

# Observing the Galaxy with WISH

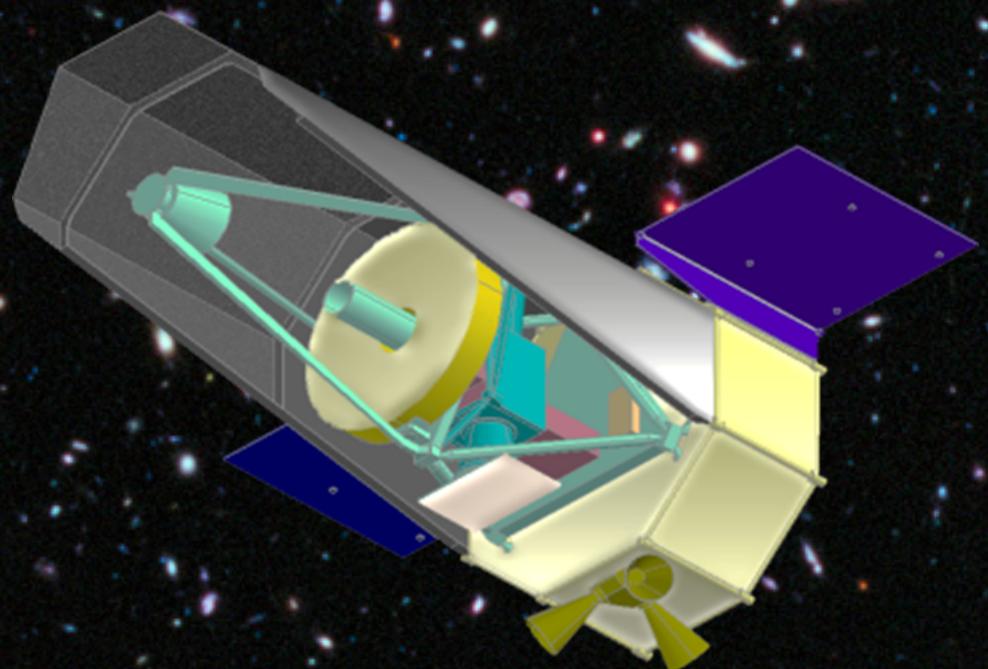


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# WISH Galactic Plane survey

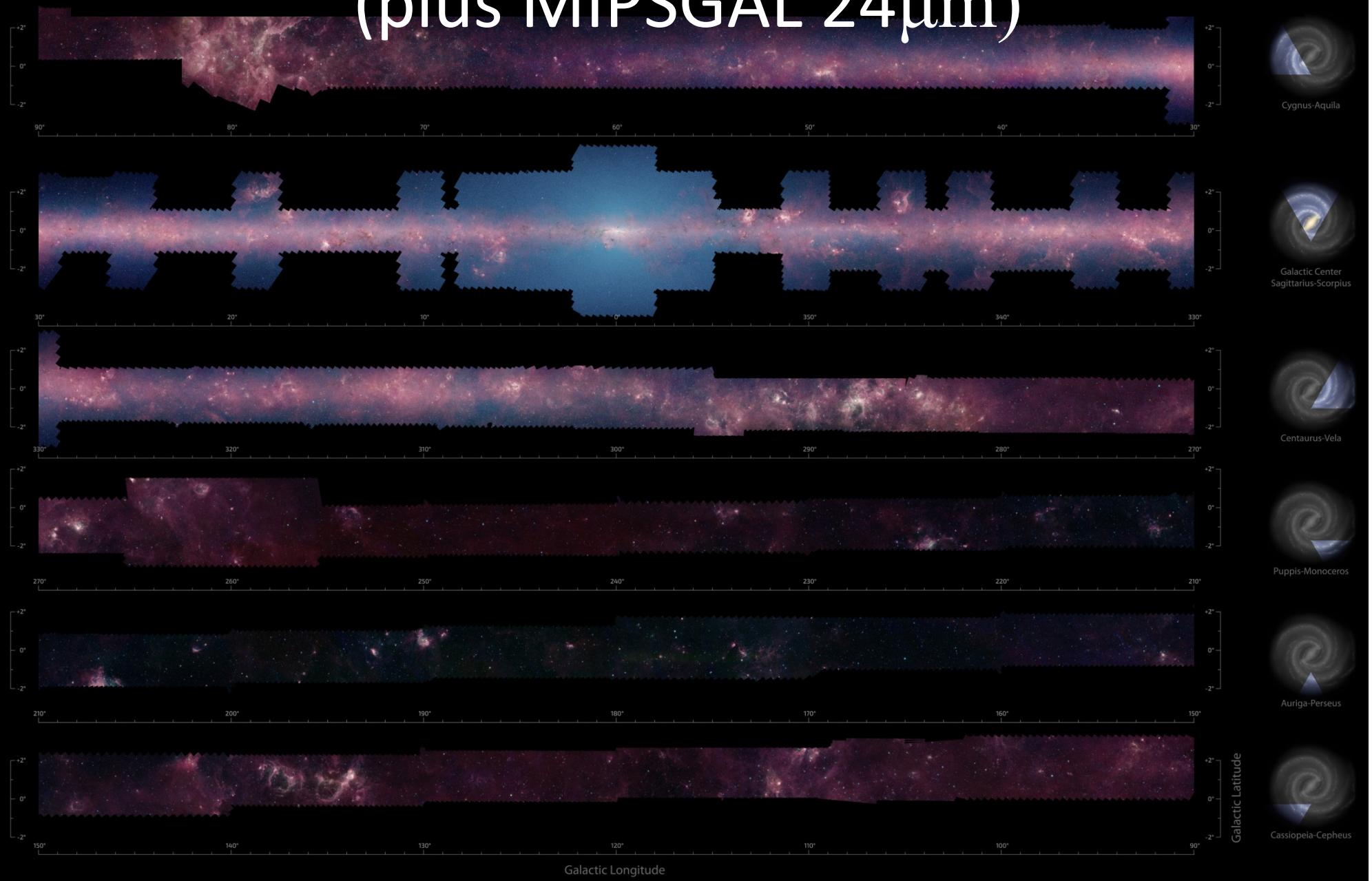
- Motivation
- Survey Design
- Applications



