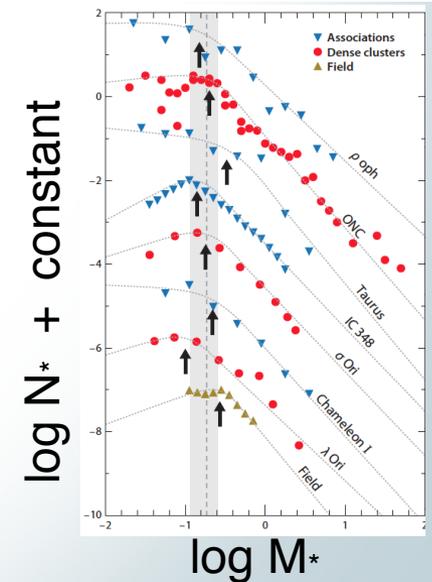
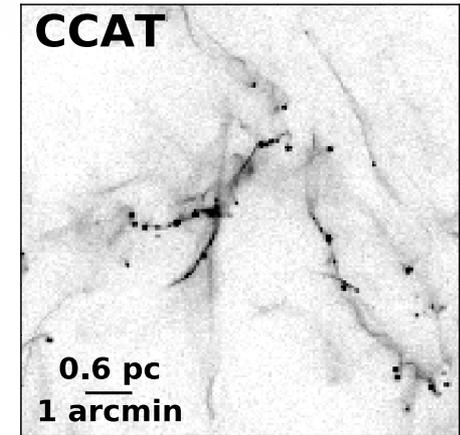
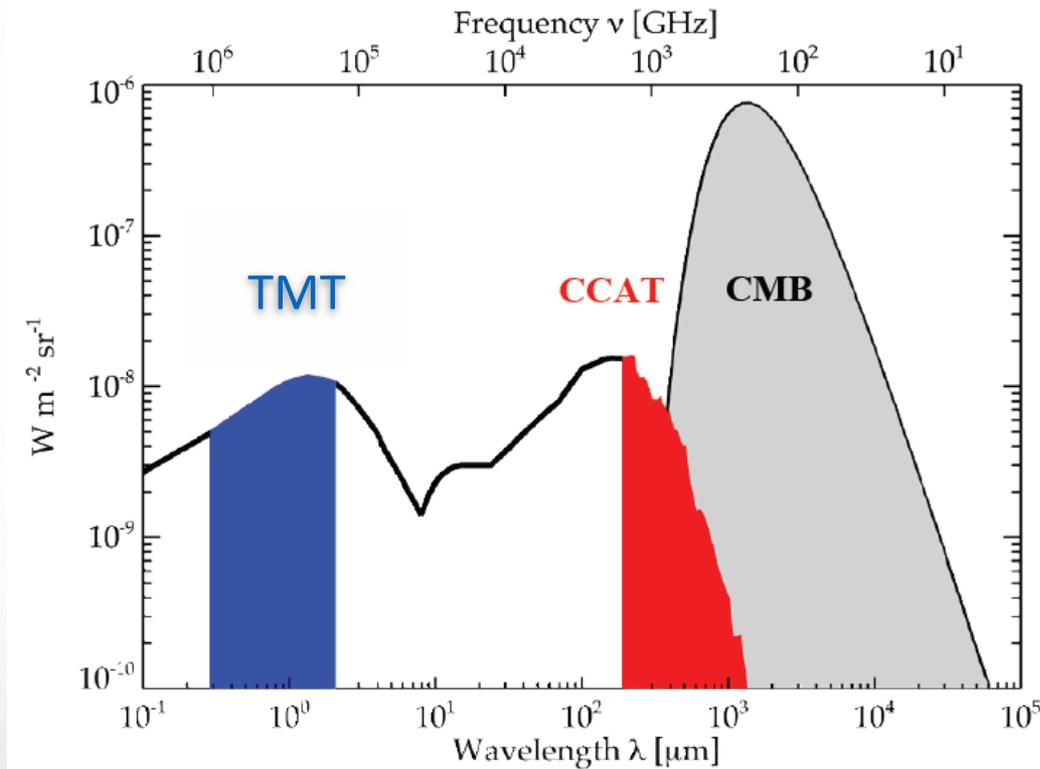
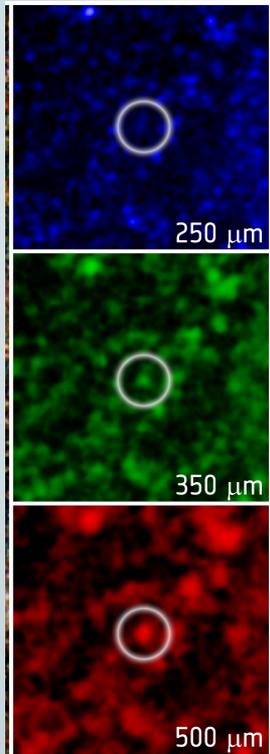


