First Results from the Very Nearby Galaxies Survey

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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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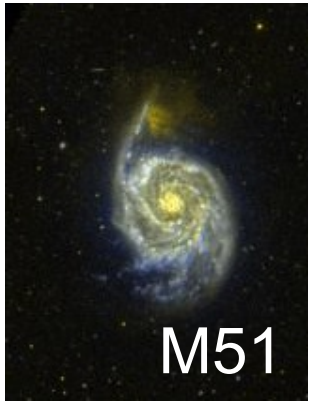
Outline of talk

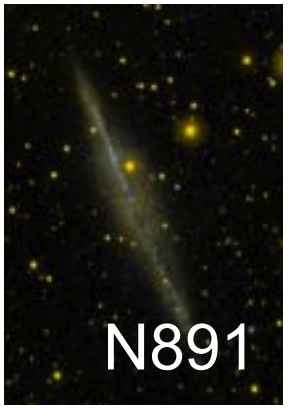
- Overview of goals and structure of the survey
- Spectroscopy
  - CO ladder and spatially extended line emission in M82
  - Thermal water in emission and absorption in Arp 220
- Photometry
  - M81 radial gradients in SPIRE colours
  - Tidal debris or Galactic cirrus?

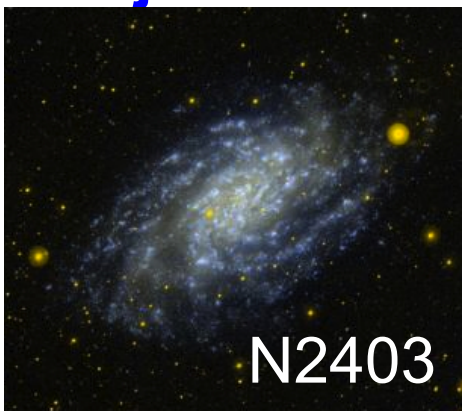
Physical processes in the interstellar medium of nearby galaxies: Science Goals

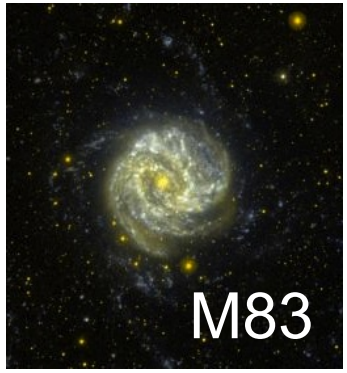
- Physical properties of dust grains
  - Size, composition, temperature, fraction of mass in different components
  - Variation with type of galaxy
- Very cold dust: where is it found?
- Heating and cooling in ISM
  - Dependence of gas heating on G_o/n, heating source for cold dust
- Gas and dust in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

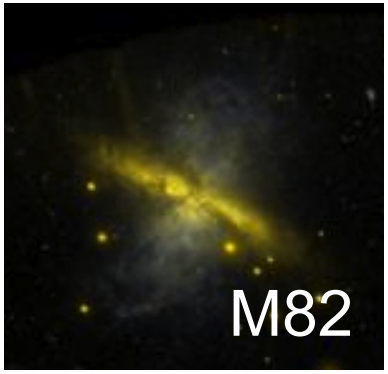
GALEX images of the VNGS target objects

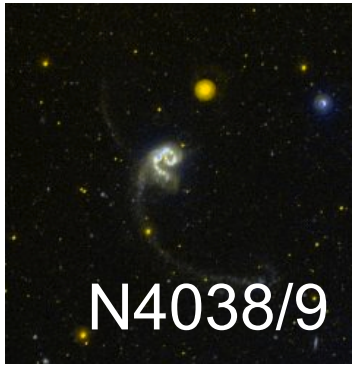


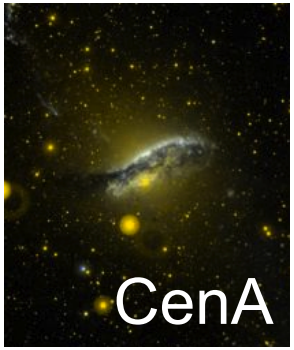


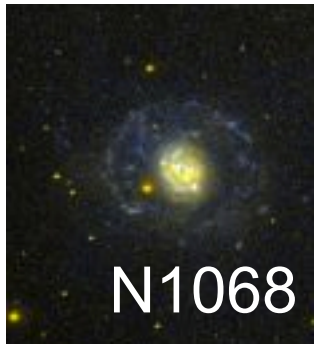


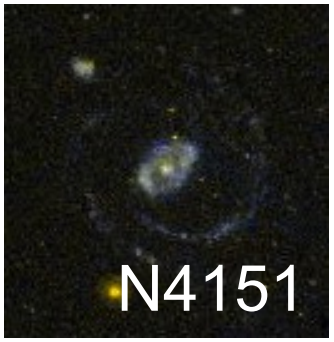


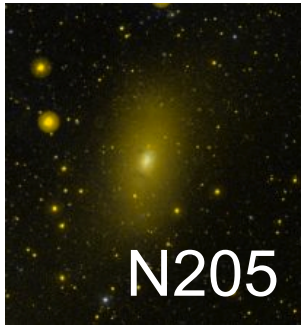












Physical processes in the interstellar medium of nearby galaxies: observing modes

