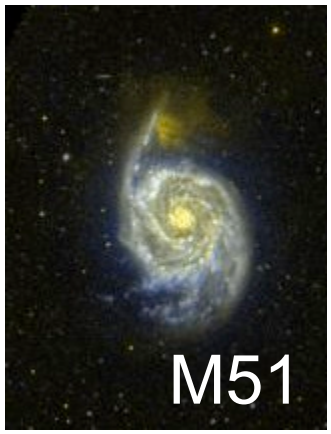
Outline of talk

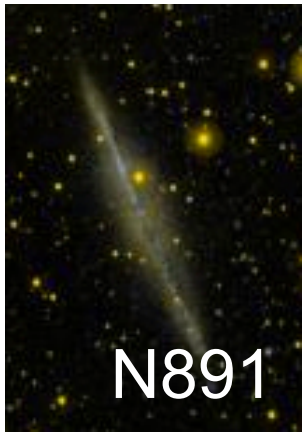
- Overview of goals and structure of the survey
- Spectroscopy
  - CO ladder traces warm H_2 in M82
  - Cooling by CO (and H_2O?) in Arp 220
- Photometry
  - Dust near the superwind in M82
  - M81 radial gradients in SPIRE colours
  - Dust and gas in the disk in Centaurus A

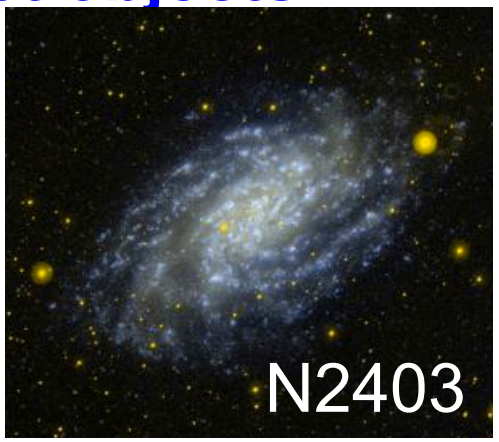
Physical processes in the interstellar medium of nearby galaxies: Science Goals

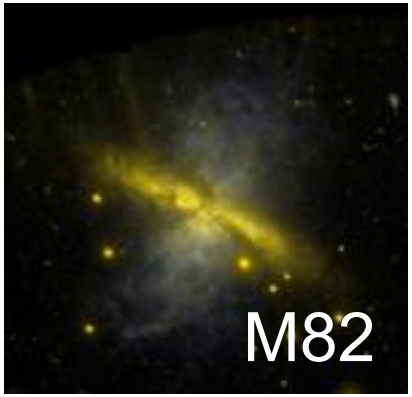
- Physical properties of dust grains
  - Size, composition, temperature, fraction of mass in different components
  - Variation with type of galaxy
- Very cold dust: where is it found?
- Heating and cooling in ISM
  - Dependence of gas heating on G_o/n, heating source for cold dust
- Gas and dust in unusual environments
  - Above the plane, near AGN, mergers/ starbursts

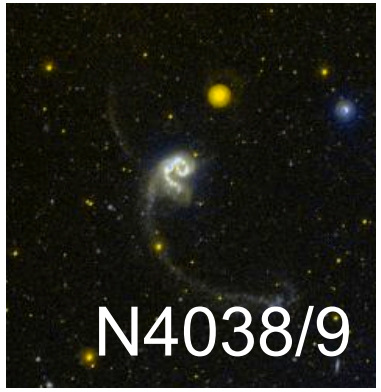
GALEX images of the VNGS target objects

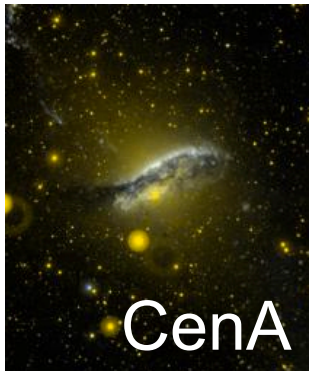


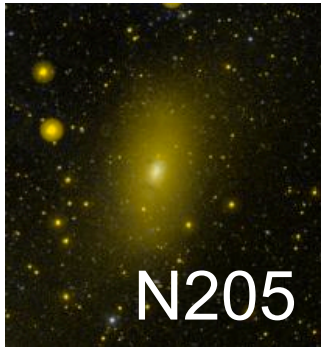












Physical processes in the interstellar medium of nearby galaxies: observing modes

- SPIRE photometric mapping to 1.5 D_{25}
- PACS photometric mapping to 1.5 D_{25}
- SPIRE spectroscopy (FTS) in nucleus and surrounding regions (one pointing)
  - CO ladder, ^{13}CO, [CI], [NII], H2O, etc.
- PACS spectroscopy in region observed with FTS and along a radial strip
  - [CII] at 158 microns
  - [OI] at 63 and 145 microns
  - [OIII] at 88 microns
  - [NII] at 122 and 205 microns

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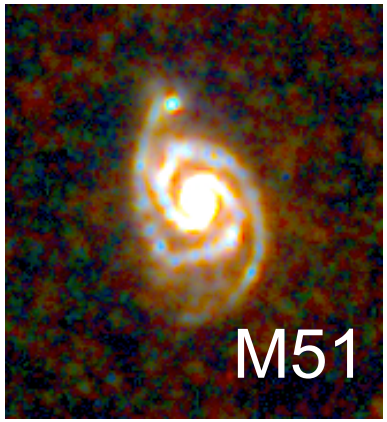
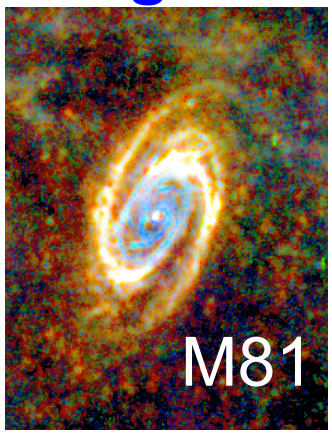
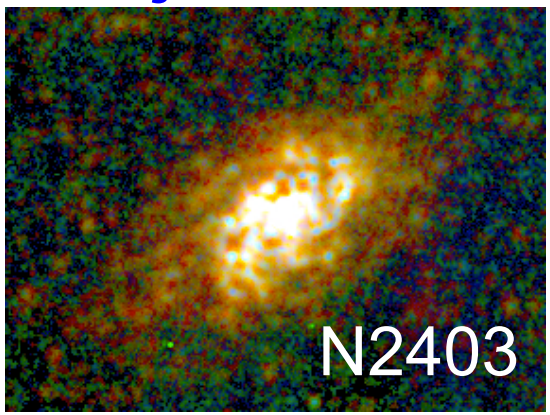
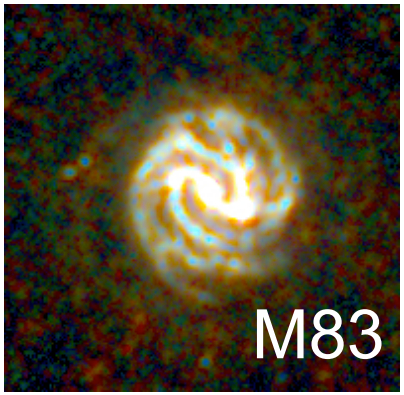
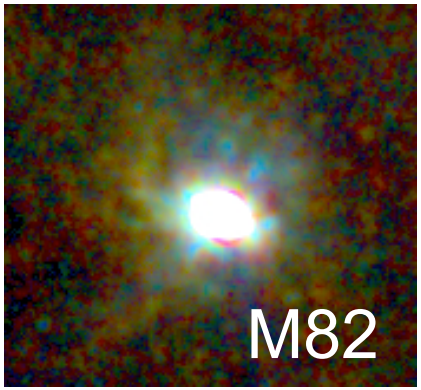
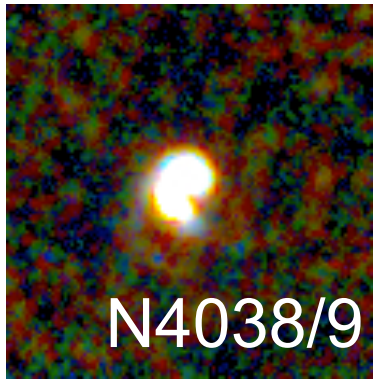