# WISH Galactic Plane Survey Motivation

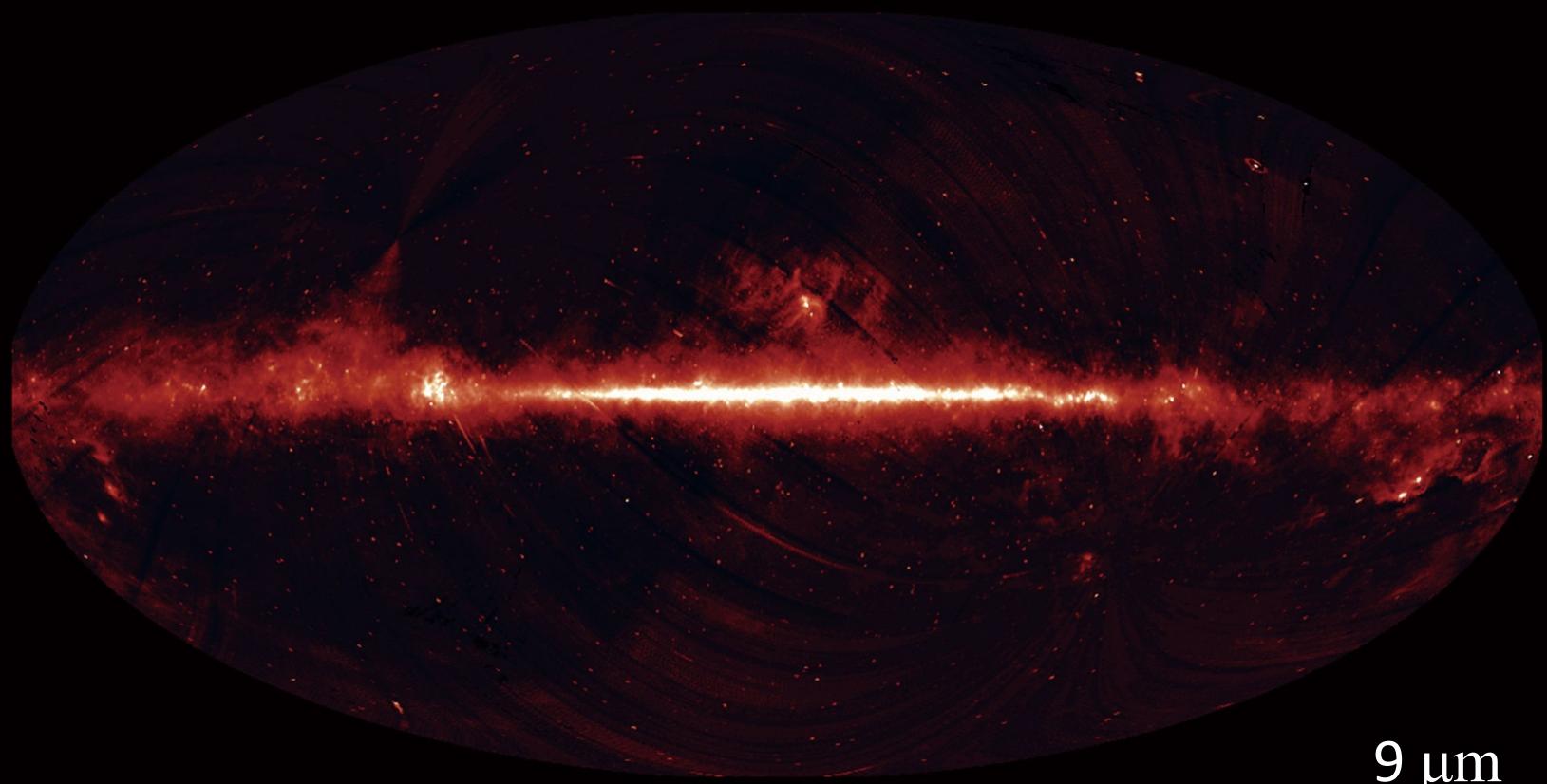
- Structure of the Milky Way
- Studies of Star Formation
  - Molecular clouds in the inner Galaxy
- Rare (distant) objects
- Advantages of an IR survey
  - High extinction in the plane
  - Cool stars, objects with IR excess or obscured by dust

# GLIMPSE Survey – 3.6, 4.5, 5.8, 8 $\mu$ m (plus MIPS-GAL 24 $\mu$ m)



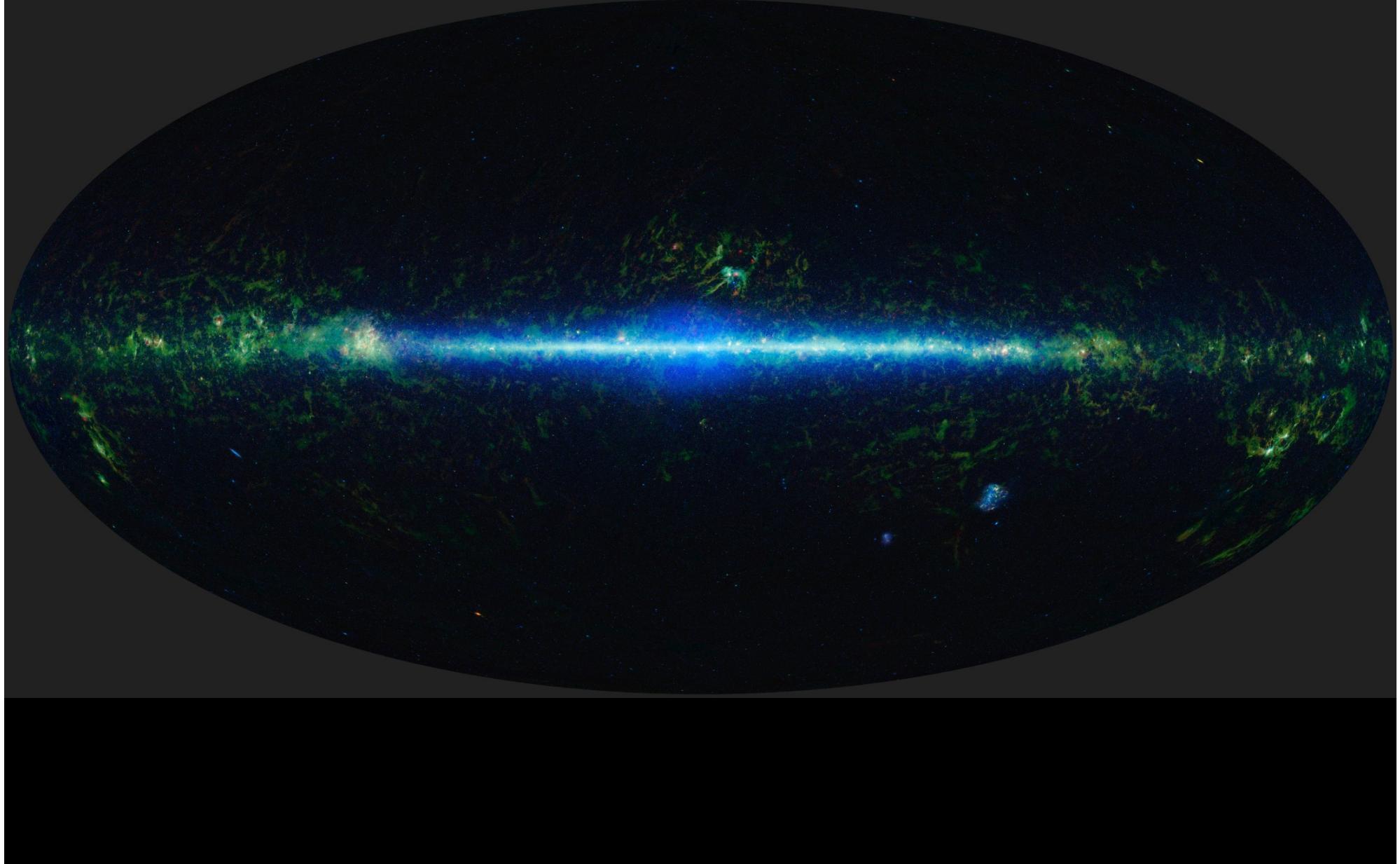
# Akari Survey

All-sky survey at 9, 18, 65, 90, 140, 160  $\mu\text{m}$



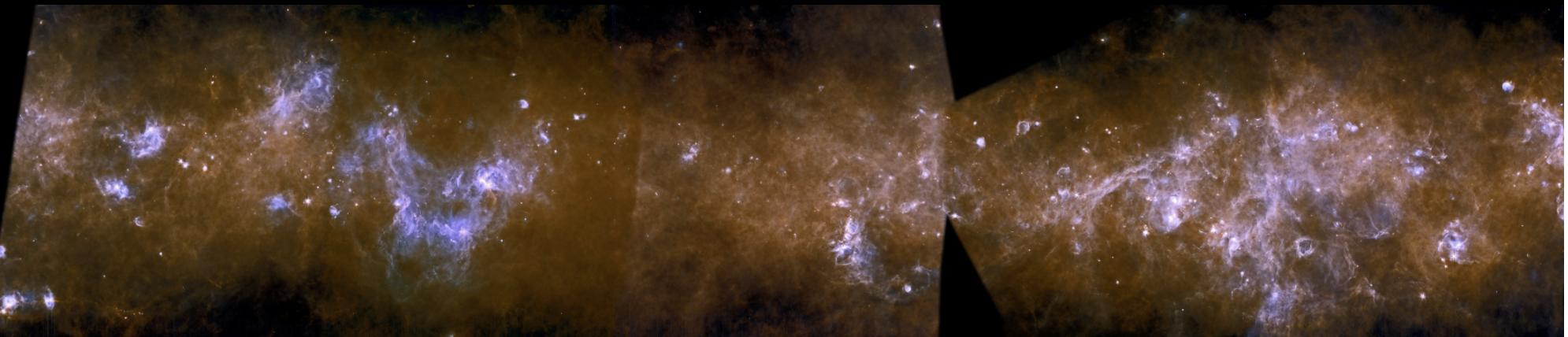
9  $\mu\text{m}$

# WISE Survey – 3.6, 4.5, 12, 22 $\mu$ m



# Herschel HiGal Survey

- 70, 160, 250, 350 and 500  $\mu\text{m}$
- Covered a  $2^\circ$  wide strip along Galactic plane