- 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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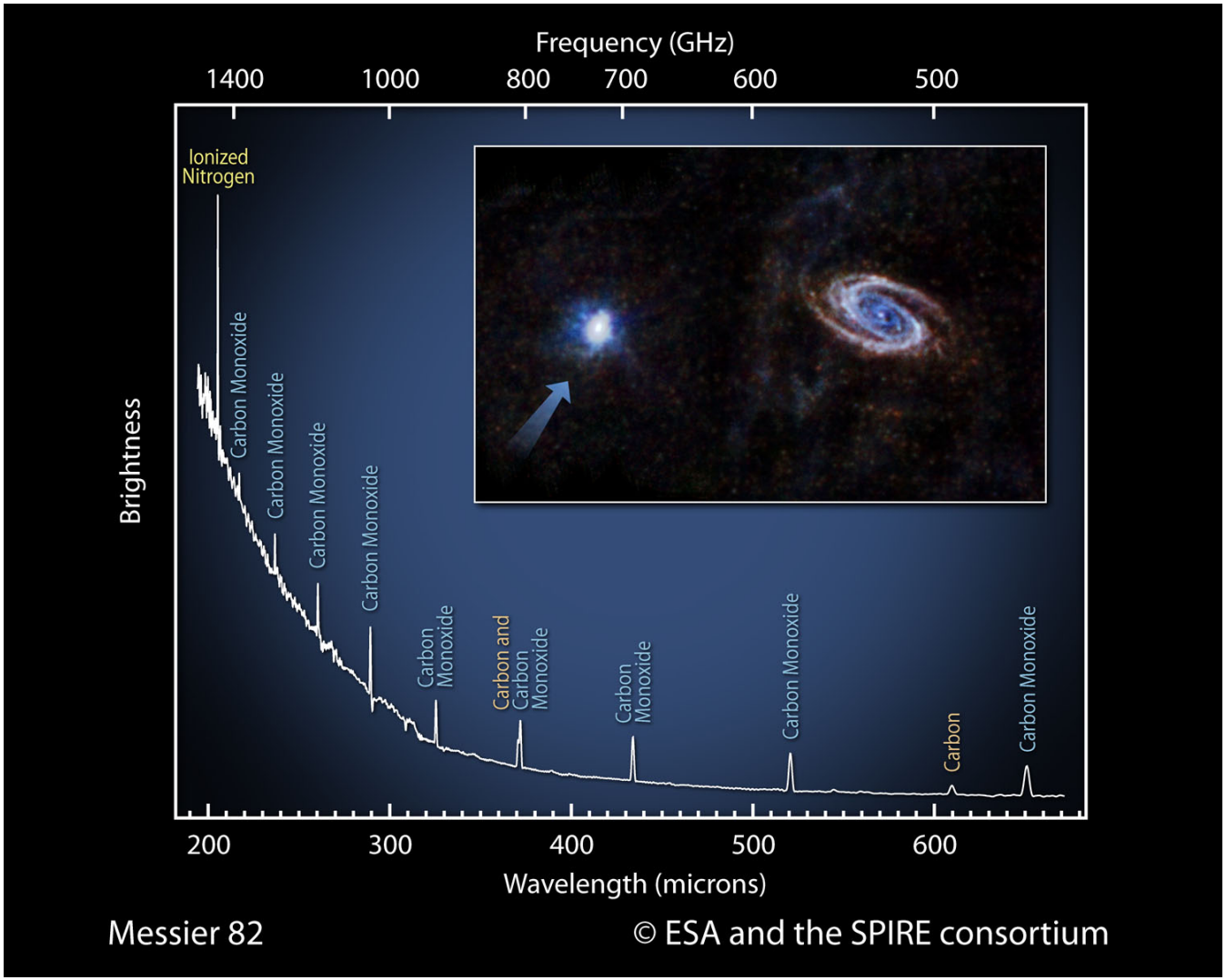
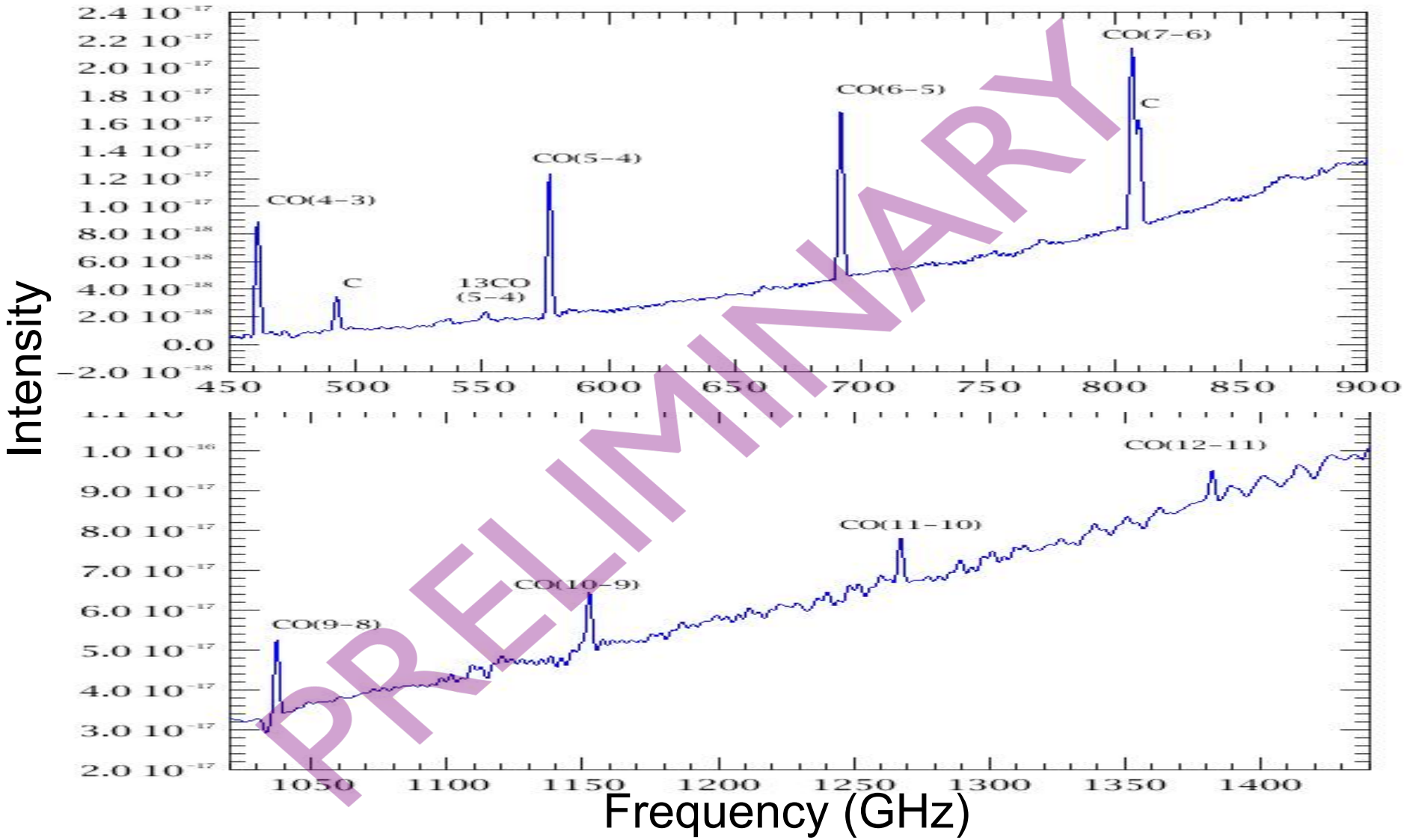
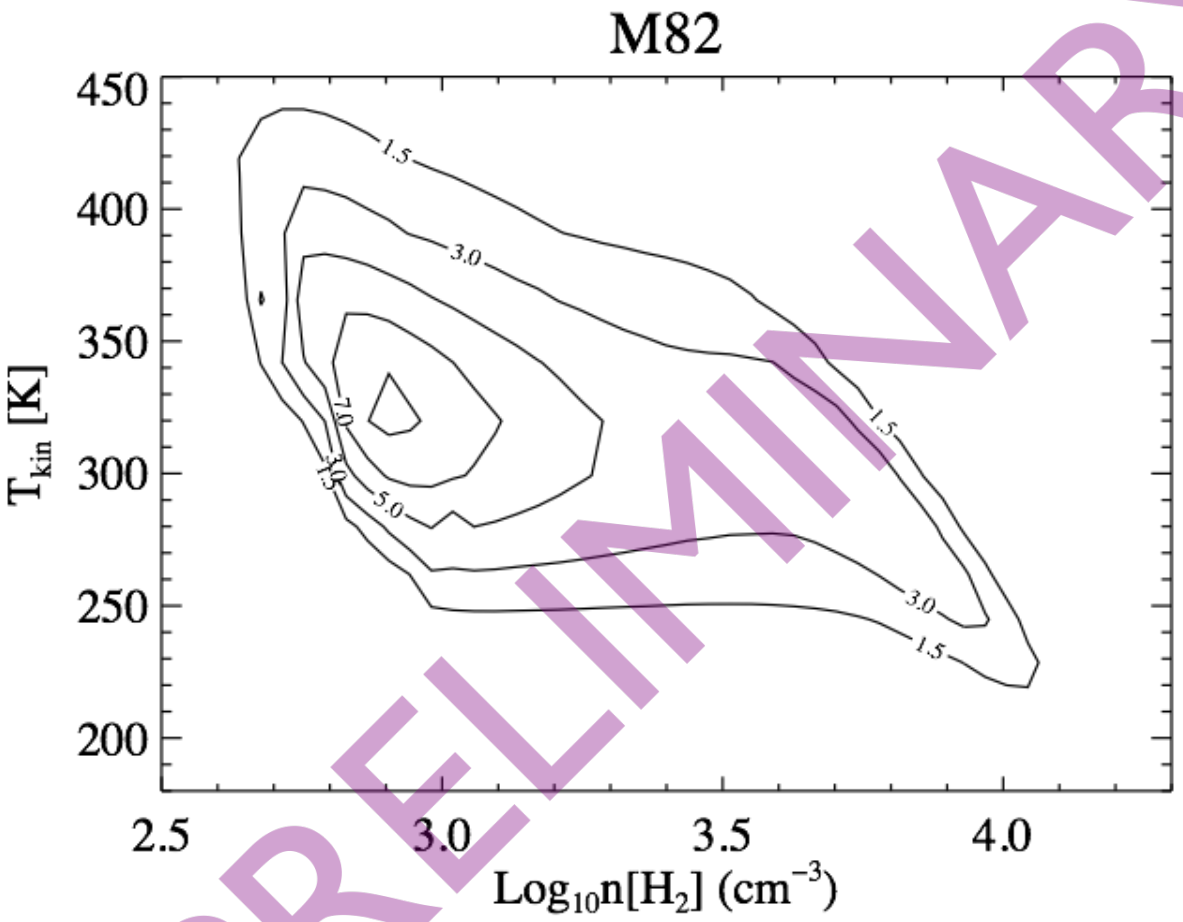
M82 Spectroscopy with SPIRE FTS