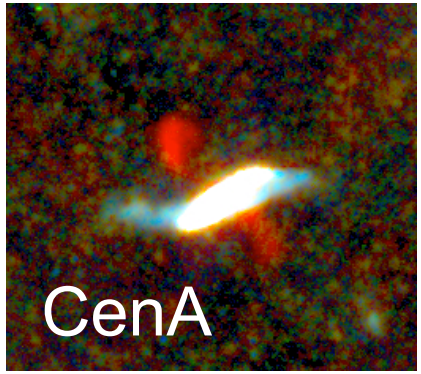


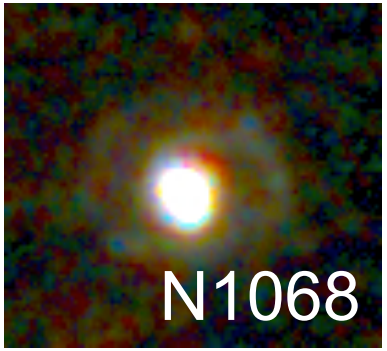


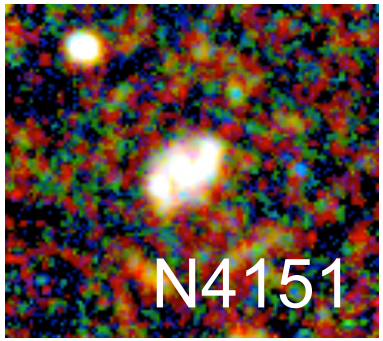


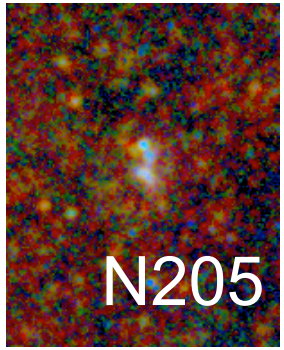


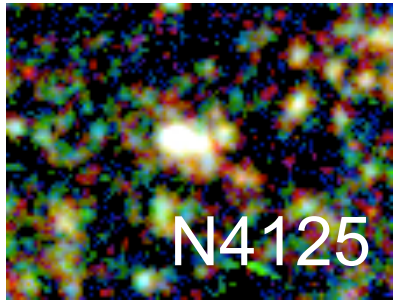






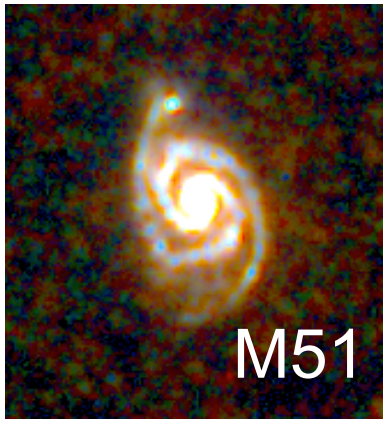


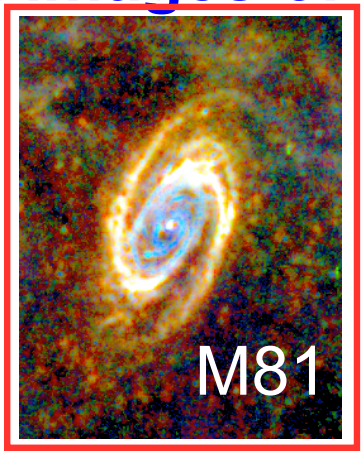


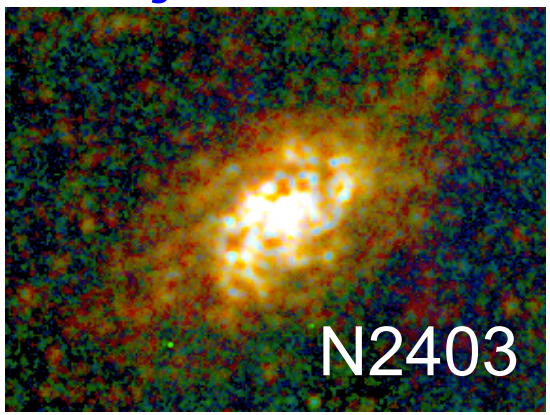


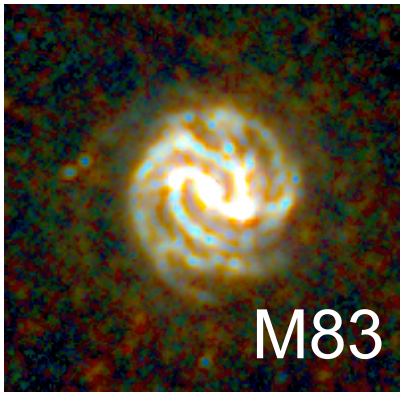
(Figures by L. Corese)