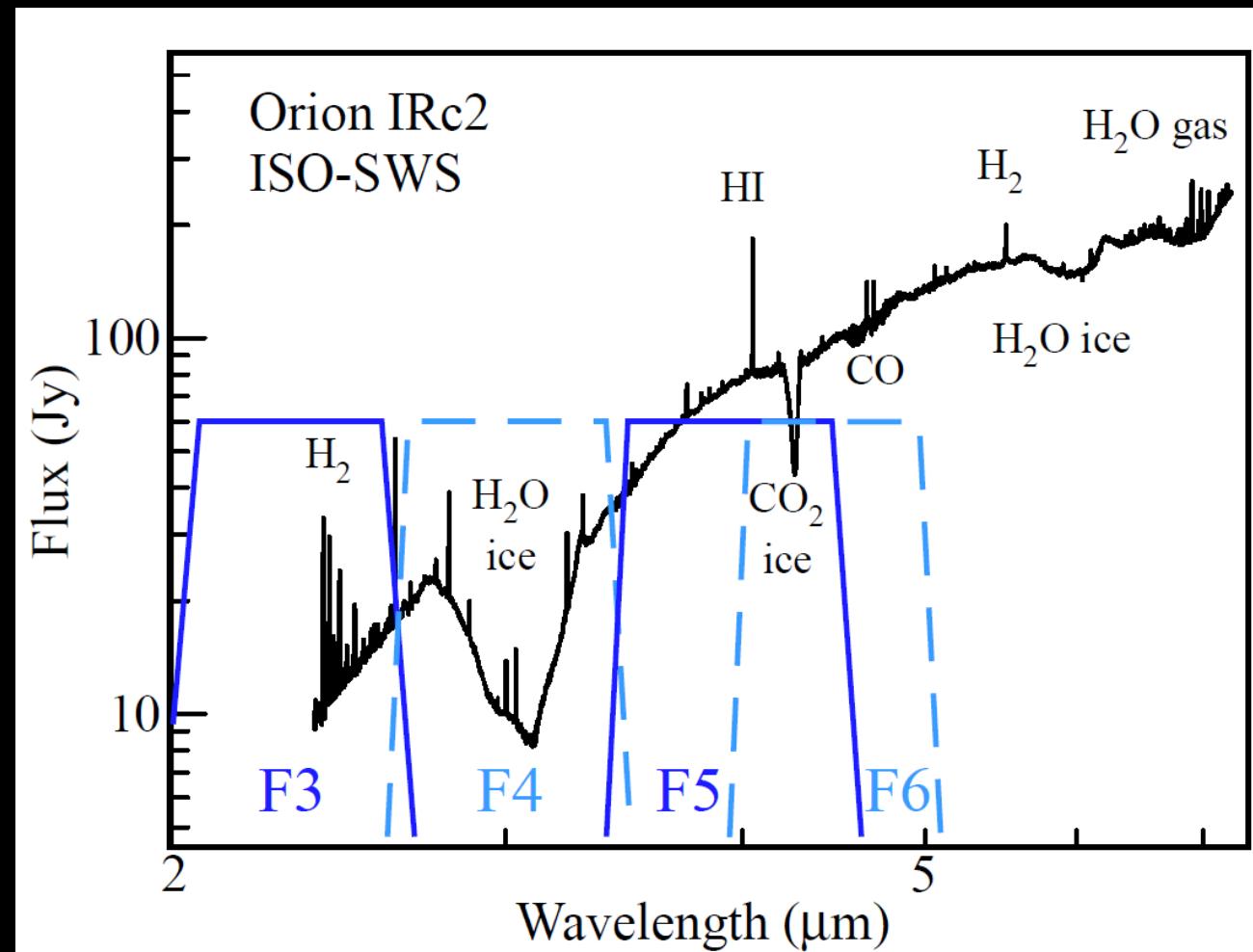
# WISH GP Survey

- The youngest embedded protostars in Galactic dark clouds went undetected by IRAC
  - Seen in the 24  $\mu\text{m}$  band of WISE, and Herschel
  - Ages less than  $10^5$  years, most reside in clusters with lower-mass objects.
- Use seven filters covering the range from 0.90 – 5.0  $\mu\text{m}$
- Will reach background-limited  $5\sigma$  depths of AB mag >23 in all bands.
  - For comparison, the IRAC 3.6  $\mu\text{m}$   $5\sigma$  flux limit in GLIMPSE was >6 magnitudes brighter, ~17 mag (a few deeper IRAC Galactic plane studies went to ~19 mag).
- WISH will survey selected regions with a total area of 500  $\text{deg}^2$ 
  - Will use shorter exposure times than the extragalactic program.
  - Saturation is expected on the brightest sources, but fast readout will ameliorate the problem
- Deep WISH results, when merged with other datasets, will enable catalogs that include both faint and bright sources, both low mass and high mass stars.