A Complete Spectrum from 200 to 600 microns



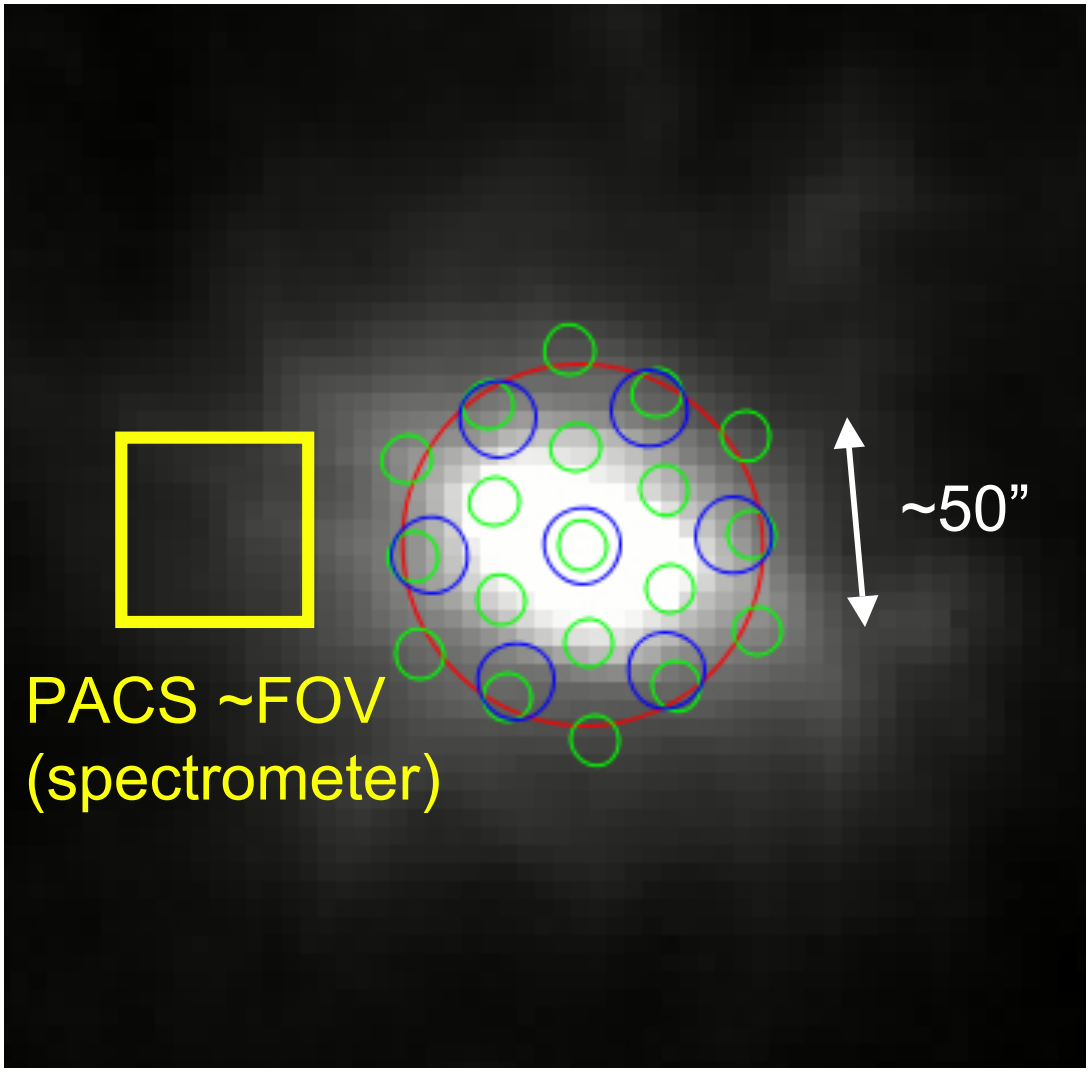
Radiative Transfer Modeling of M82



Panuzzo, P., Rangwala, N., Glenn J., Issak, K., Wilson, C., et al.

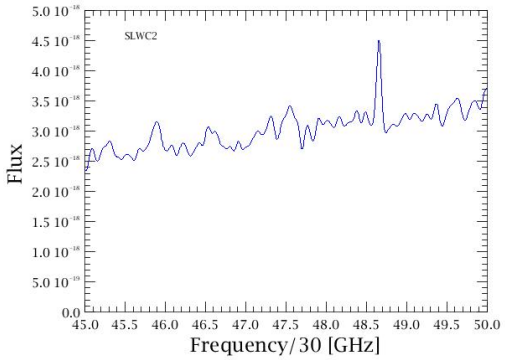
- Lines used: ^{12}CO ladder from J=4 to J=12
- Fixed beam sizes used for SLW (25”) and SSW (19.6”)
- Central pixel only
- Single component model
- Preferred P/k = nT ~ $2.5x10^5$ K cm^{-3}
- P/k is order of magnitude larger under assumption o flarger filling factor from emitting regions
- Presence of warm gas indicated in M82