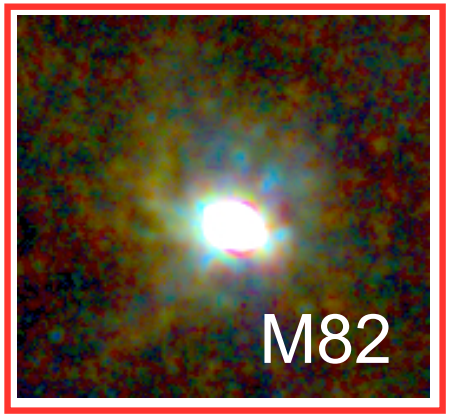
SPIRE images of the VNGS target objects

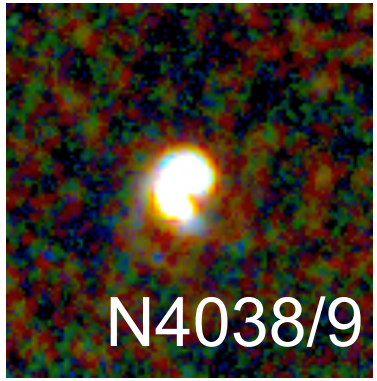


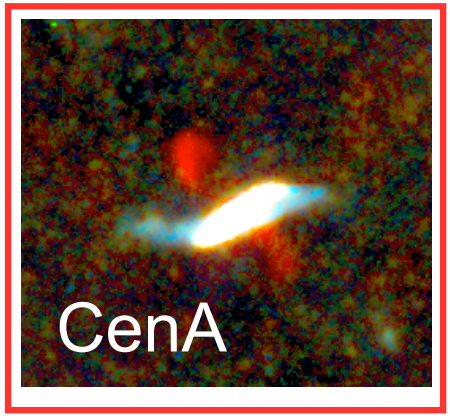


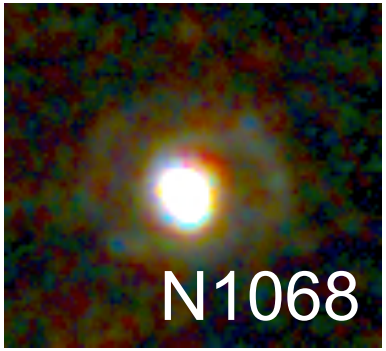


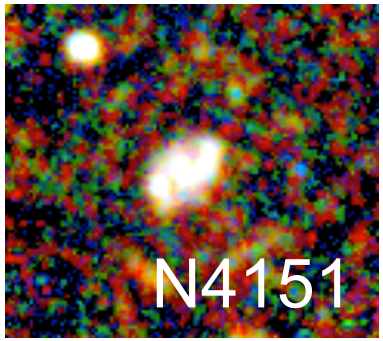


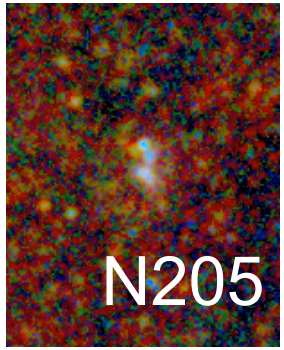


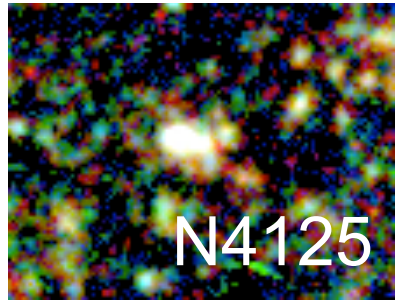






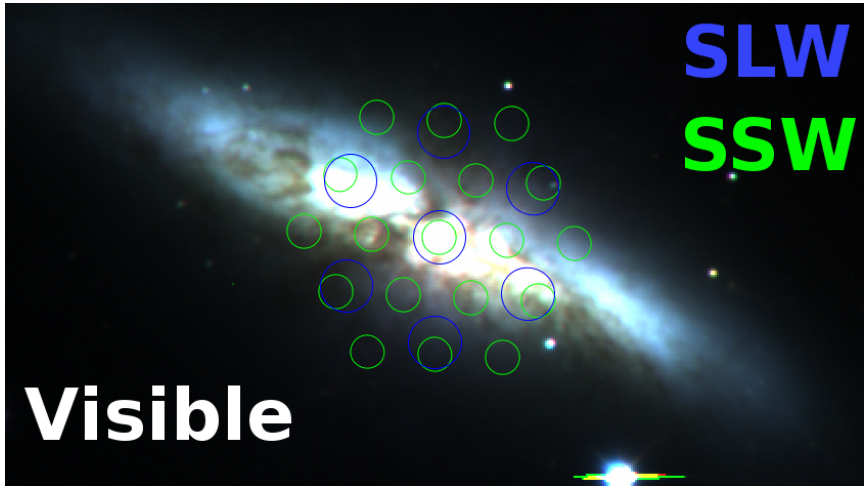


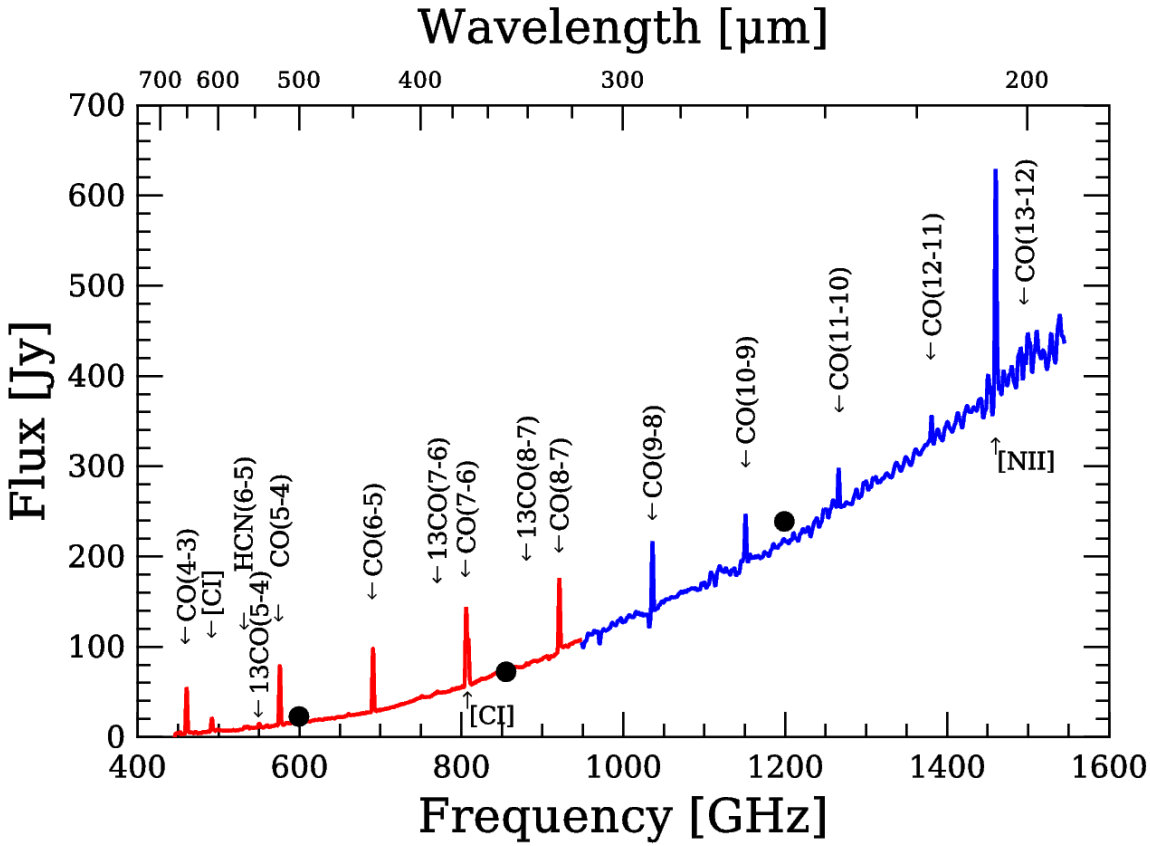




(Figures by L. Corese)

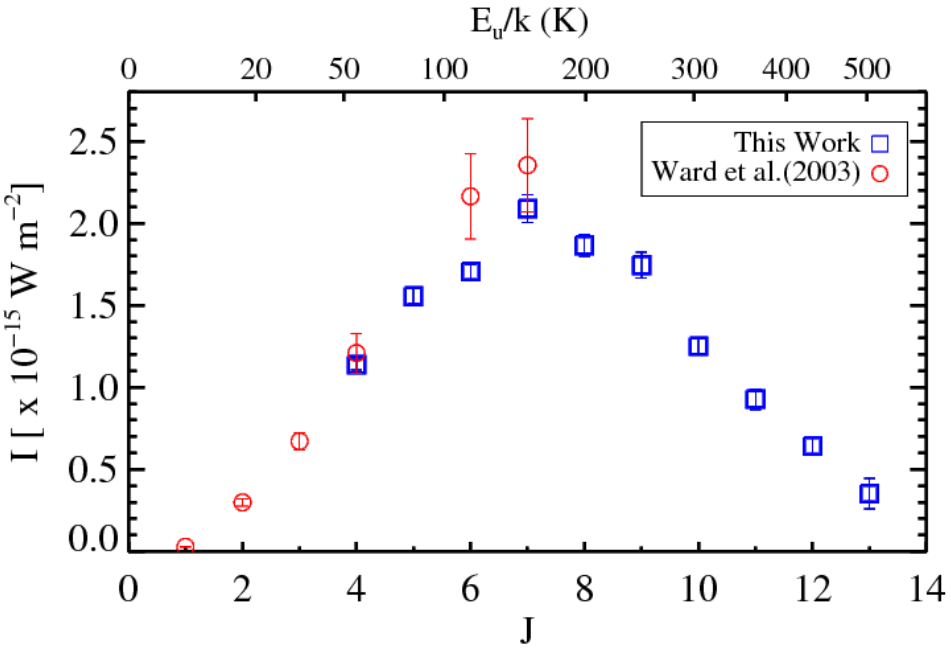
Probing the interstellar medium of M82 (P. Panuzzo et al., 2010, in press)