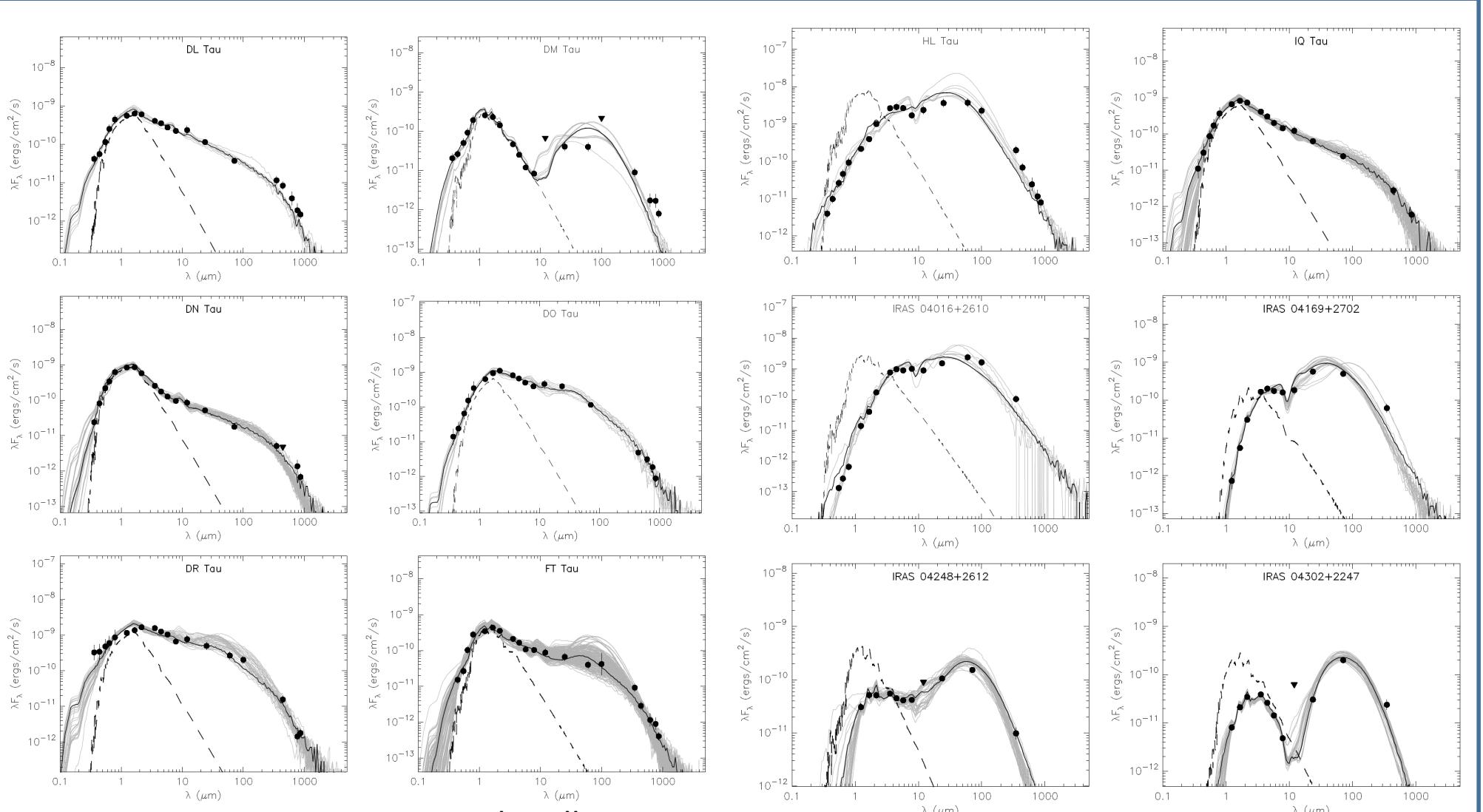
# WISH GP Survey

- WISH will measure the 0.9 – 5  $\mu\text{m}$  SEDs of protostars
  - Help to fix the stellar mass (down to  $\sim 0.1 M_\odot$ )
  - Disk mass, age, and accretion rate
- WISH's high angular resolution will resolve many MIPS single sources into clusters of stars.
- WISH multi-band images will contain extended features of ice and excited atoms and molecules
- The WISH filters span a key set of these features
  - WISH 3-band images will be able to identify regions of water ice, a critical constituent whose abundance and water reservoir capacity has long remained uncertain
  - Shock- or UV-excited extended regions will also be discovered in the WISH filters
- WISH Filter 6 is similar to IRAC Band 2 (4.5  $\mu\text{m}$ ), a proven probe of outflows
- Follow-up spectral survey using IFU spectrograph could obtain spectra of clusters of YSOs