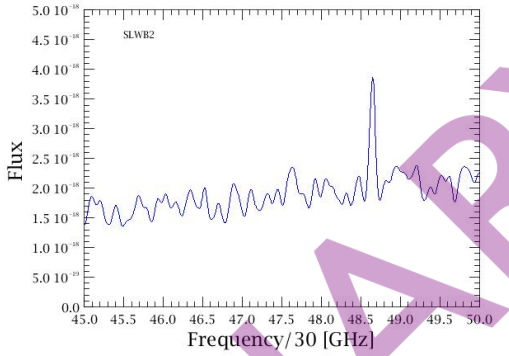
Imaging M82 with the SPIRE FTS

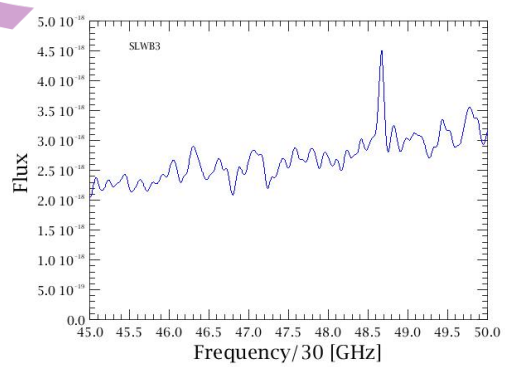


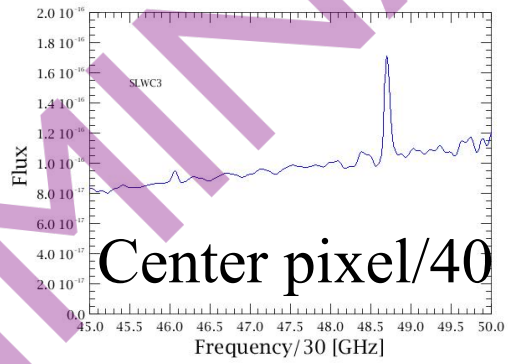
Background image: SPIRE 250 microns

Extended [NII] in M82

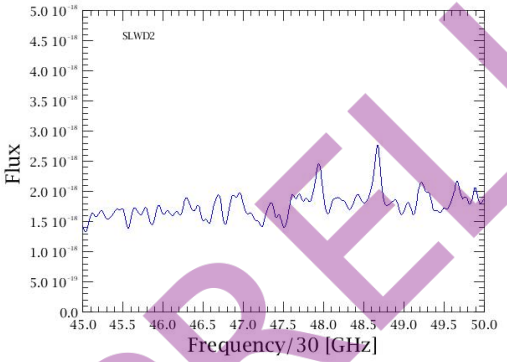


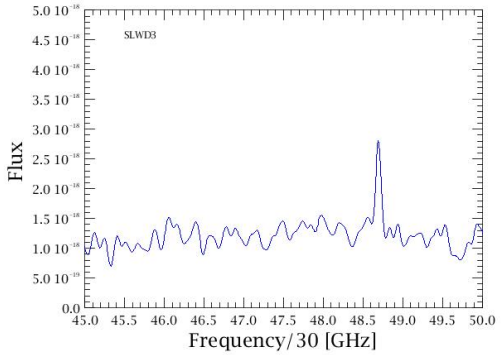


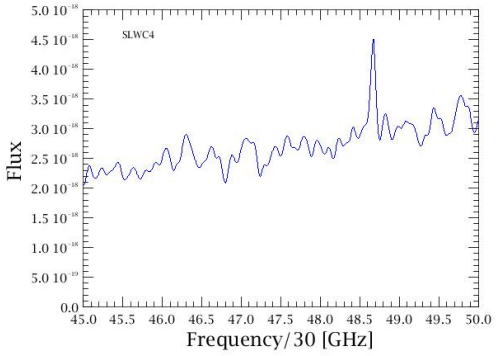




Center pixel/40



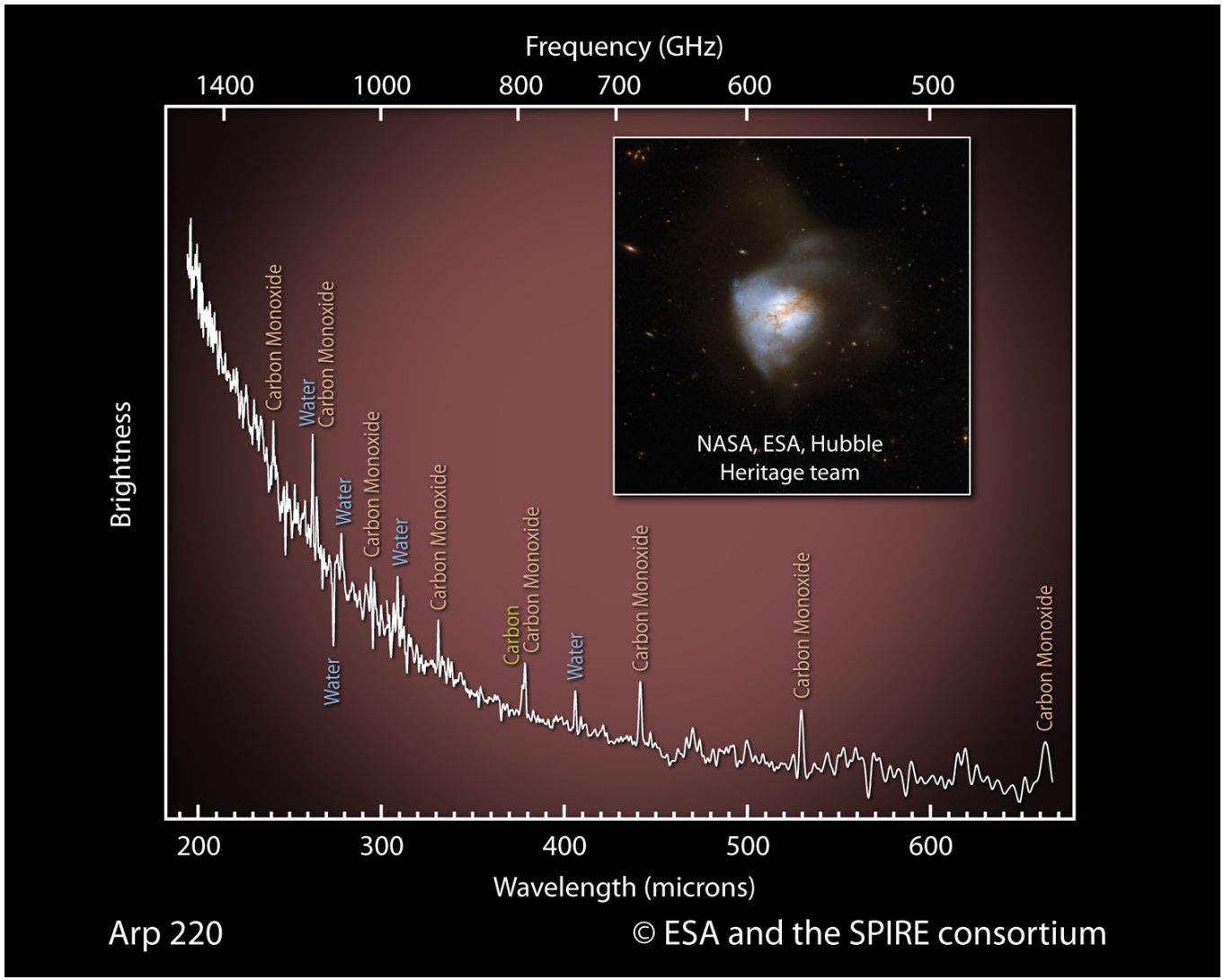




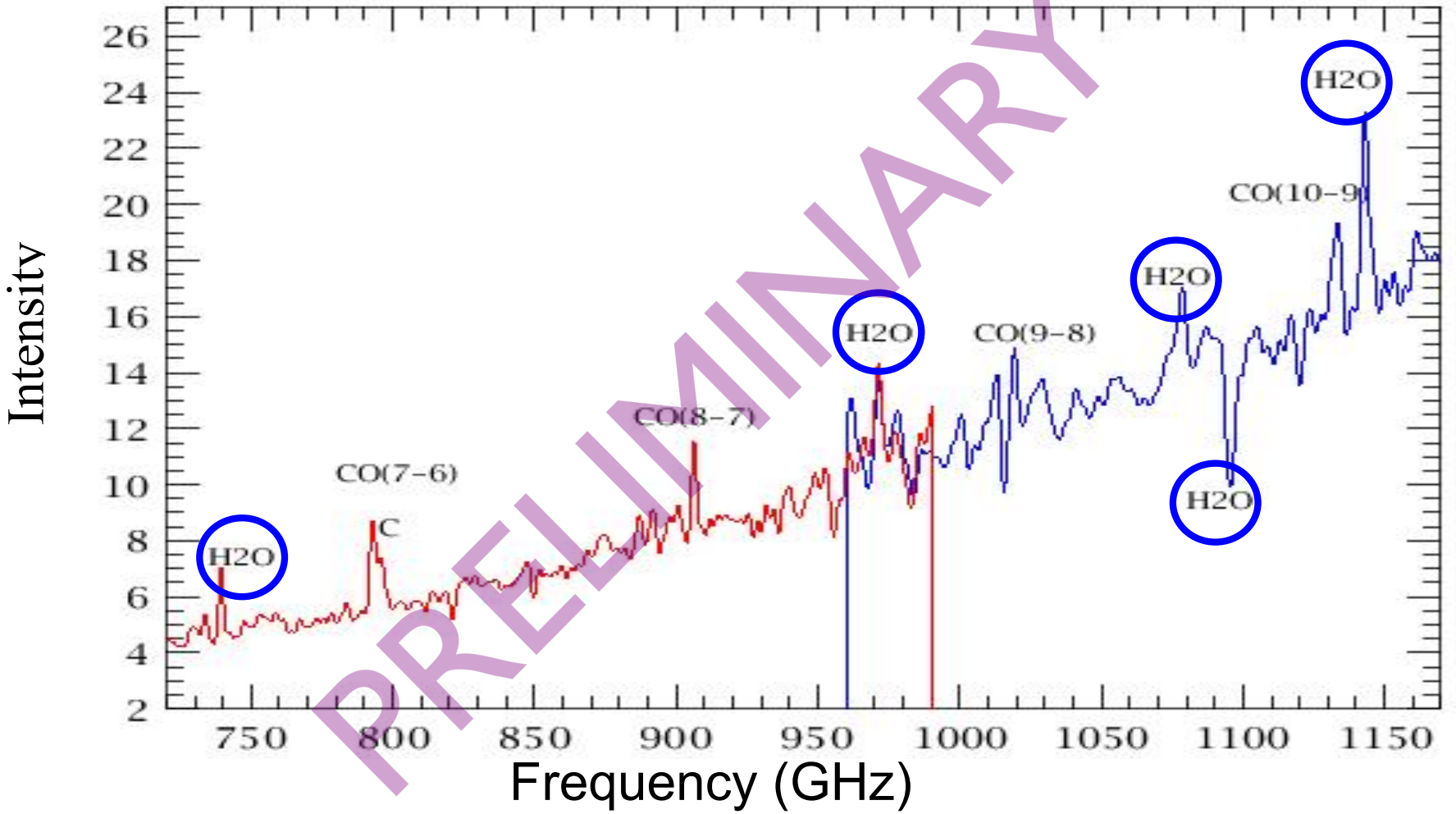
50”