Submillimeter Surveys with CCAT and Synergies with the TMT



John Carpenter (Caltech, CCAT Project Scientist)

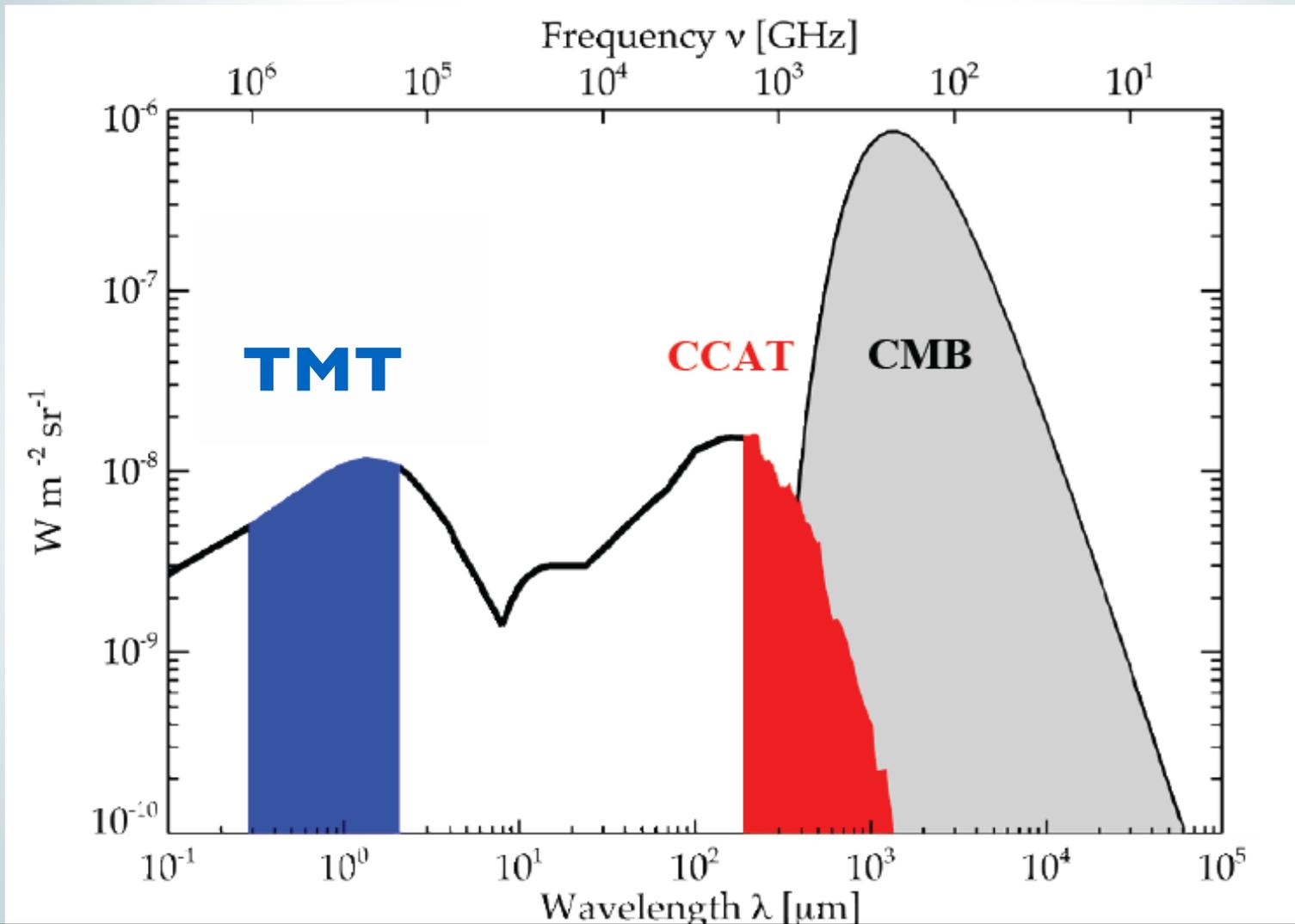




CCAT Overview

- CCAT is a 25 m diameter submillimeter telescope
- Investigate the origin of galaxies, galaxy clusters, and stars
- Optimized for wide-field continuum imaging and spectroscopy between $200\mu\text{m}$ and $3000\mu\text{m}$
- Timeline:
 - PDR passed in October 2013
 - Site permission granted in Jan 2014
 - Ready for construction!
- Partners: Cornell, Caltech, Colorado, Canada, Germany

Why submillimeter wavelengths?