# Ice features in YSO Spectra



# YSOs in Taurus



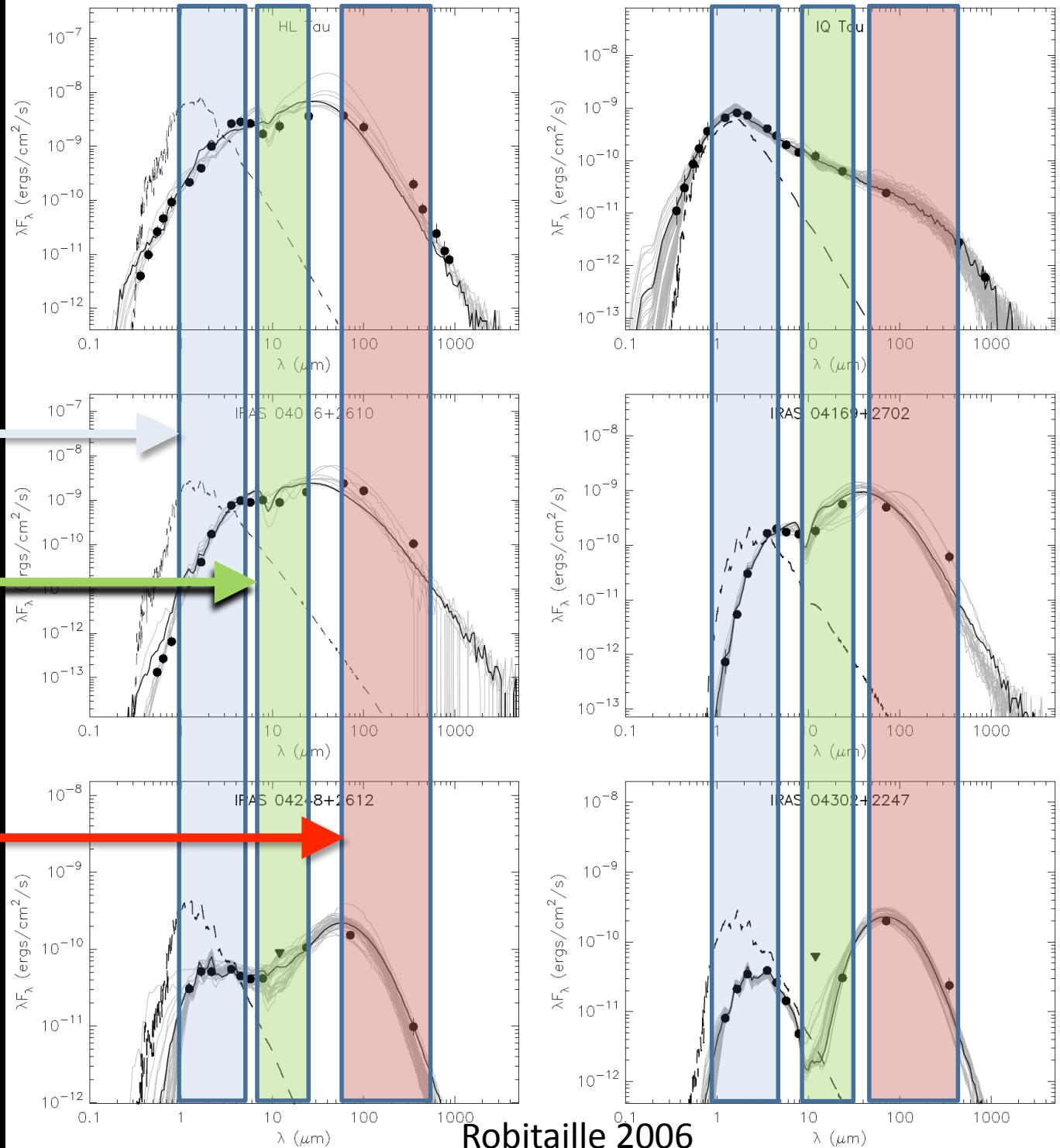
Robitaille 2006

# YSO models/ Photometry

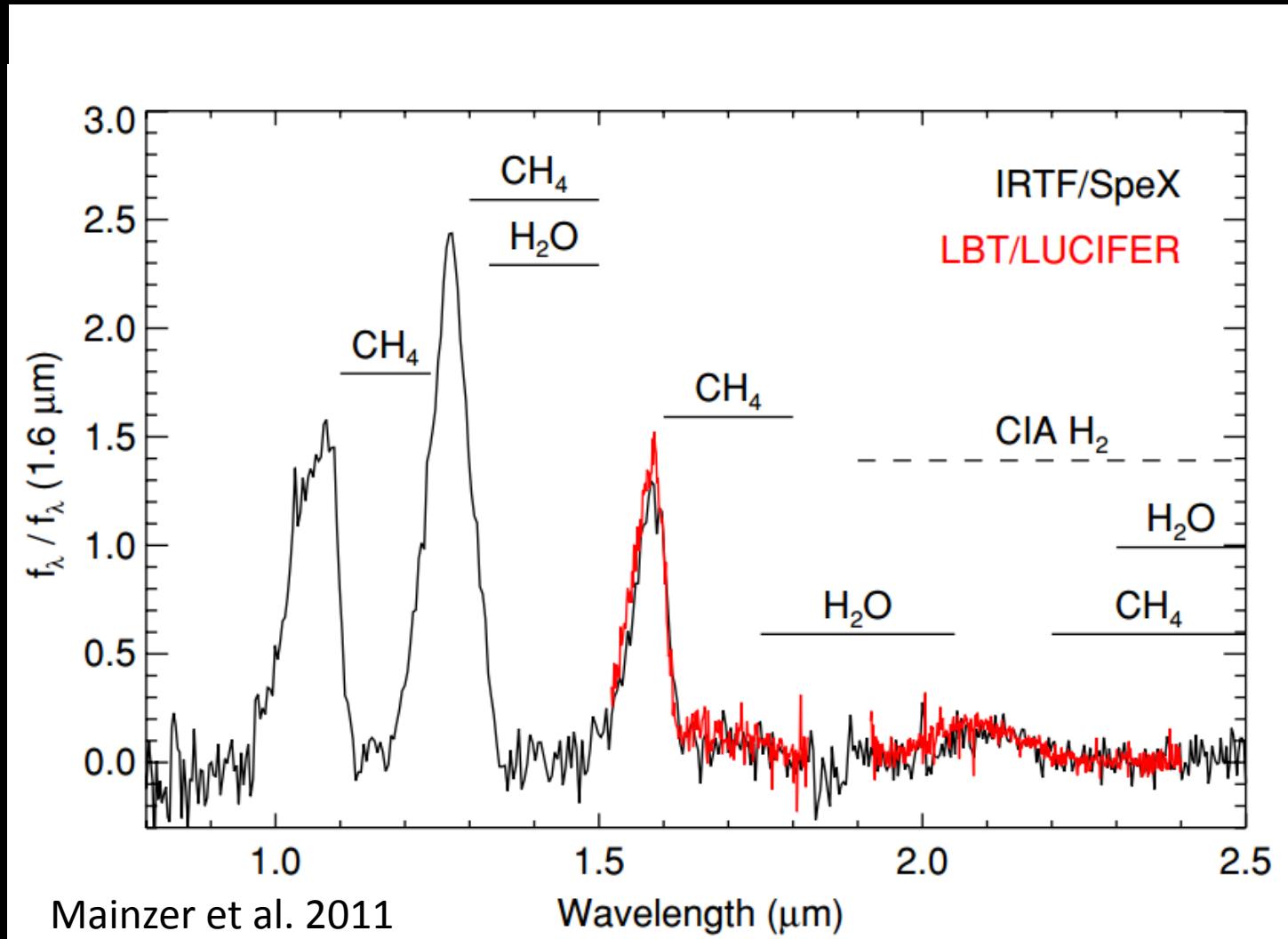
WISH

WISE  
/Spitzer

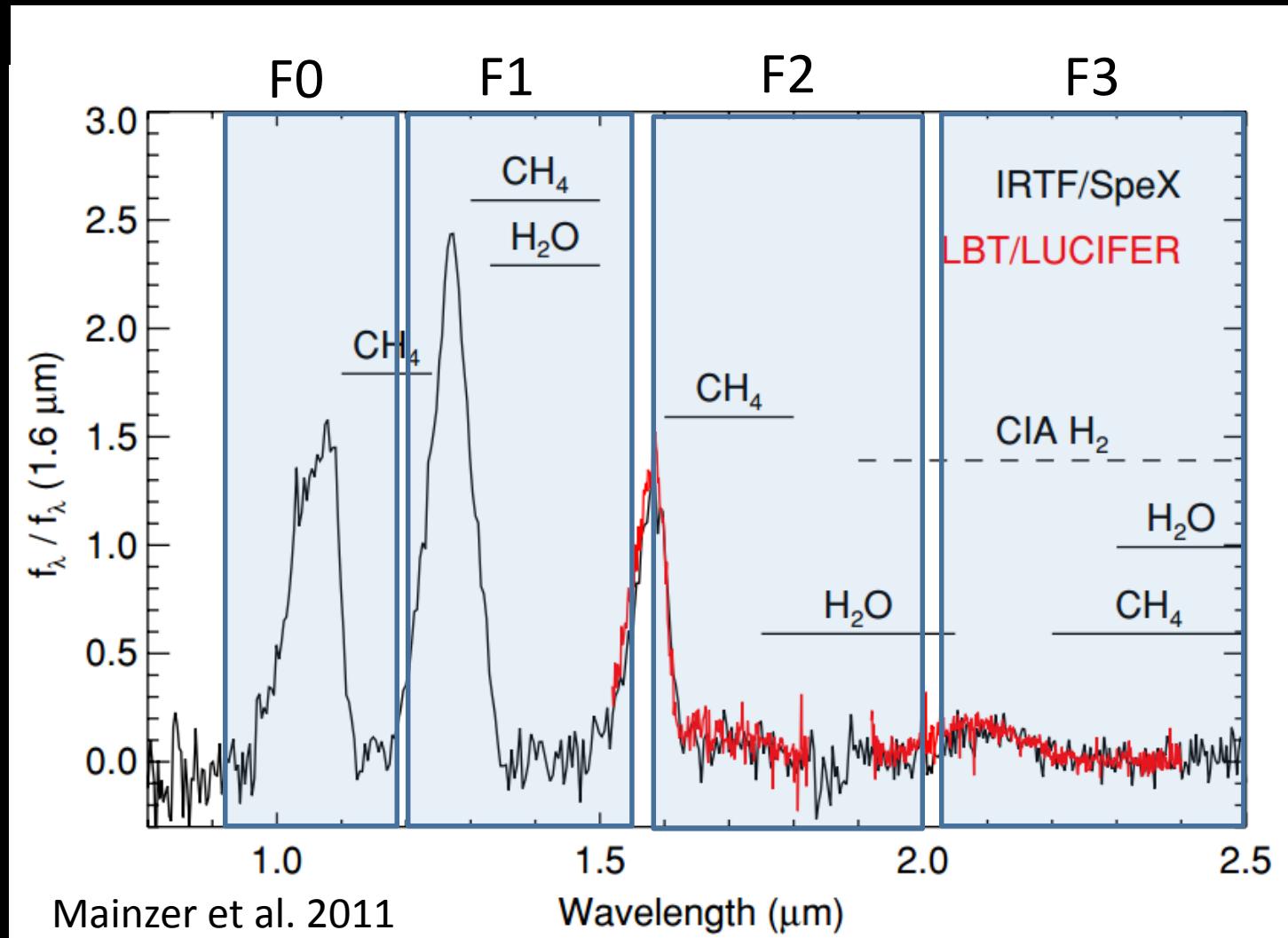
Herschel



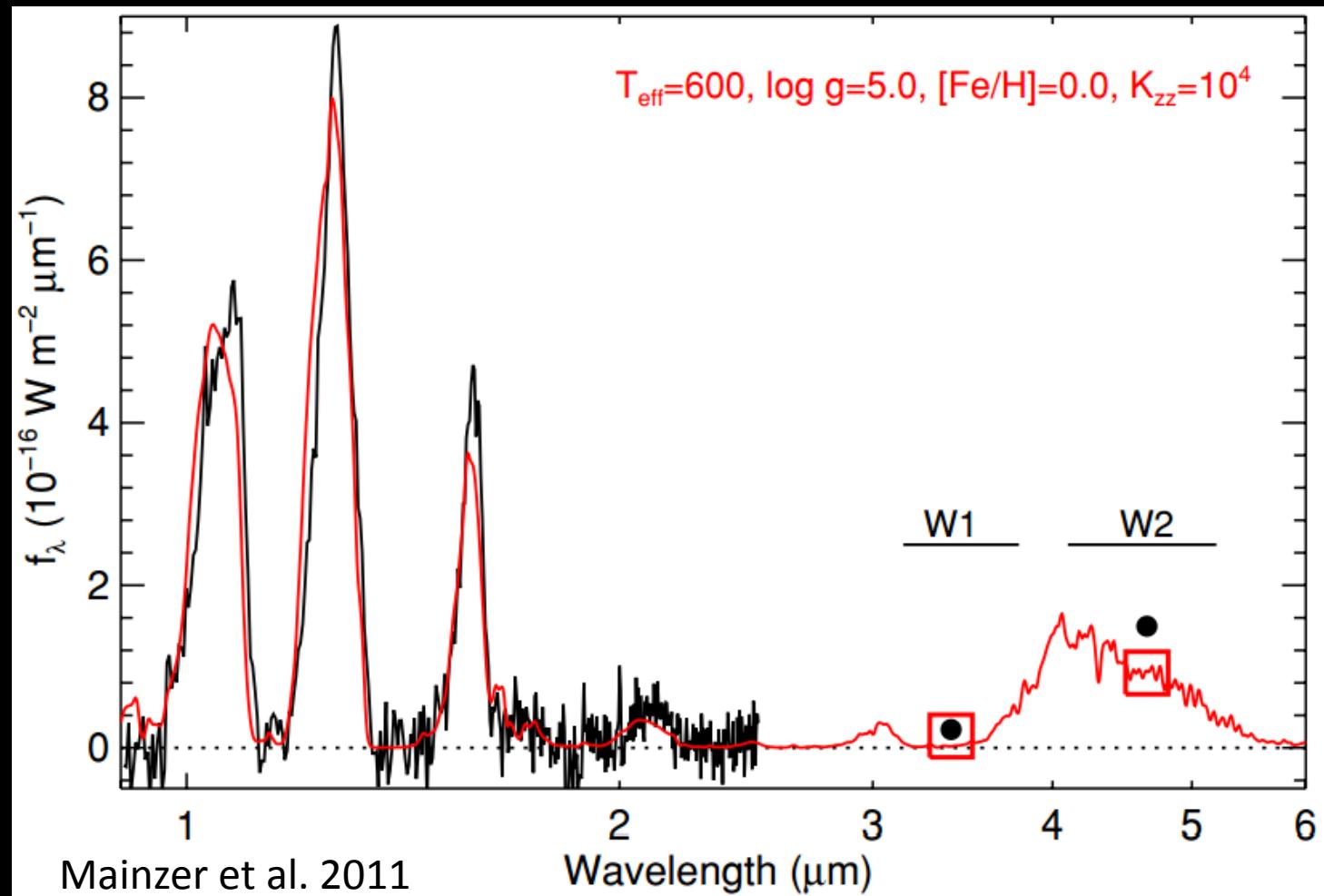
# Ultra-Cool BD WISEPC J0458+64



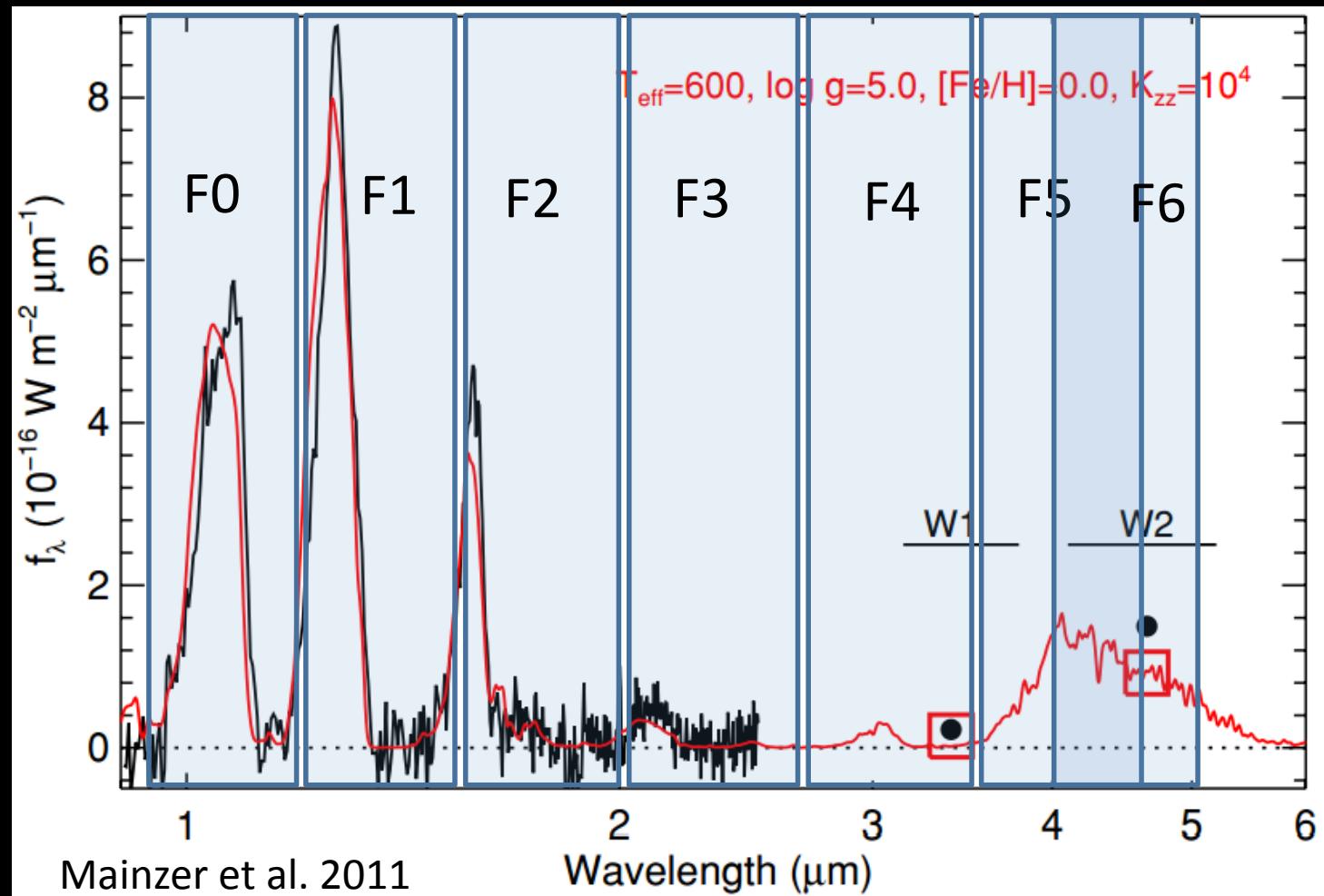