Approx. Beam FWHM

Arp 220: Thermal Water Emission

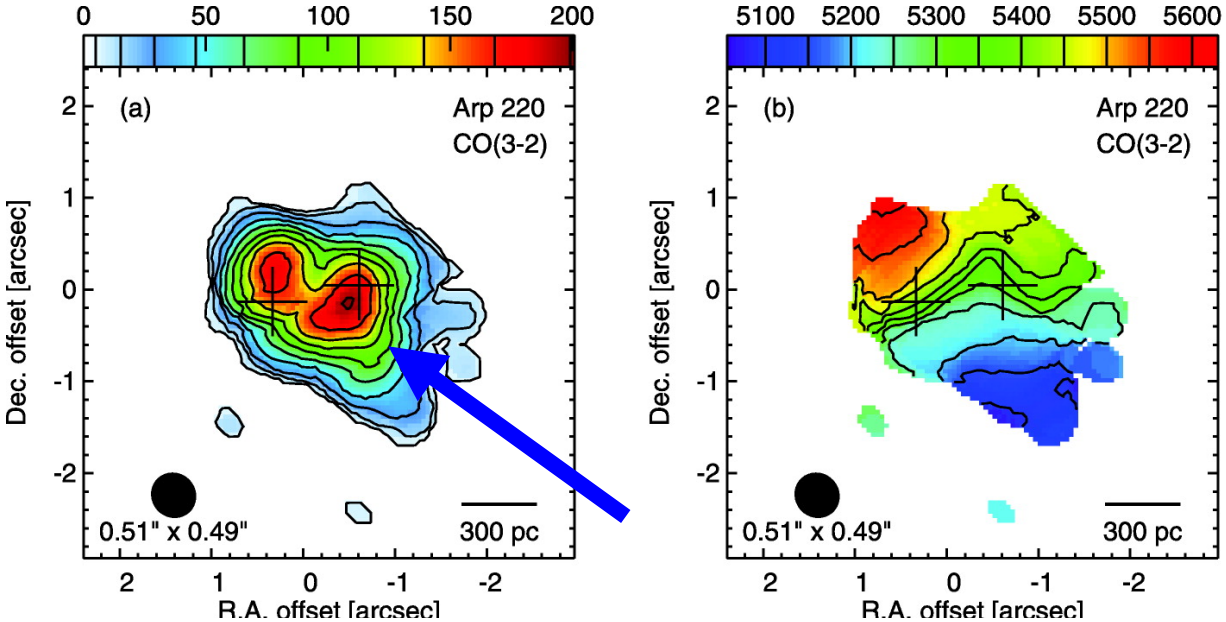


Arp 220: a rich molecular spectrum



Results for water in Arp 220

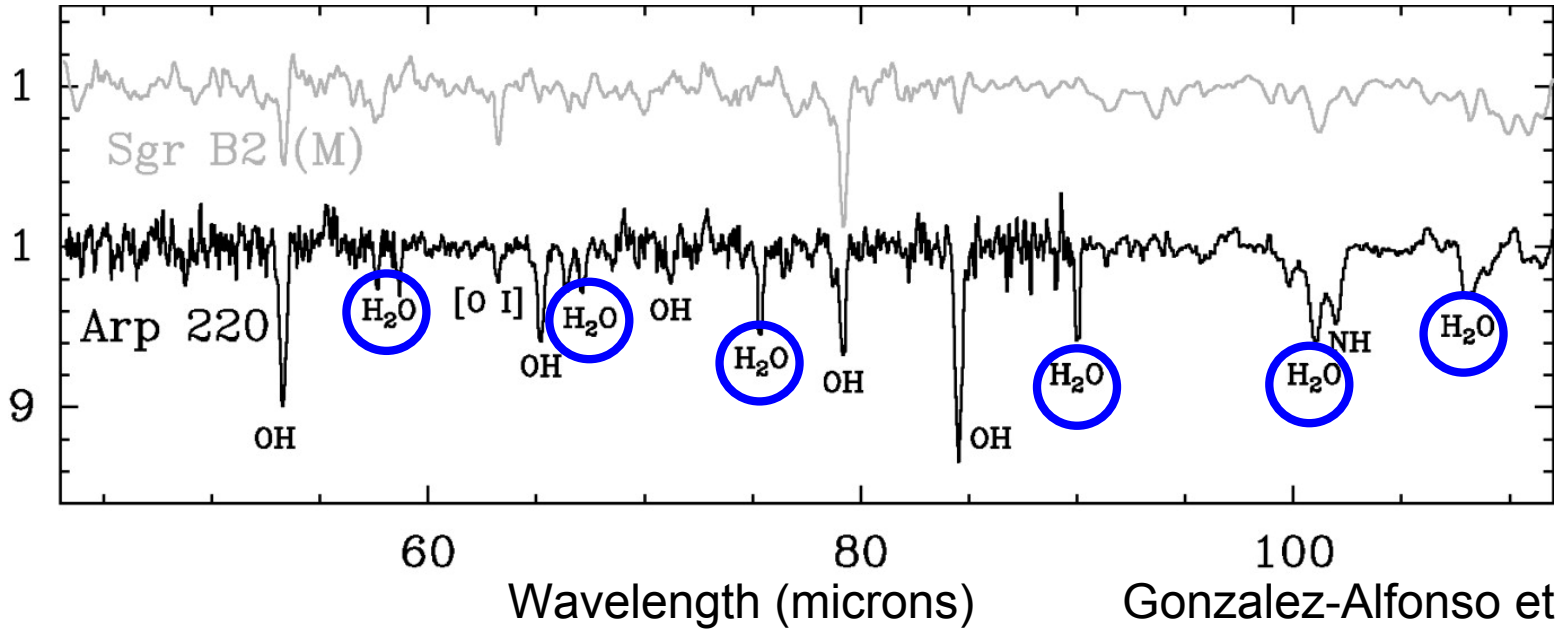
- Detect 7 of 8 water lines between 600 and 1210 GHz
  - only line not detected is the weakest (SPLATALOGUE)
- Mean redshift of H_2O lines 0.01790 or 5370 km/s
  - Blueshift suggests emission coming from the western nucleus, which is also brighter in continuum



SMA image
Sakamoto
et al. 2008

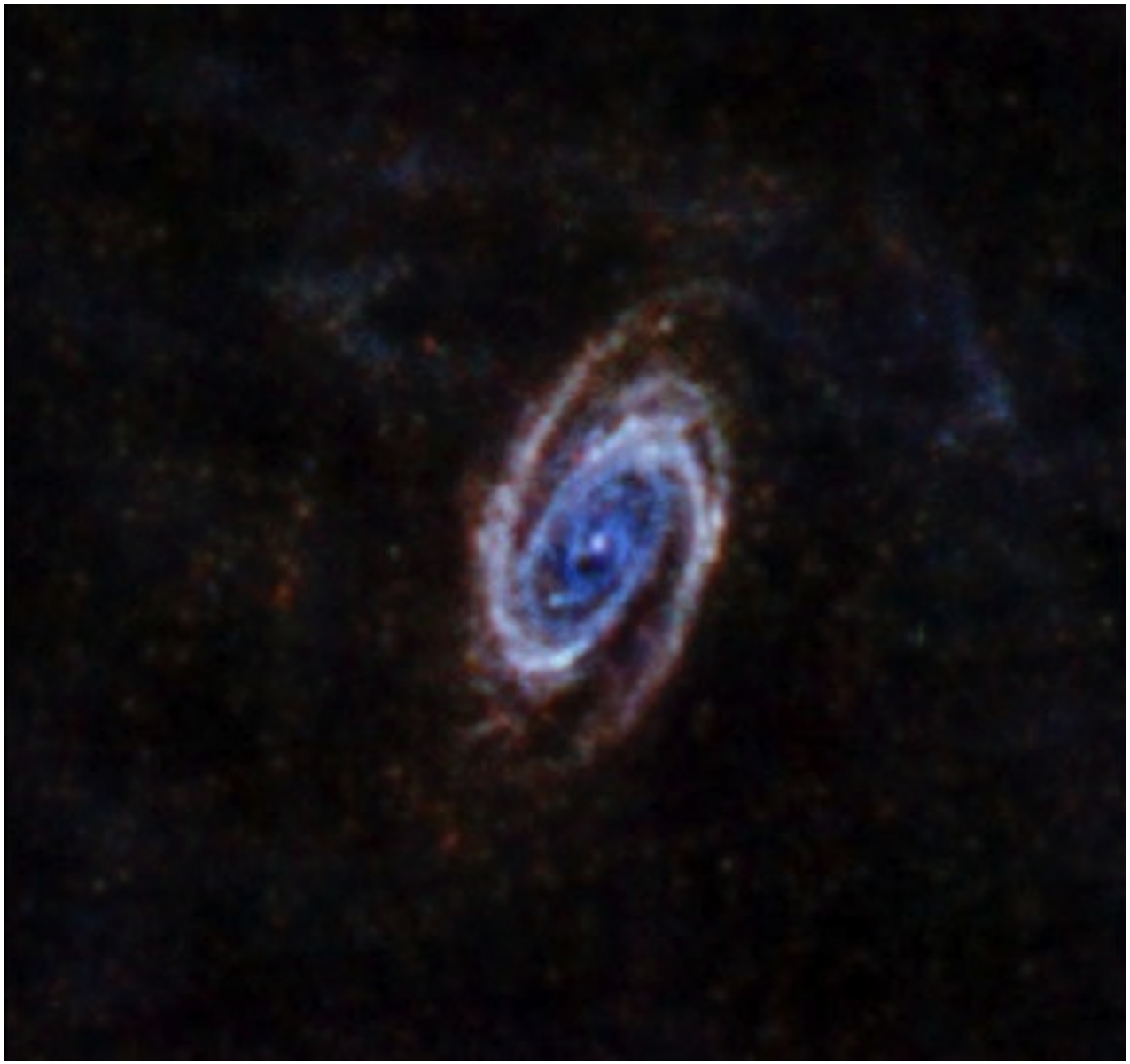
Results for water in Arp 220

- Ground-state line is in absorption and appears broadened
- Remaining lines are in emission
  - Interesting contrast to ISO data, where H_2O in this galaxy always seen in absorption
- Combination with ISO and PACS data will pinpoint temperature