3

Half of the energy from starlight emitted in far-IR/submillimeter

The Power of CCAT



High angular resolution

- large diameter (25 m)
- 3.5 arcsec at $350\mu\text{m}$

Wavelength coverage

- 200-3000 μm

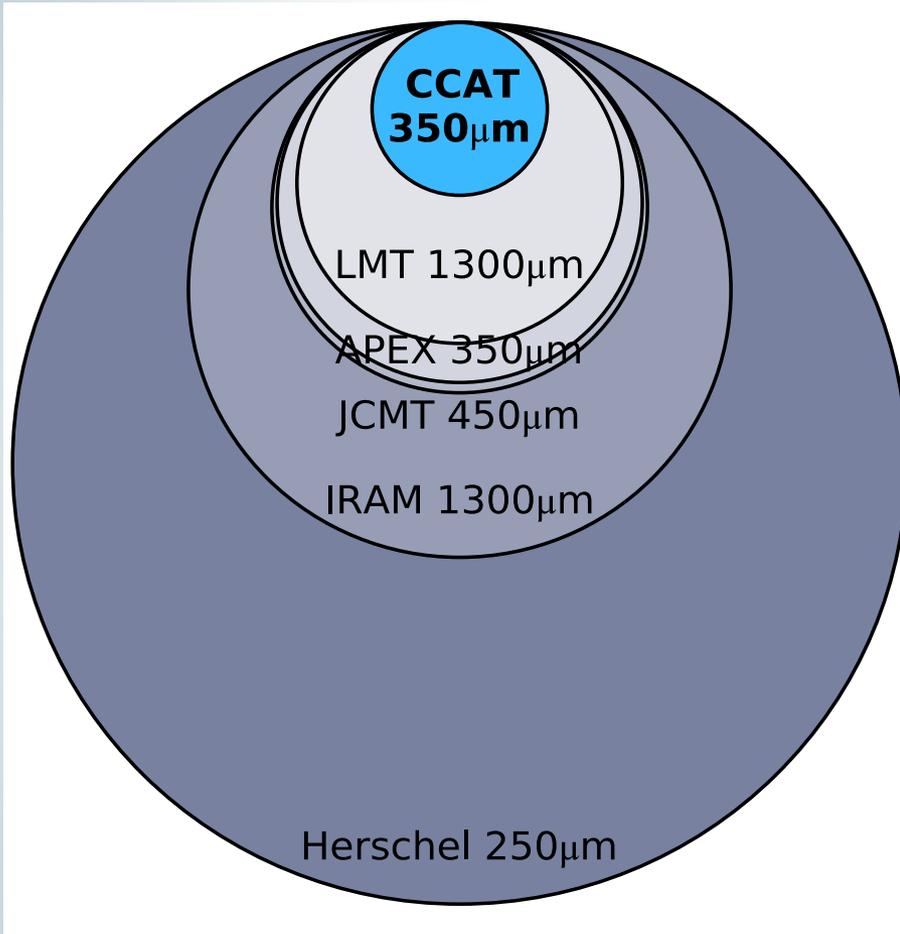
High sensitivity

- superb observing site

Field-of-view