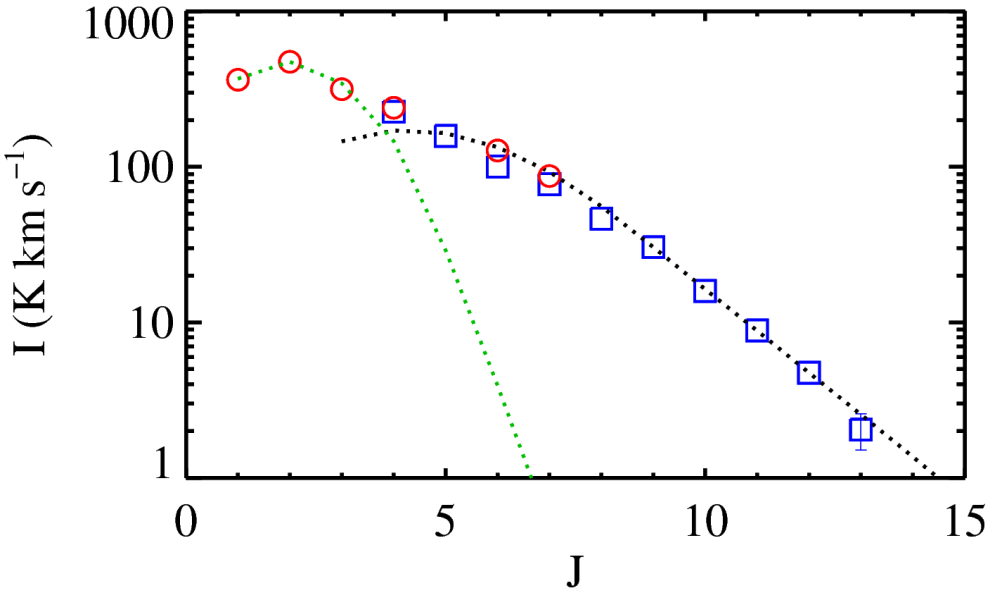




- **Spectrum from central pixel scaled to sample a 43” beam at all wavelengths**

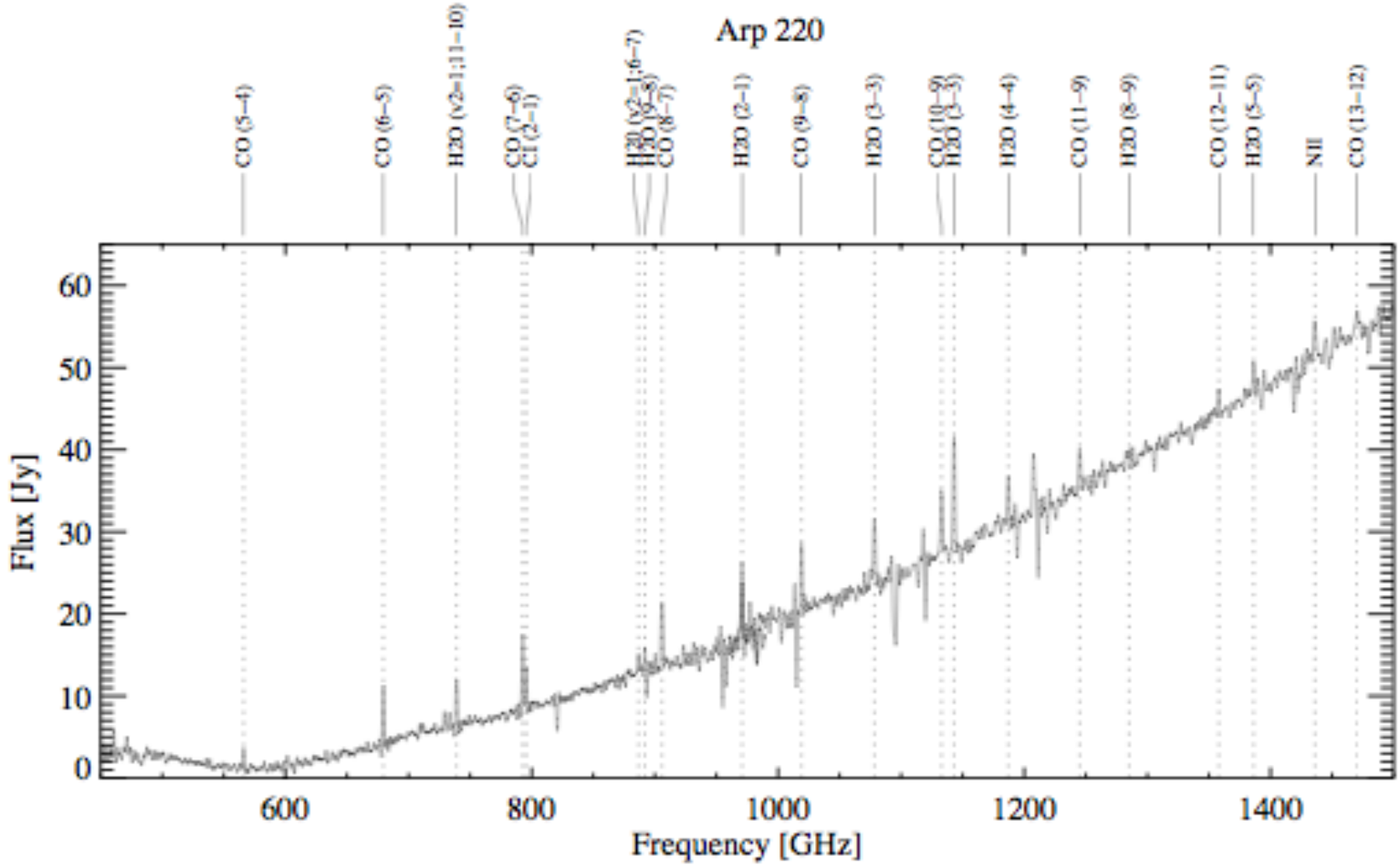
The CO spectral line energy distribution of M82 (P. Panuzzo et al., 2010, in press)





- **Best-fit model has T=545 K and 1.2x10^7 M_o of warm H_2 gas**
  - **warm H2 also seen directly (Beirao et al. 2008)**
- **Low-J lines dominated by cold gas (e.g. Ward et al. 2003)**

Arp 220: CO and Water Lines



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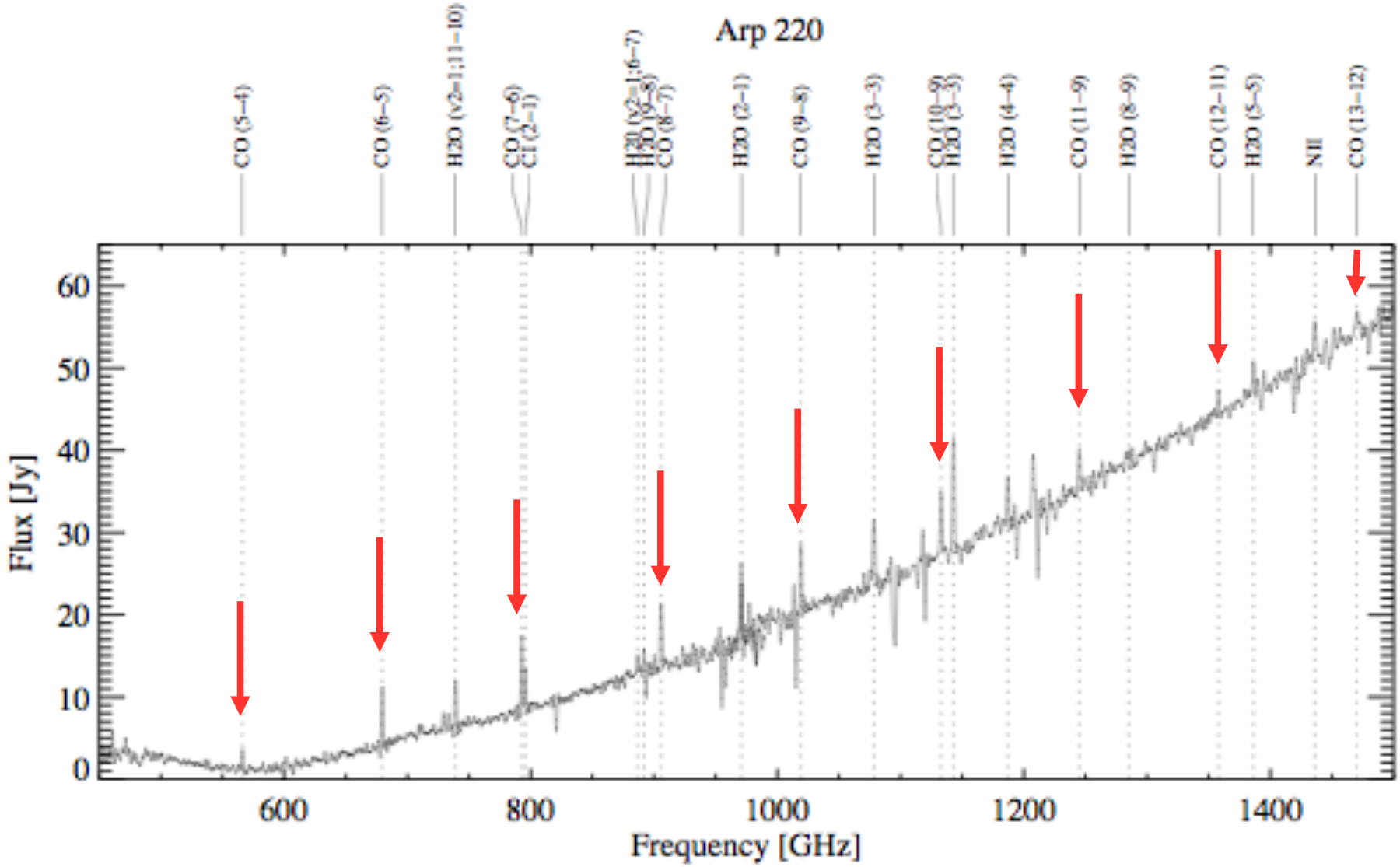