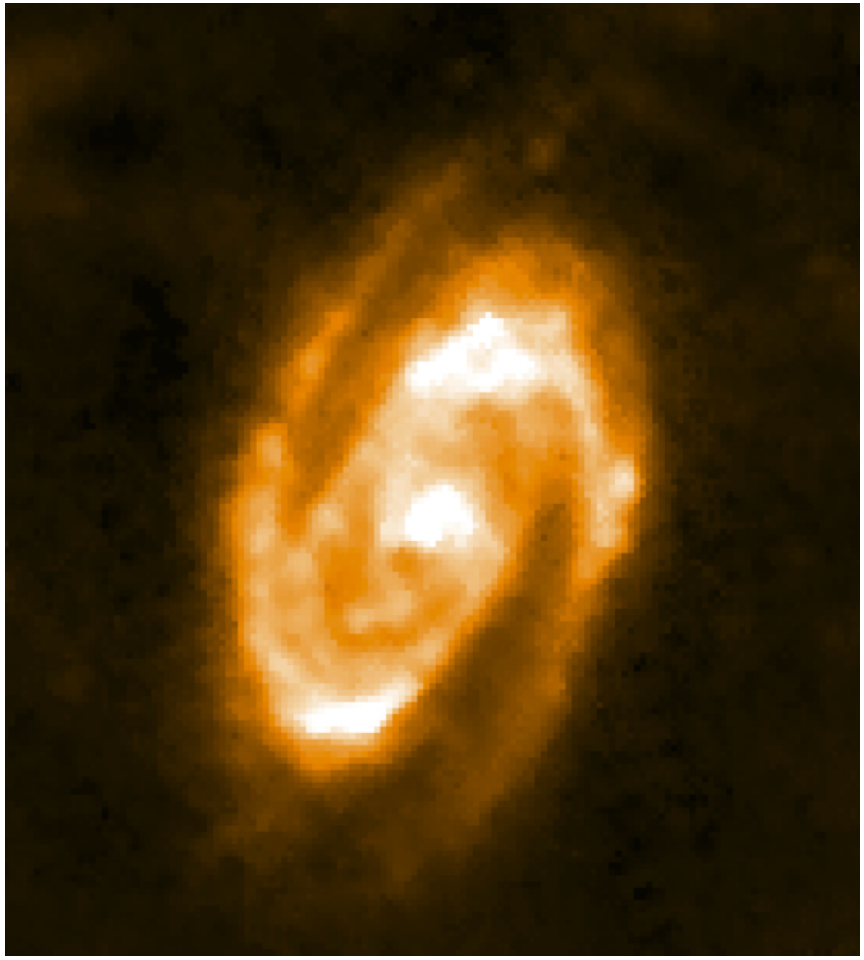


Gonzalez-Alfonso et al. 2004

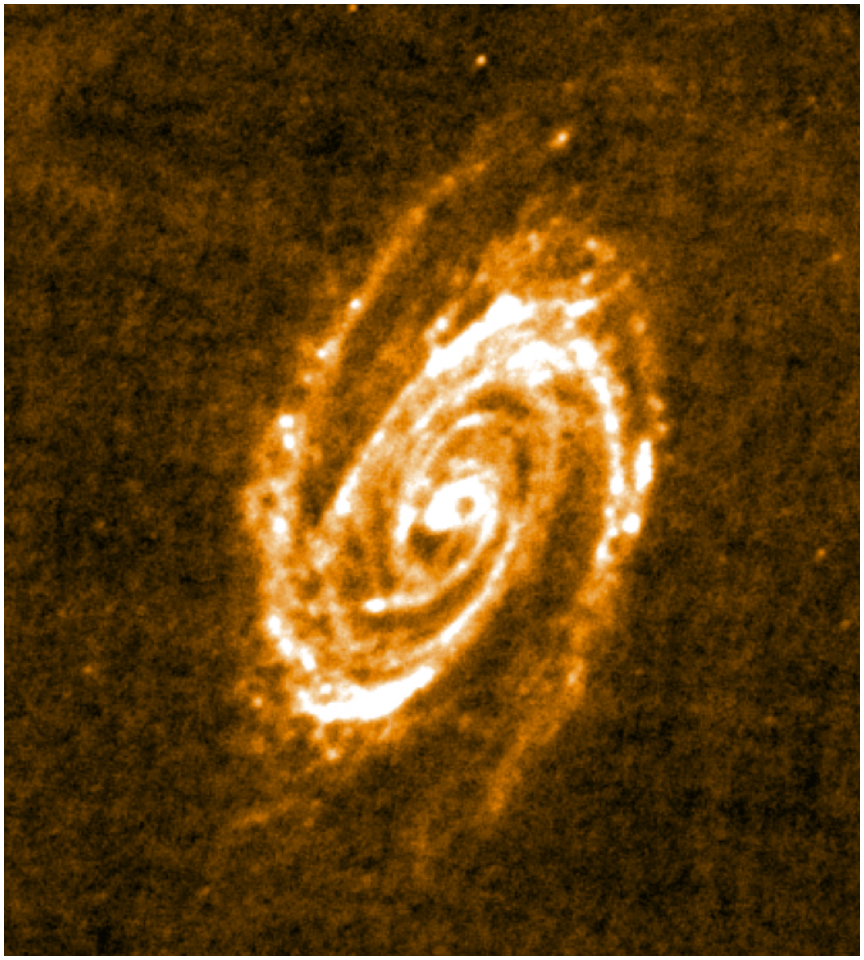
M81 from 250 to 500 microns with SPIRE



M81 near the dust emission peak

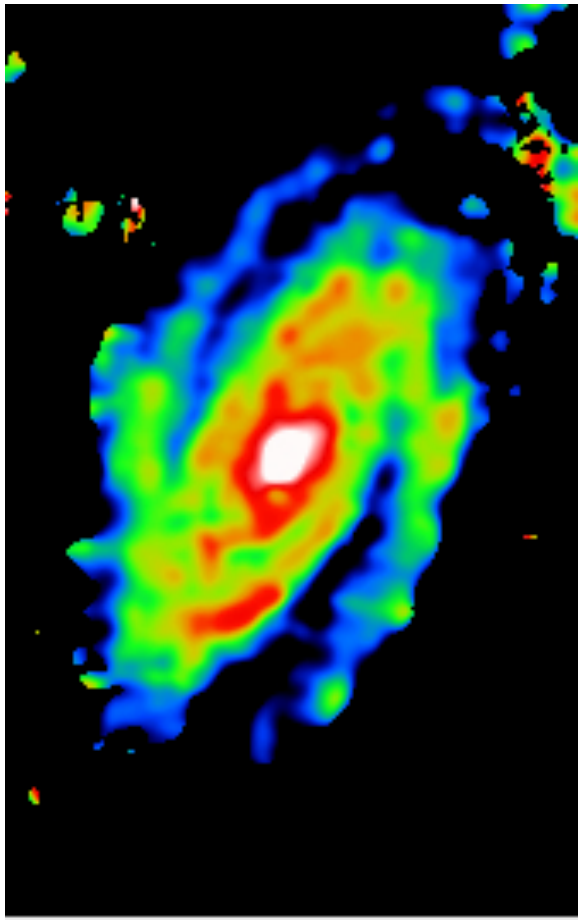


MIPS 160 microns
(Gordon et al. 2004)

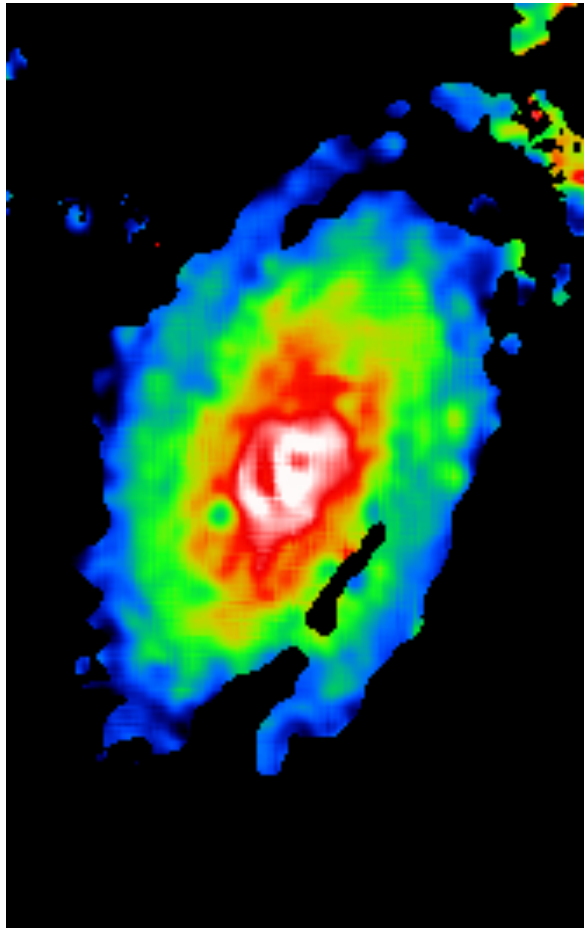


PACS 160 microns

M81 far-infrared colour maps

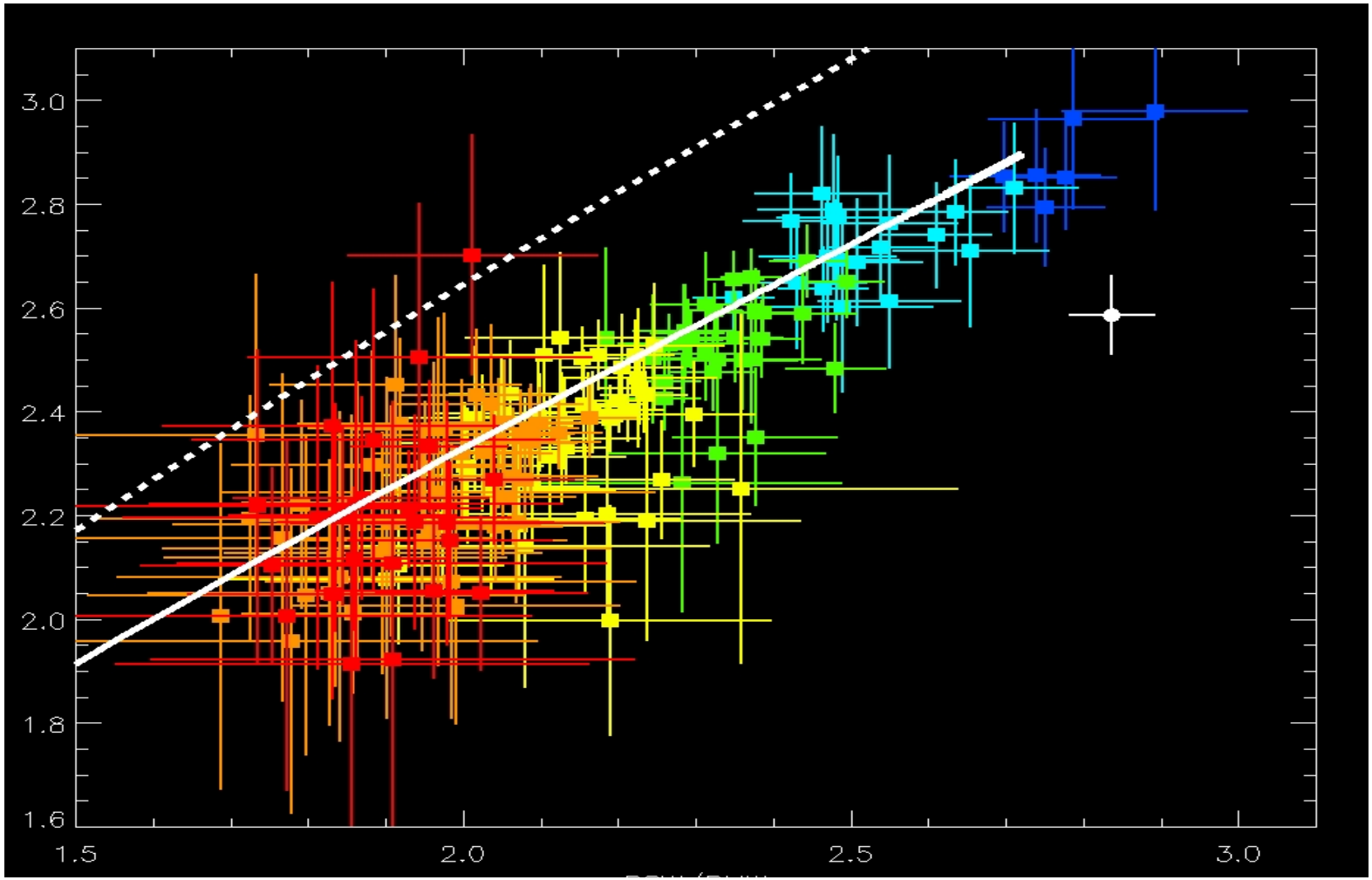


(PACS 160) / (SPIRE 250)