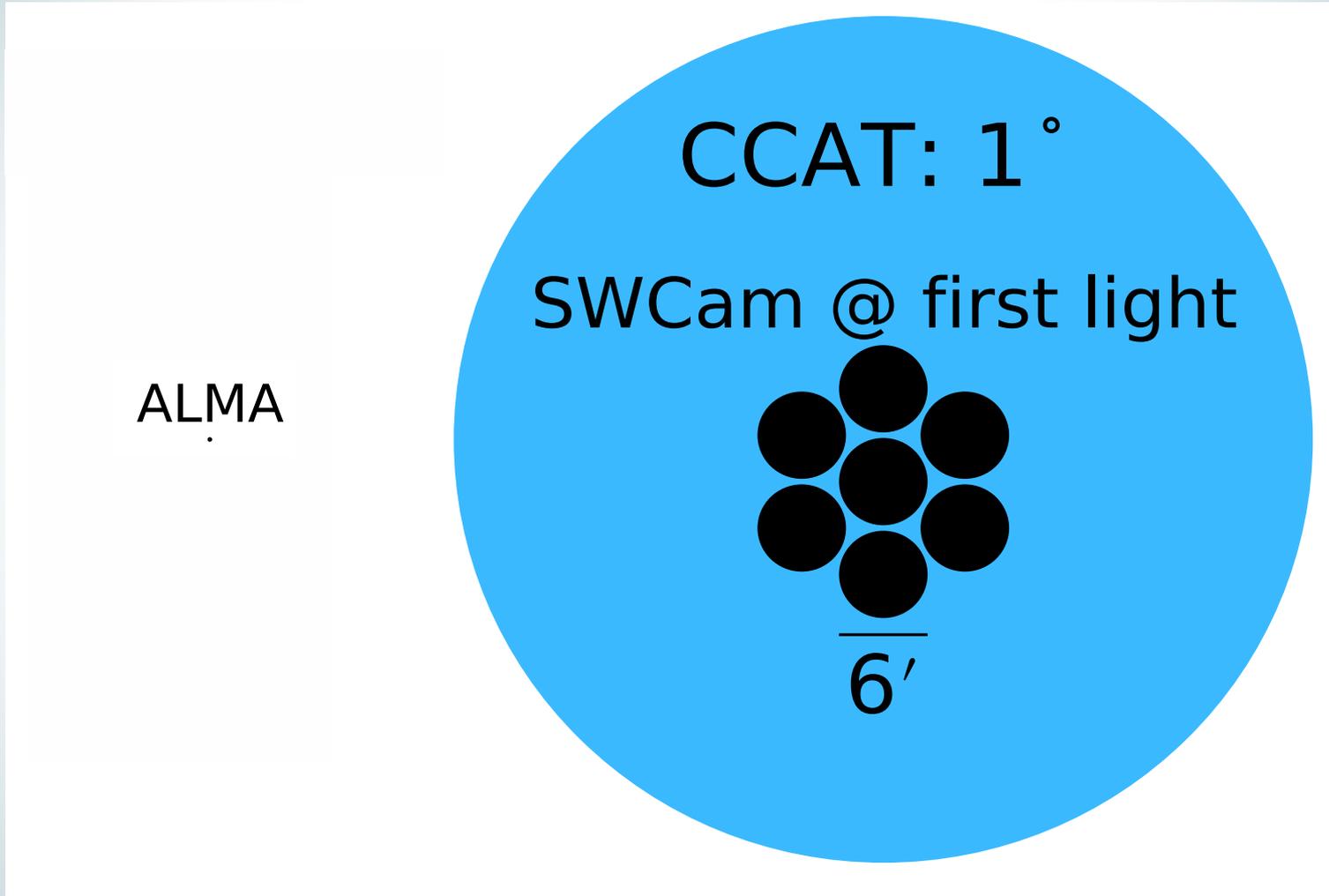
- 1 degree field-of-view

CCAT: Angular resolution

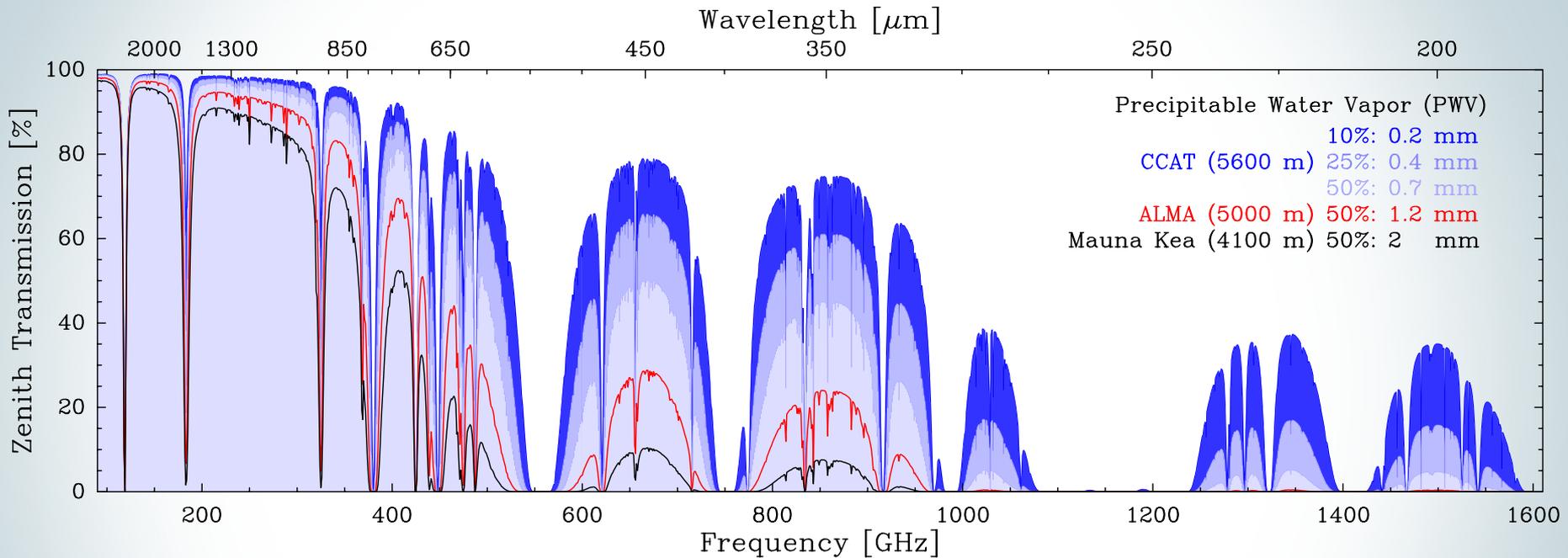