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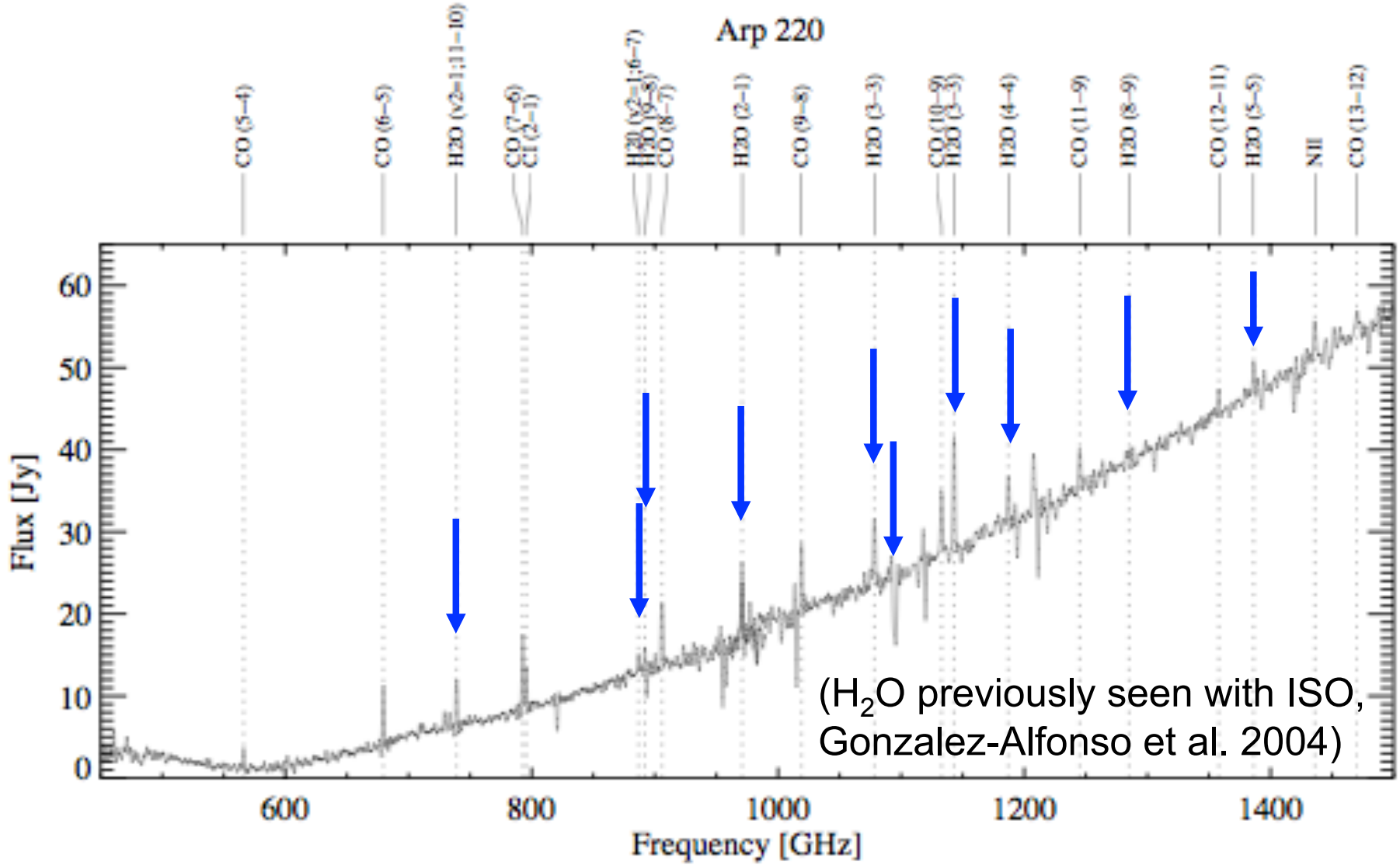
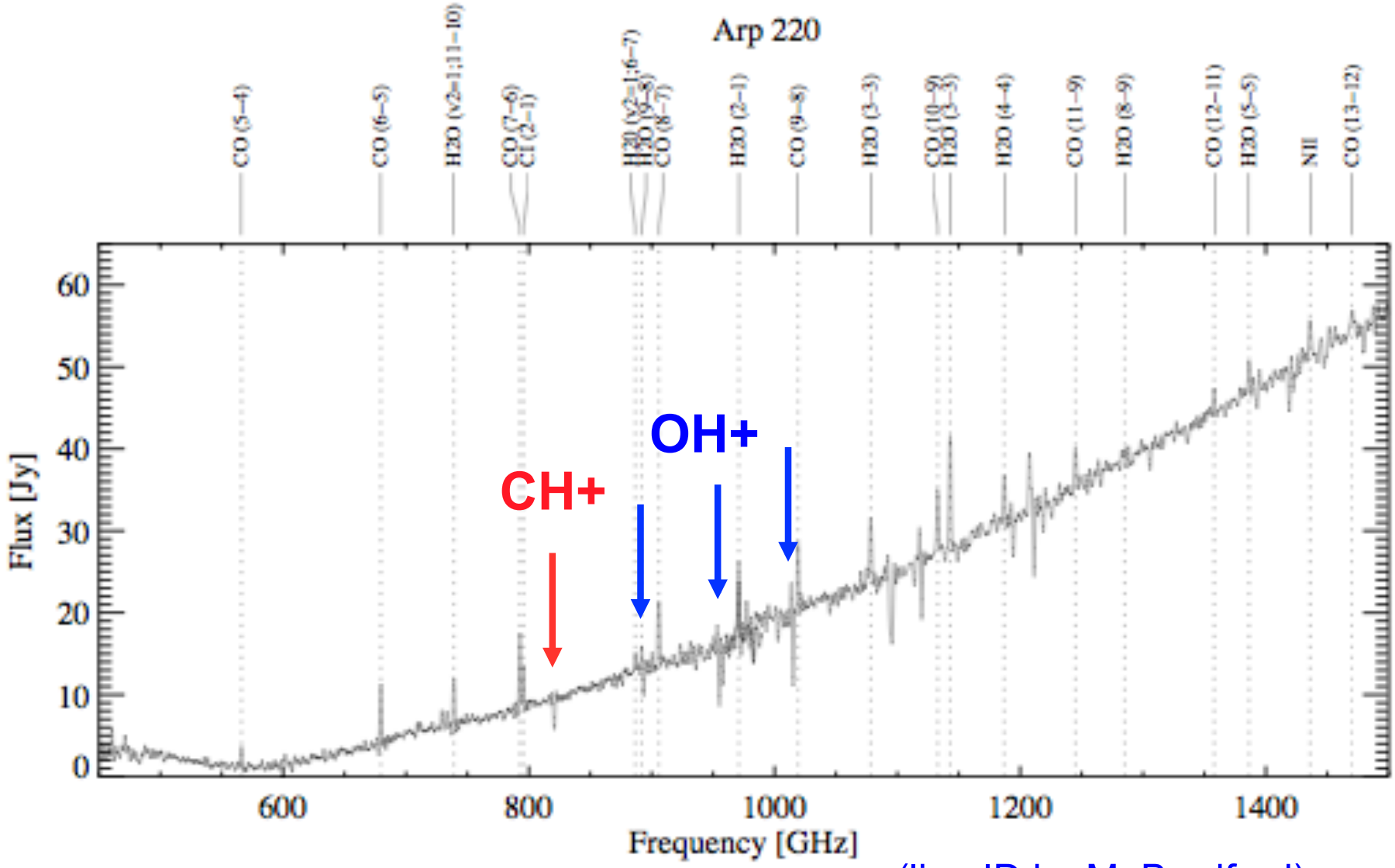
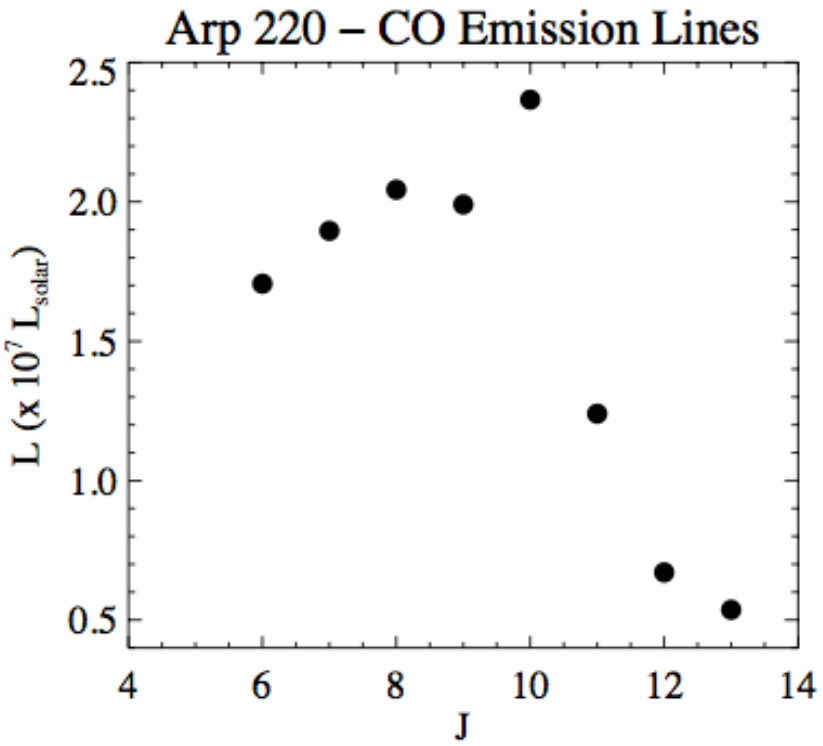