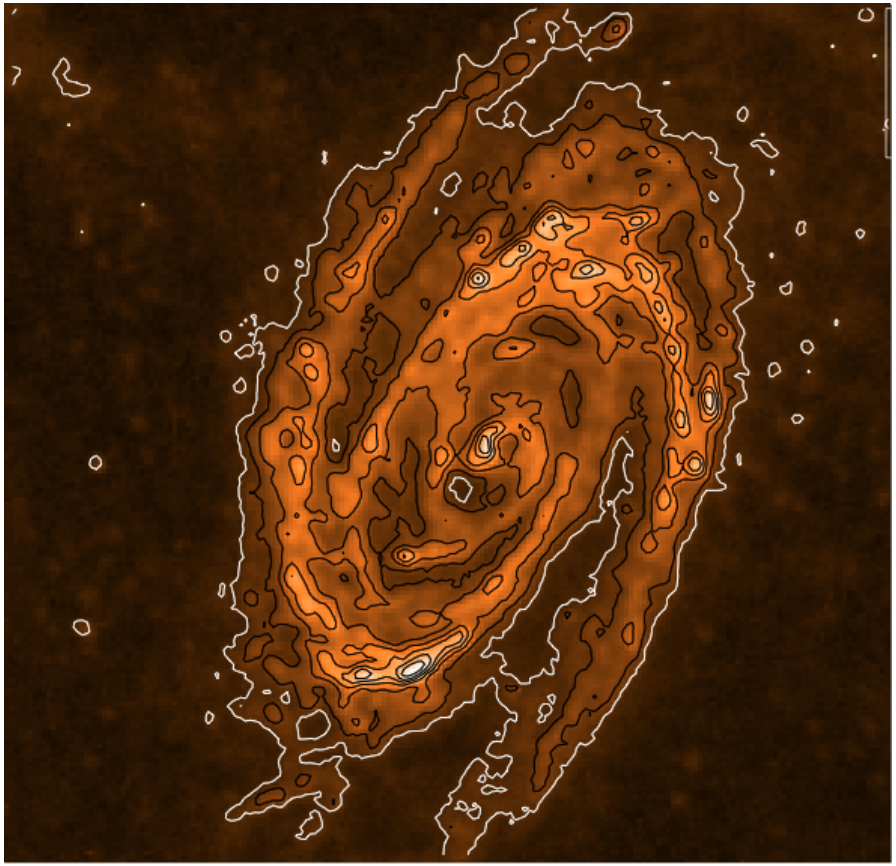
(SPIRE 250) / (SPIRE 350)

Radial temperature gradient in M81

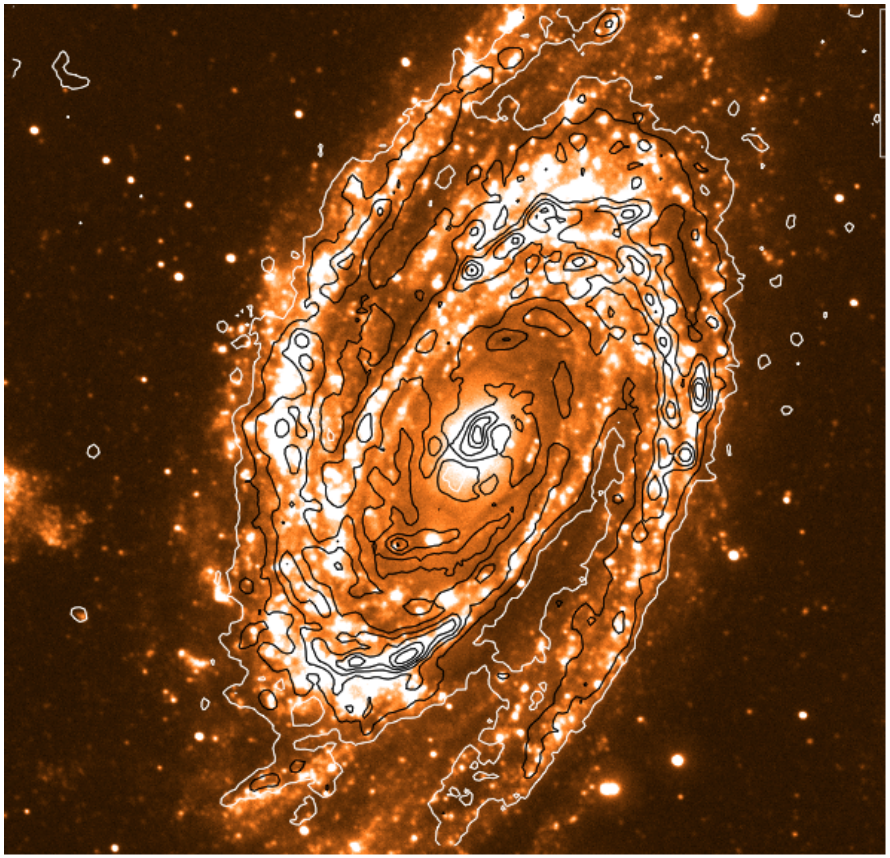


Good correlation with dust and star formation

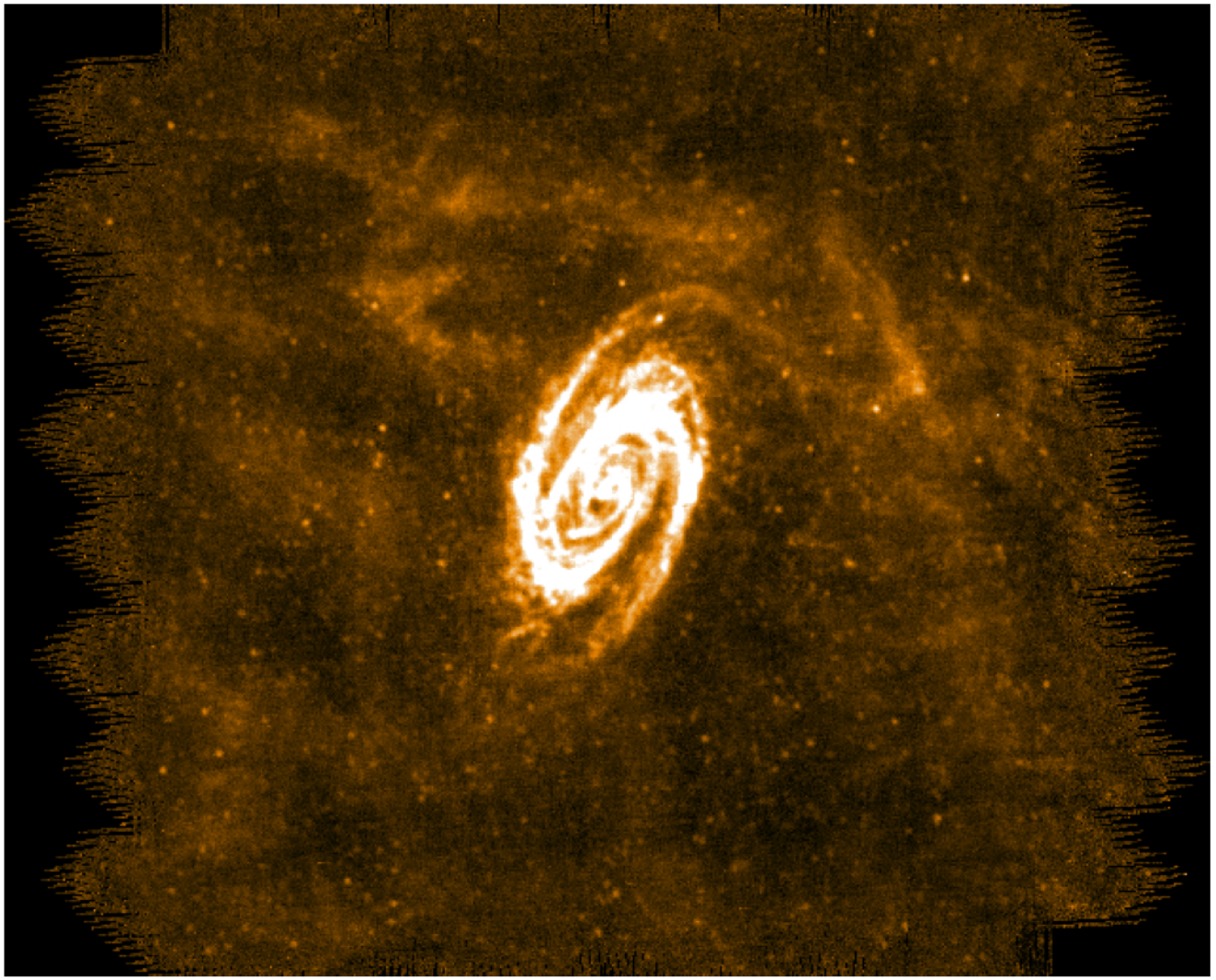
250 microns (colour+contours)