# Ultra-Cool BD WISEPC J0458+64



# Ultra-Cool BD WISEPC J0458+64



# Ultra-Cool BD WISEPC J0458+64



# The power of WISH GP Survey

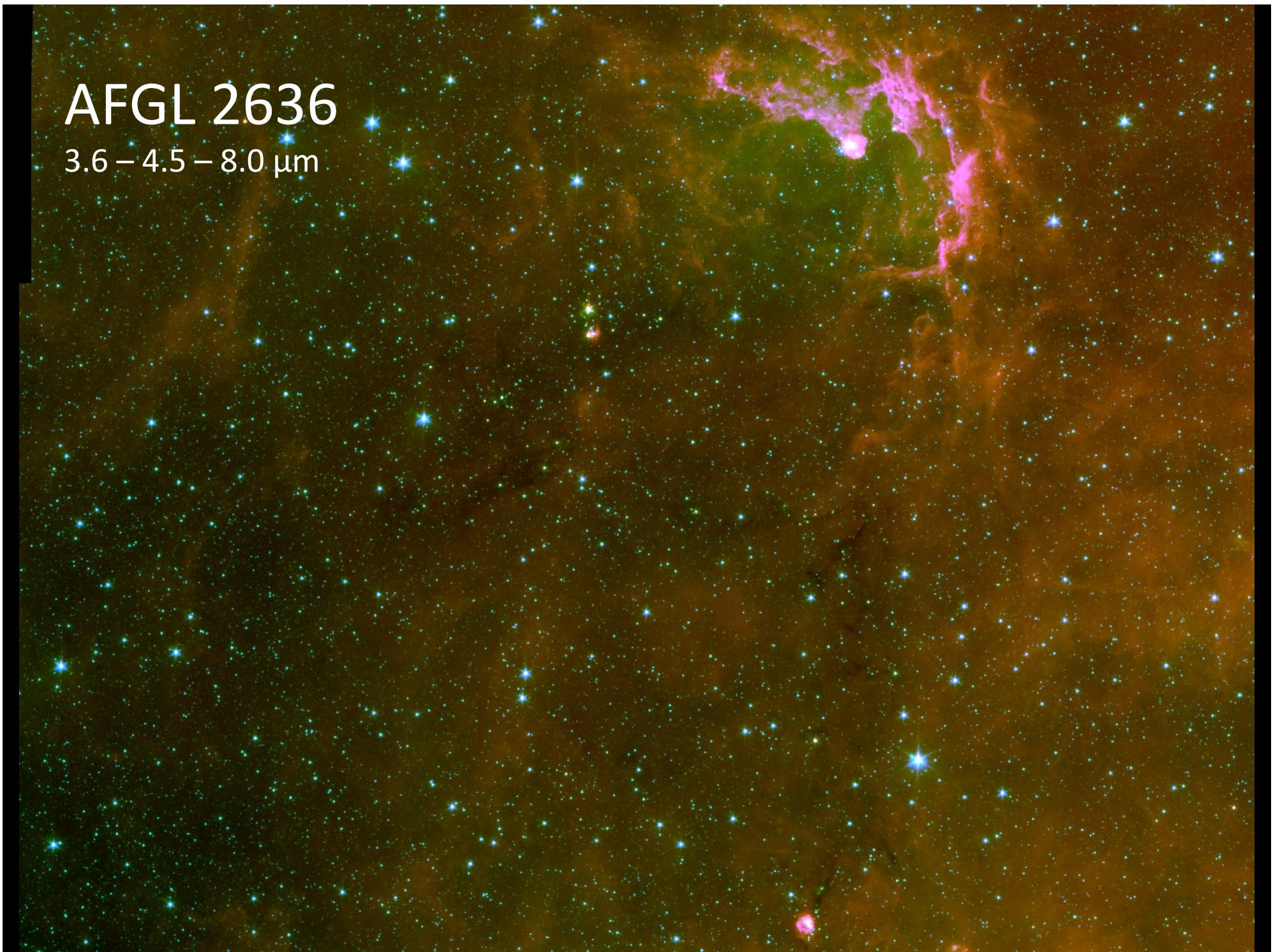
- Sensitivity, resolution
  - WISE:
    - Resolution of 6.1", 6.4", 6.5", & 12.0" in the four bands.
    - WISE achieved  $5\sigma$  point source sensitivities of 0.08, 0.11, 1 and 6 mJy at 3.4, 4.5, 12, 22  $\mu$ m in UNCROWDED regions
  - GLIMPSE:
    - Resolution of 1.7, 1.7, 1.9, 2.0" in the four bands
    - Catalog limit of 0.6, 0.4, 2, 10 mJy at 3.6, 4.5, 5.8, 8  $\mu$ m
  - WISH:
    - Resolution of 0.18 – 0.8" in the 1 – 4  $\mu$ m bands
    - Sensitivity of 1 – 5  $\mu$ Jy from 1-4  $\mu$ m, factor of  $\sim$ 100-1000 better
    - Reduced confusion in crowded regions

# The power of WISH GP Survey

- Variable sources, proper motion objects:
  - WISH will provide a second epoch with large time baseline to 2MASS, GLIMPSE