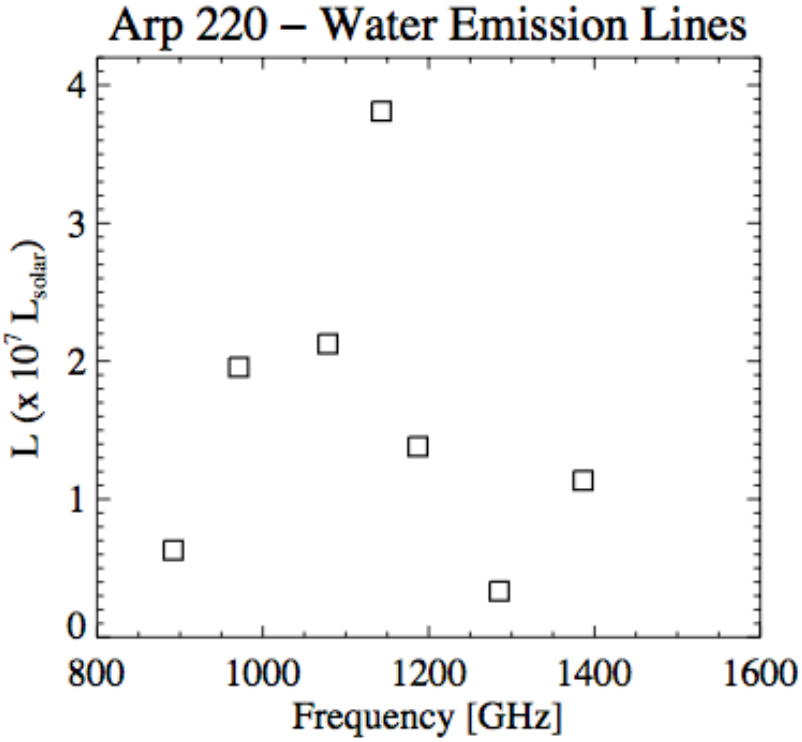
Arp 220: Hydride Lines in absorption



(line ID by M. Bradford)

Strong cooling by water in Arp 220?

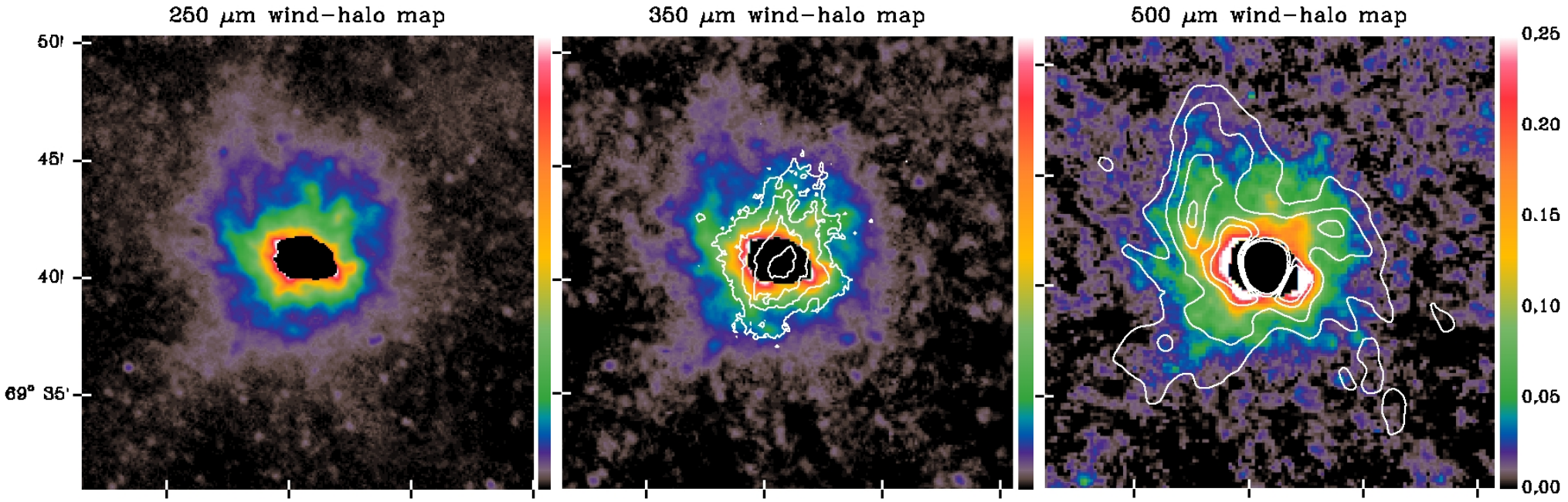




- Cooling by CO is ~ 1x10^8 L_o
  - For comparison, CO cooling in M82 is ~ 5x10^6 L_o
- Cooling by H_2O is ~7x10^7 L_o (unless IR pumped …)

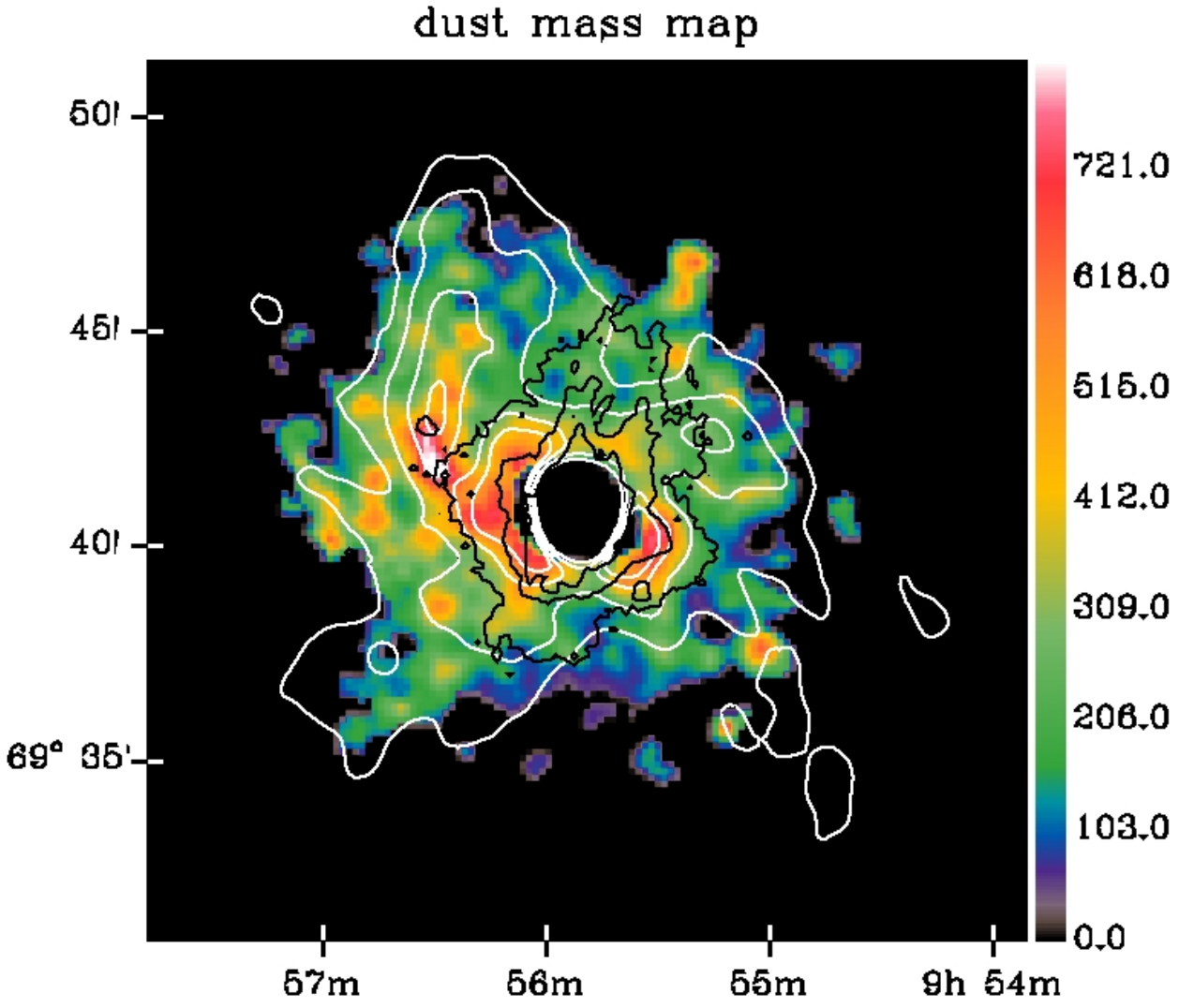
(Figures by N. Rangwala)

Cool dust in the wind and tidal streams of M82 (H. Roussel et al., in press; P2.43)