GALEX NUV with 250 micron contours

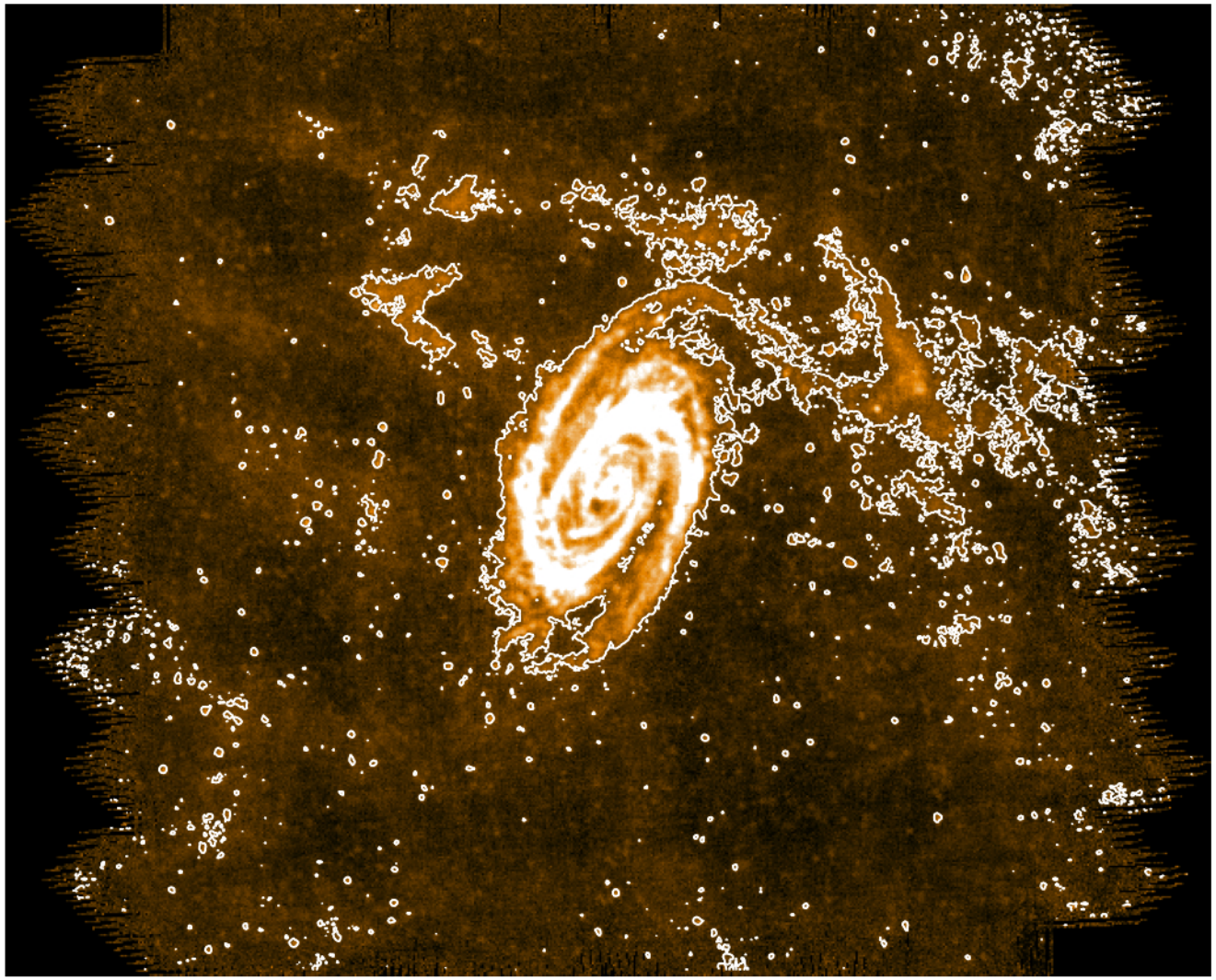


M81: the big picture



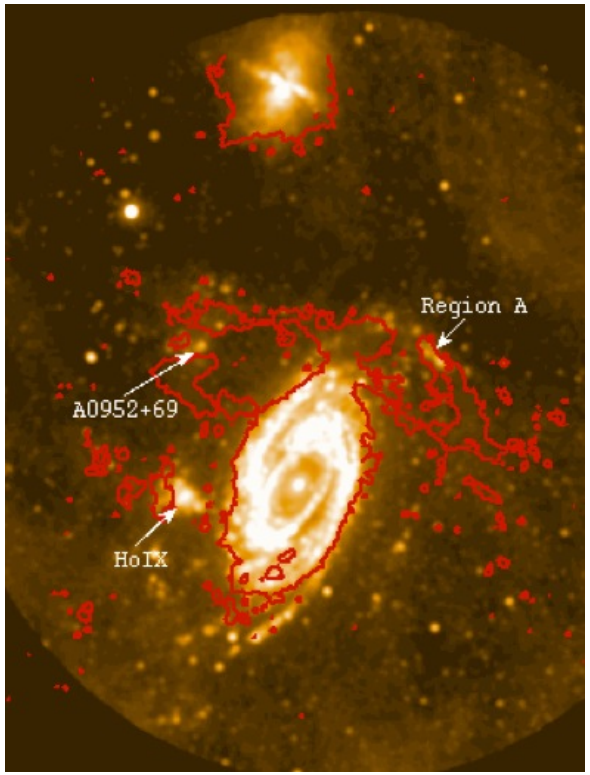
SPIRE 250 microns

M81: the big picture

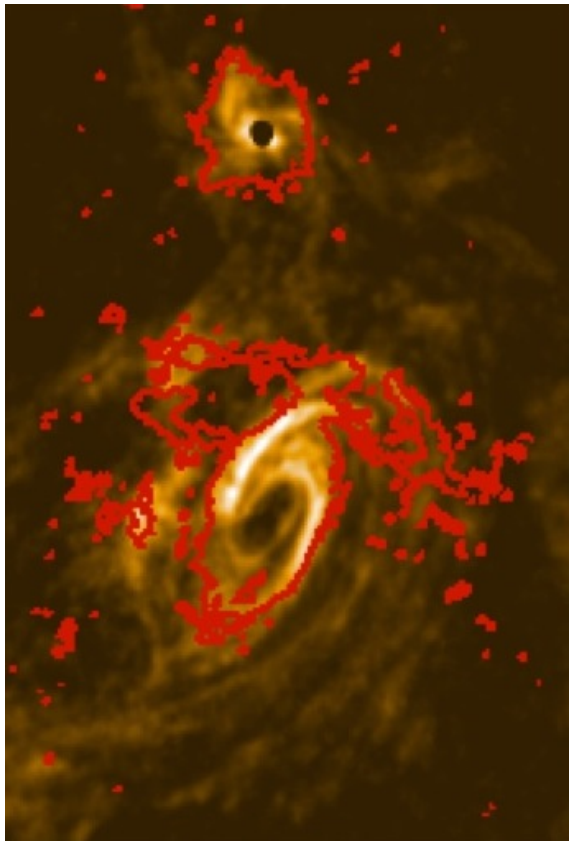


SPIRE 250 microns

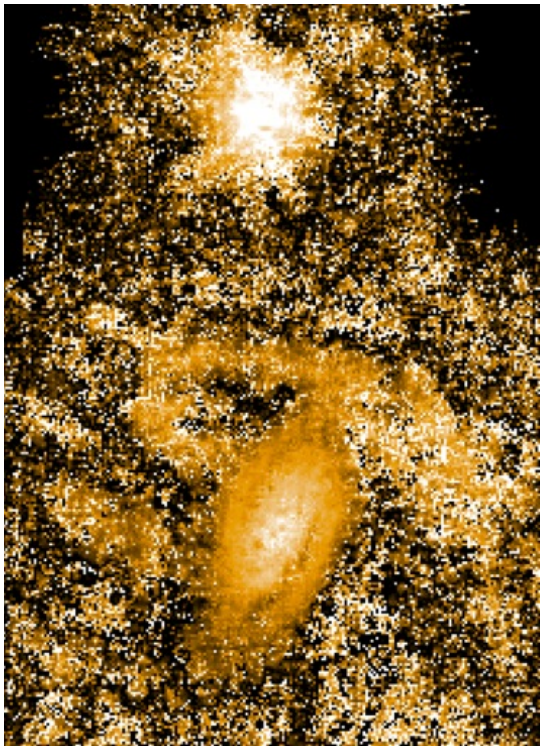
Galactic Cirrus or Tidal Debris near M81?



SPIRE contours on GALEX FUV



SPIRE contours on HI



SPIRE 250:500 micron colours

Summary

- Strong and spatially extended molecular and atomic emission lines seen in M82
- Arp 220: First detection of thermal water in emission in an external galaxy
- M81: radial far-infrared colour gradients and possible tidal debris

We anticipate additional exciting new results from these and future Herschel observations of very nearby galaxies!