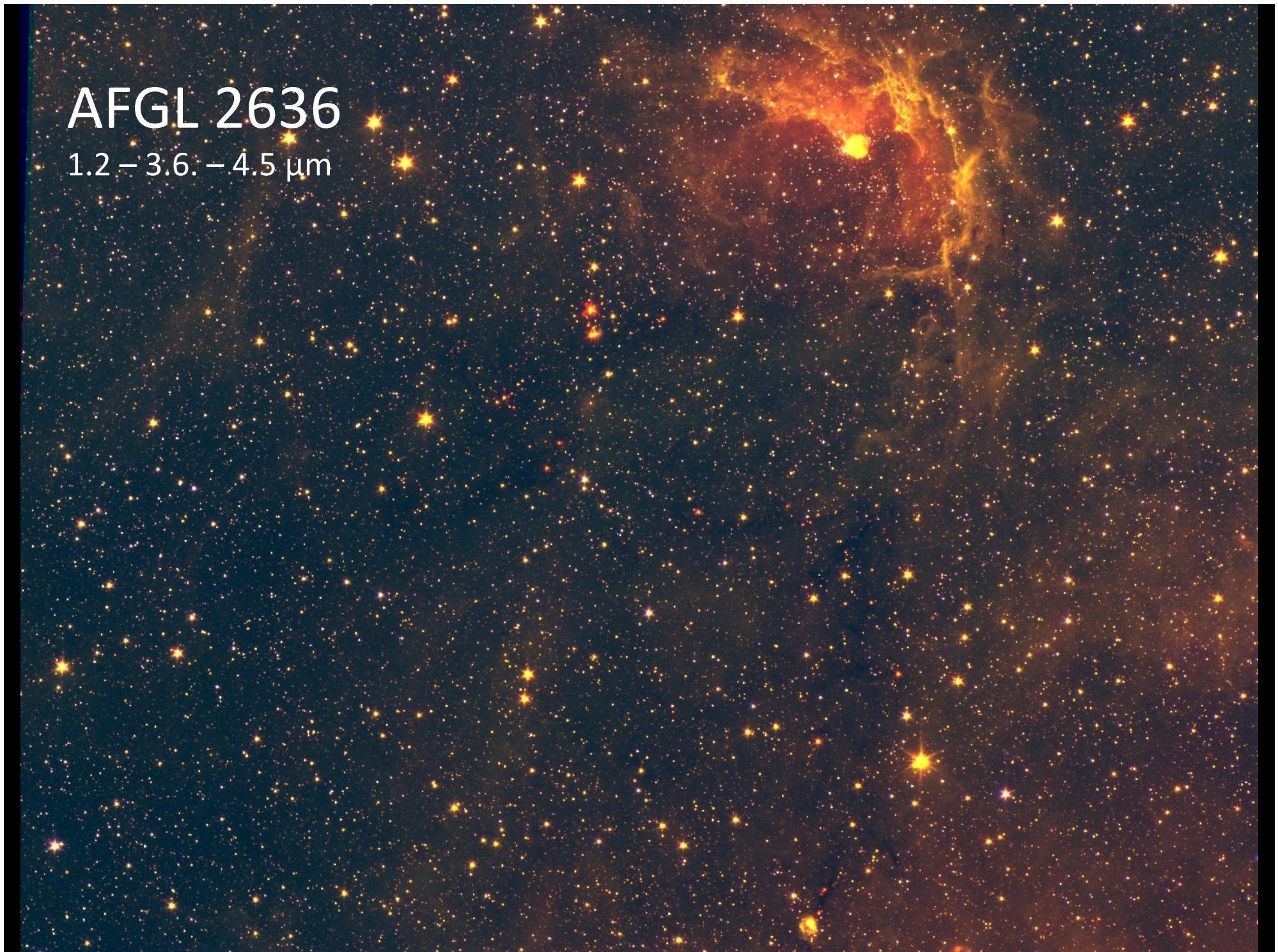
# AFGL 2636

3.6 – 4.5 – 8.0  $\mu\text{m}$



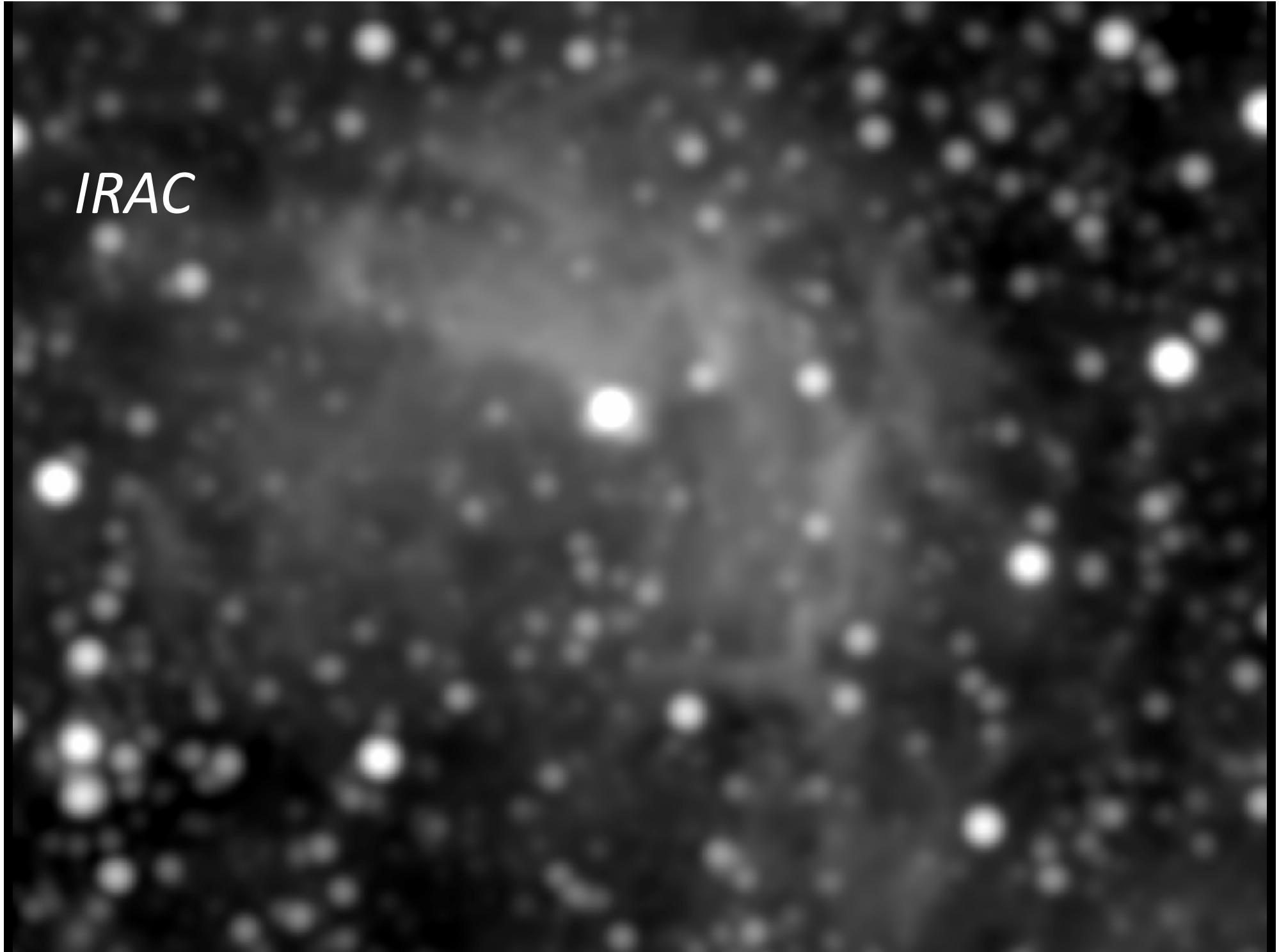
# AFGL 2636

1.2 – 3.6. – 4.5  $\mu\text{m}$



*WISE*

*IRAC*



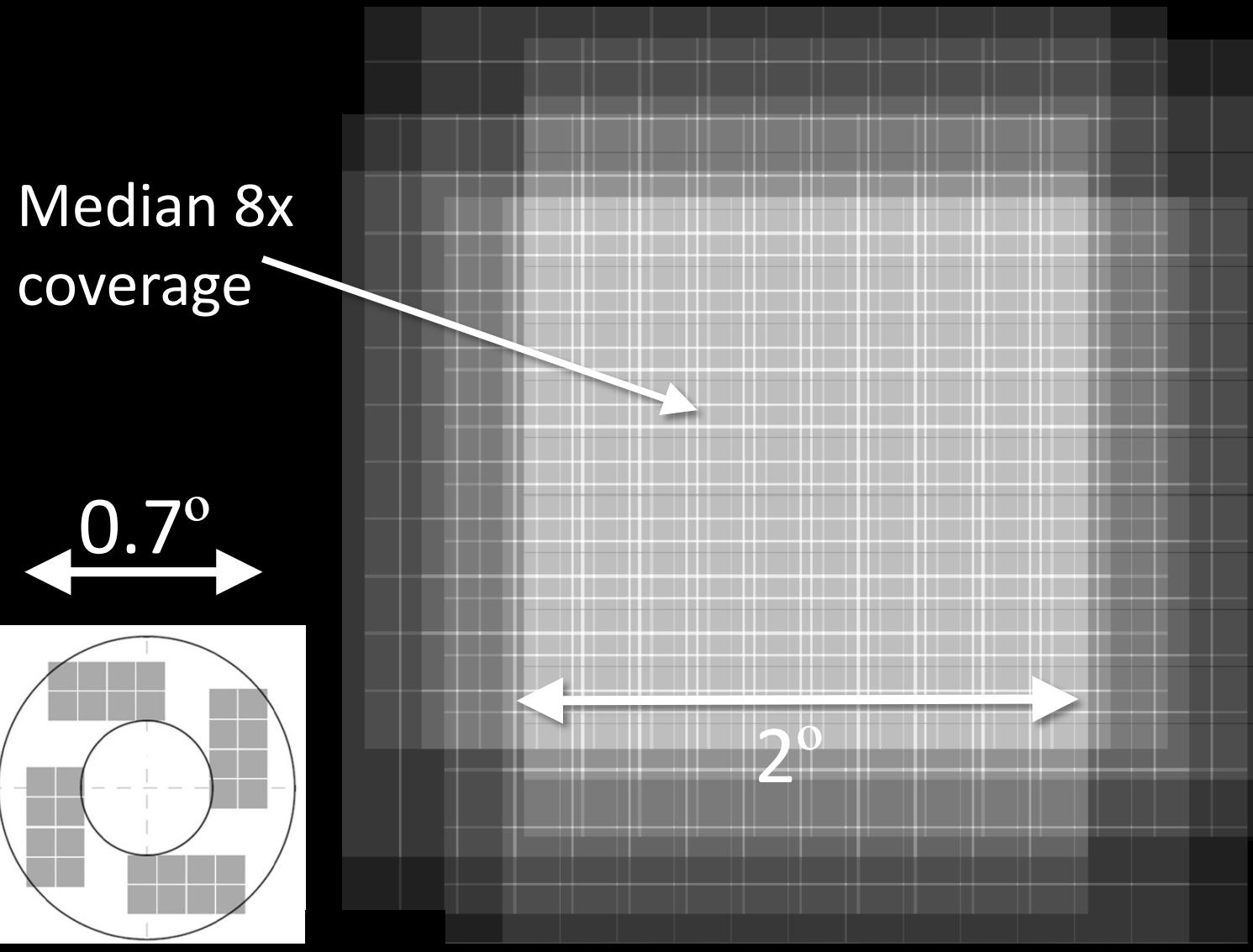
*WISH*



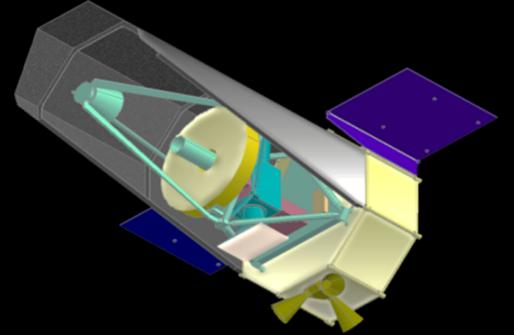
# WISH GP Survey Design

- Obtain 10 sec integrations (2 detector reads)
- Use 15x15 dither pattern that covers 2x2 degrees (4 sq. deg) in ~3.125 hr.
- Assume ~40% efficiency
- Can observe 500 deg<sup>2</sup> in 5 filters in ~81 days
- Options –
  - Pointed survey of specific regions
  - Unbiased survey +/- 2deg from Galactic Plane of a range of Gal. longitudes, like GLIMPSE/MIPSGAL and Herschel HiGal surveys

# Coverage pattern for 15x15 dither



# Conclusions



- Large area of Galactic plane can be quickly surveyed with WISH
- Will be a significant advance in resolution, sensitivity to low-mass young stellar objects, brown dwarfs
- Will build on Spitzer, WISE, Akari, Herschel surveys, complement HST/JWST capabilities