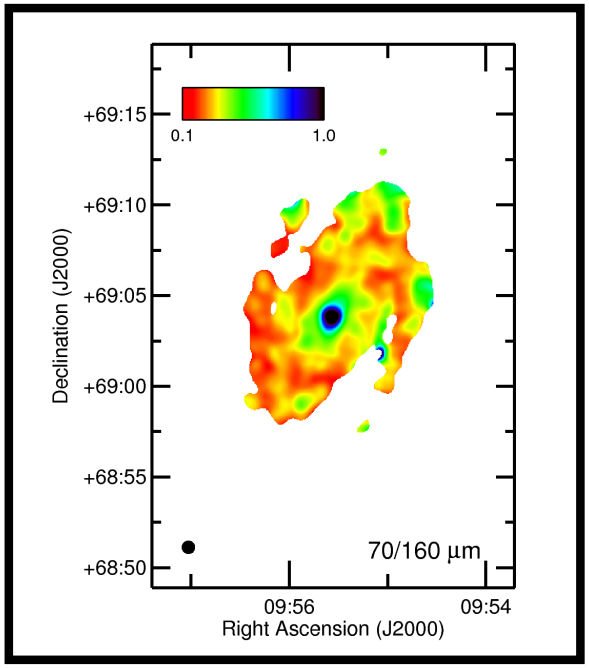
- Emission from central starburst removed
- Contours are Hα+NII (middle, Boselli & Gavazzi 2002) and HI (right, Yun et al. 1994)
- data reduced with Scanamorphos (H. Roussel, in prep)
  - software will be made public very soon

M82: Effects of tides and winds on dust emission (Roussel et al., in press; P2.43)

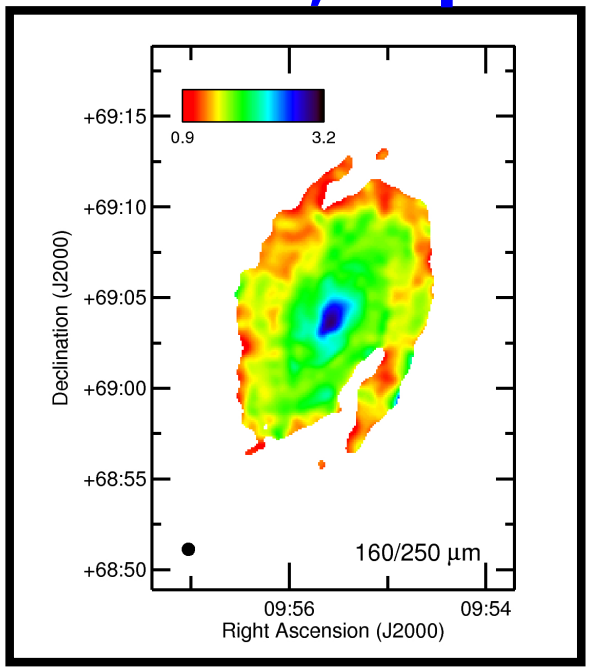


- Mass dominated by dust associated with tidal streams
- Dust in superwind warmer, more diffuse
- Up to 25% of dust ejected from disk

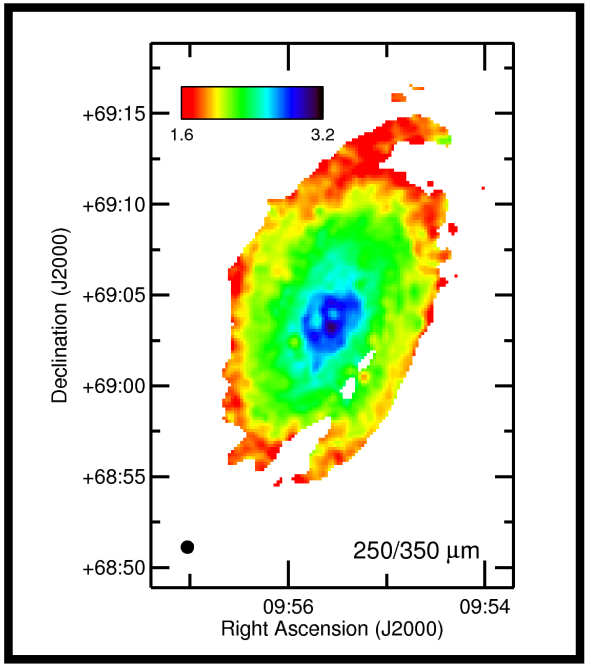
The Herschel Space Observatory View of the 70-500 µm Emission from M81 (G. J. Bendo et al., in press)



70/160 microns



160/250 microns

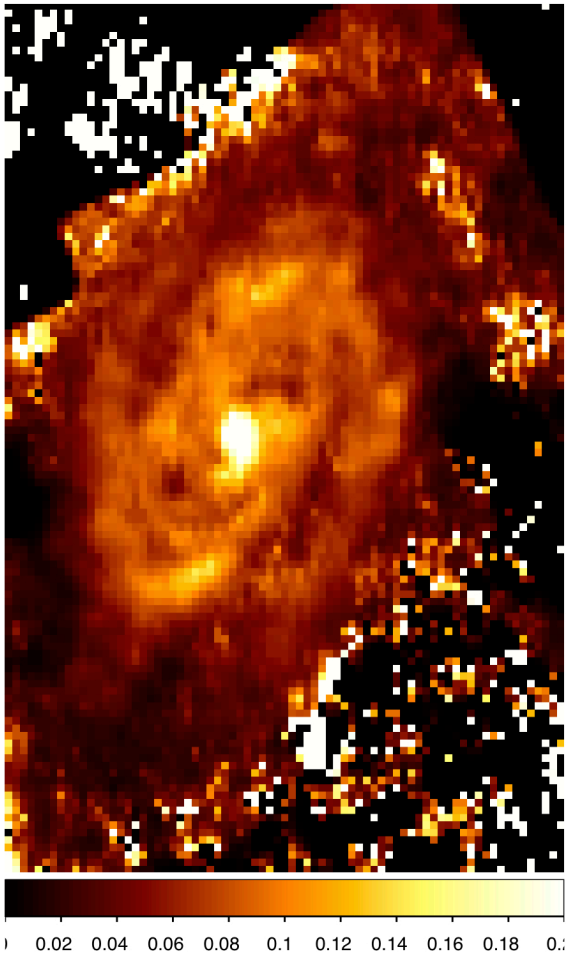


250/350 microns

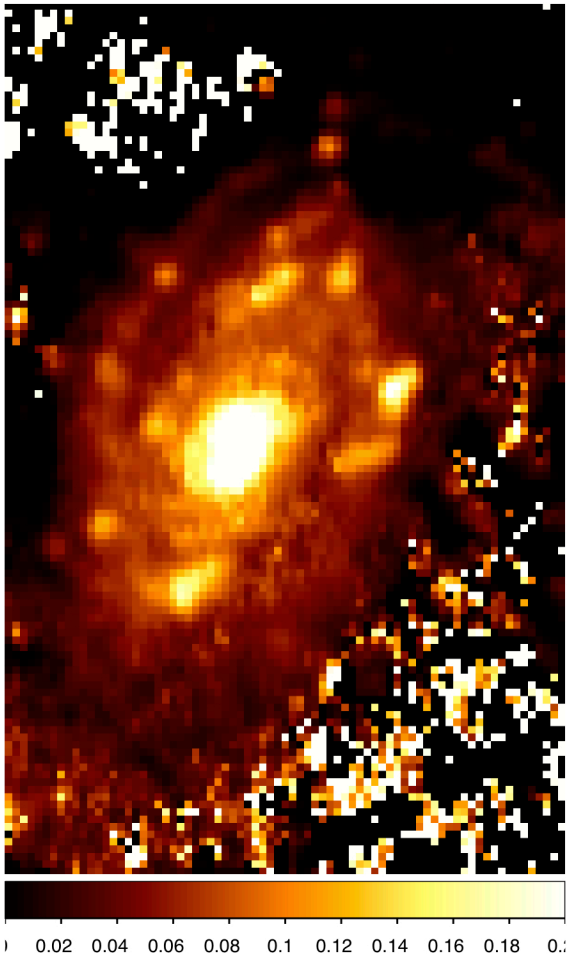
70 µm emission strongly affected by local dust heating (star formation) while 160-500 µm bands are not

- **longer wavelengths primarily trace dust heated by the evolved stellar population in the disk and bulge**

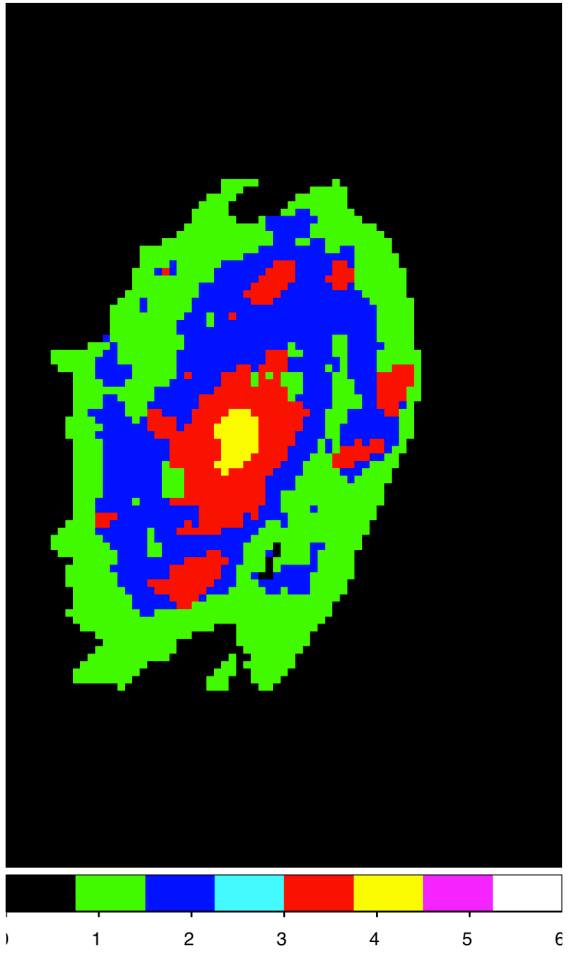
Separating warm and cold PAH in M81 (Lu et al., in prep.)



8/500 micron

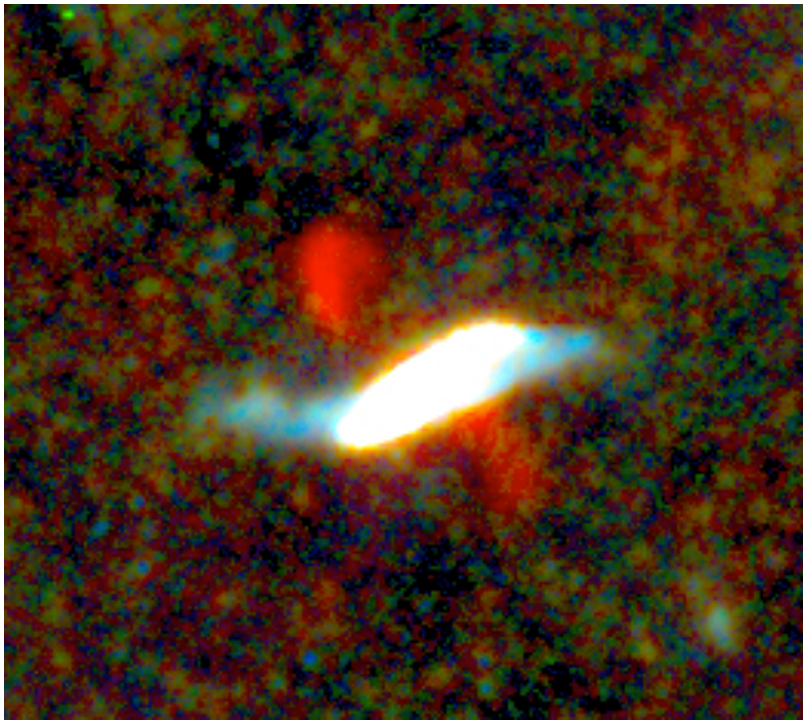


24/500 micron



coding by colours

Dust and gas in the disk in Centaurus A

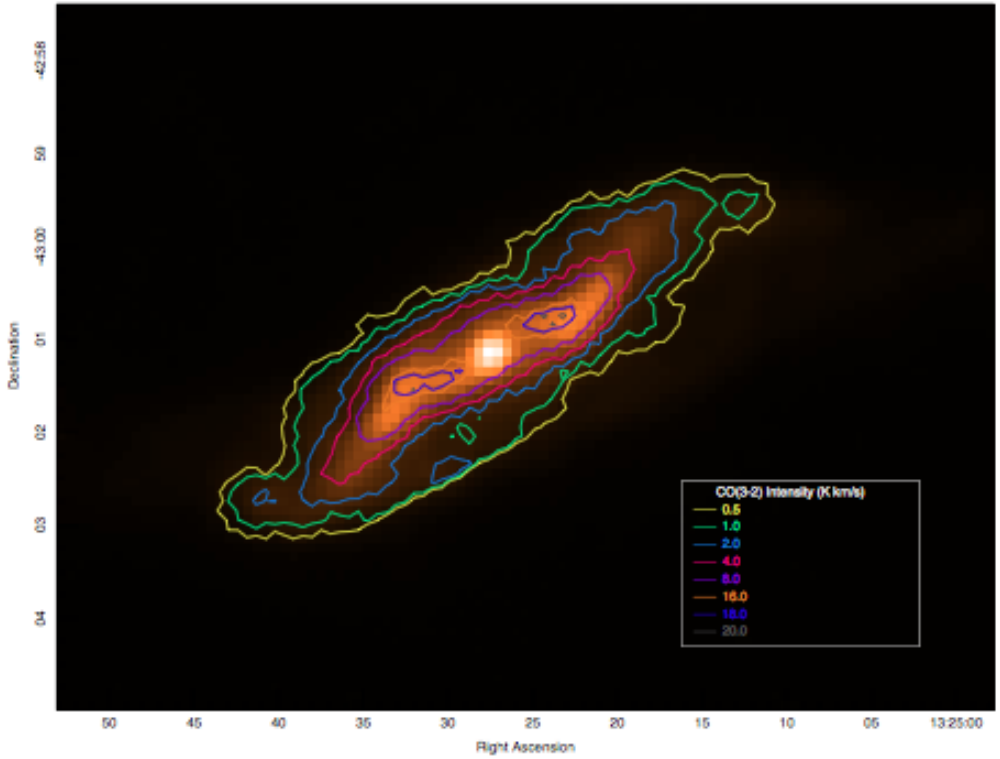


SPIRE 250, 350, 500 micron

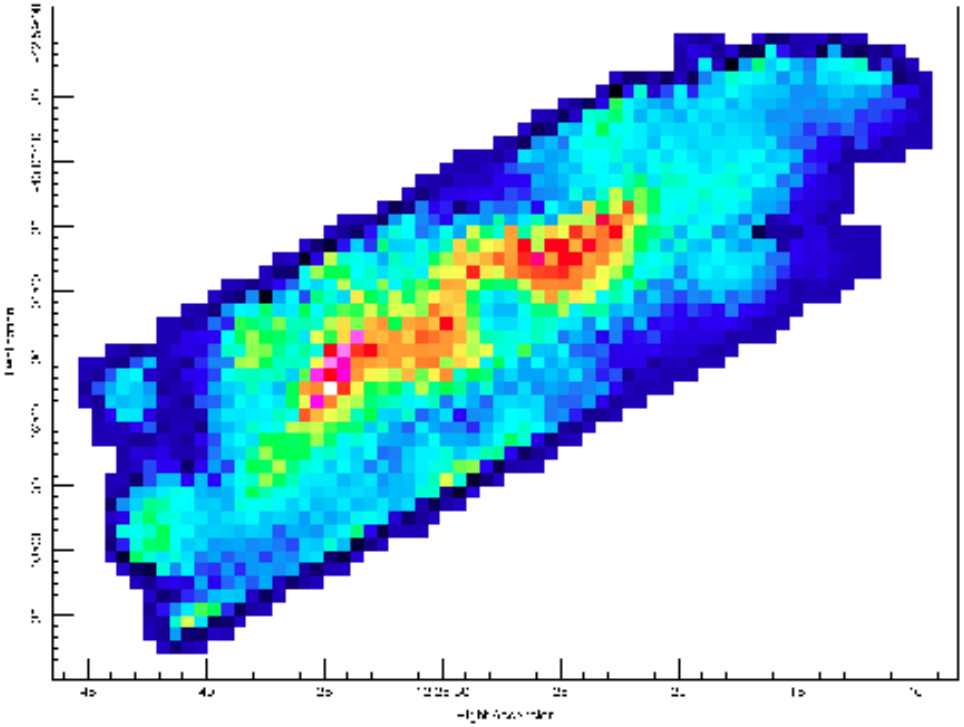
GALEX UV

- **Continuum emission from disk but also from radio jet at longest SPIRE wavelengths**
- **Central source variable in mm (Israel et al. 2008)**

Dust and gas in the disk in Centaurus A



CO 3-2 contours on 250 micron



CO(3-2)/250 micron

- **Radial gradient could be indicating either variation in dust temperature or variation in the gas-to-dust mass ratio**

(Figures by T. Parkin)

Summary

- Significant mass of warm (545 K) molecular gas in M82 traced by high-J CO lines
- In Arp 220, cooling by water lines is comparable to cooling by CO lines
- Different heating sources for warm and cool dust in M81
- More dust ejected by tidal processes than by the superwind in M82
- Continuum traces radio jet as well as dust in Cen A

More exciting results (especially spectroscopy) to come soon!