- CCAT: 3.5'' at 350 μm
- Identify counterparts to optical / infrared

CCAT: Wide Field of View

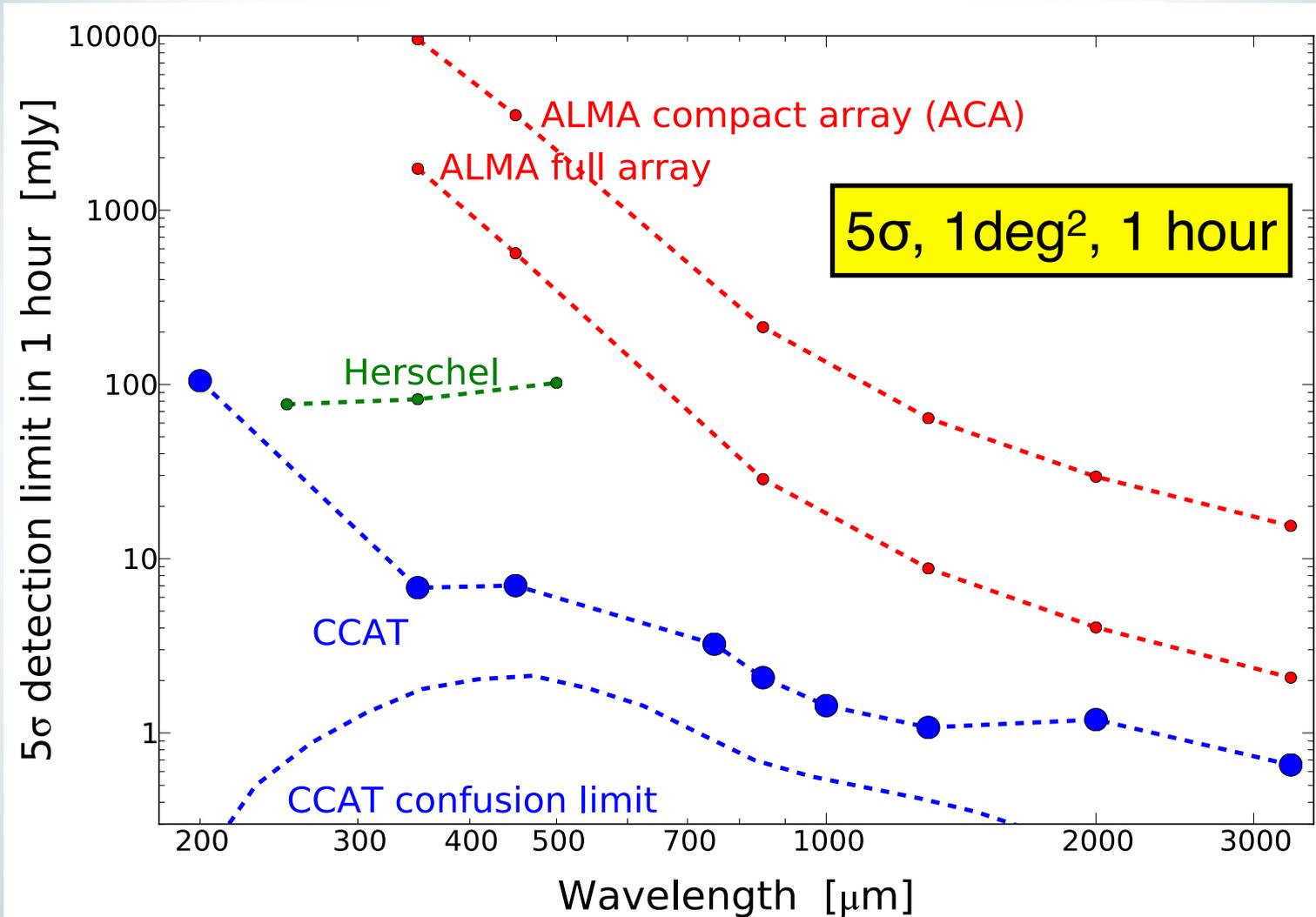


CCAT: Site conditions

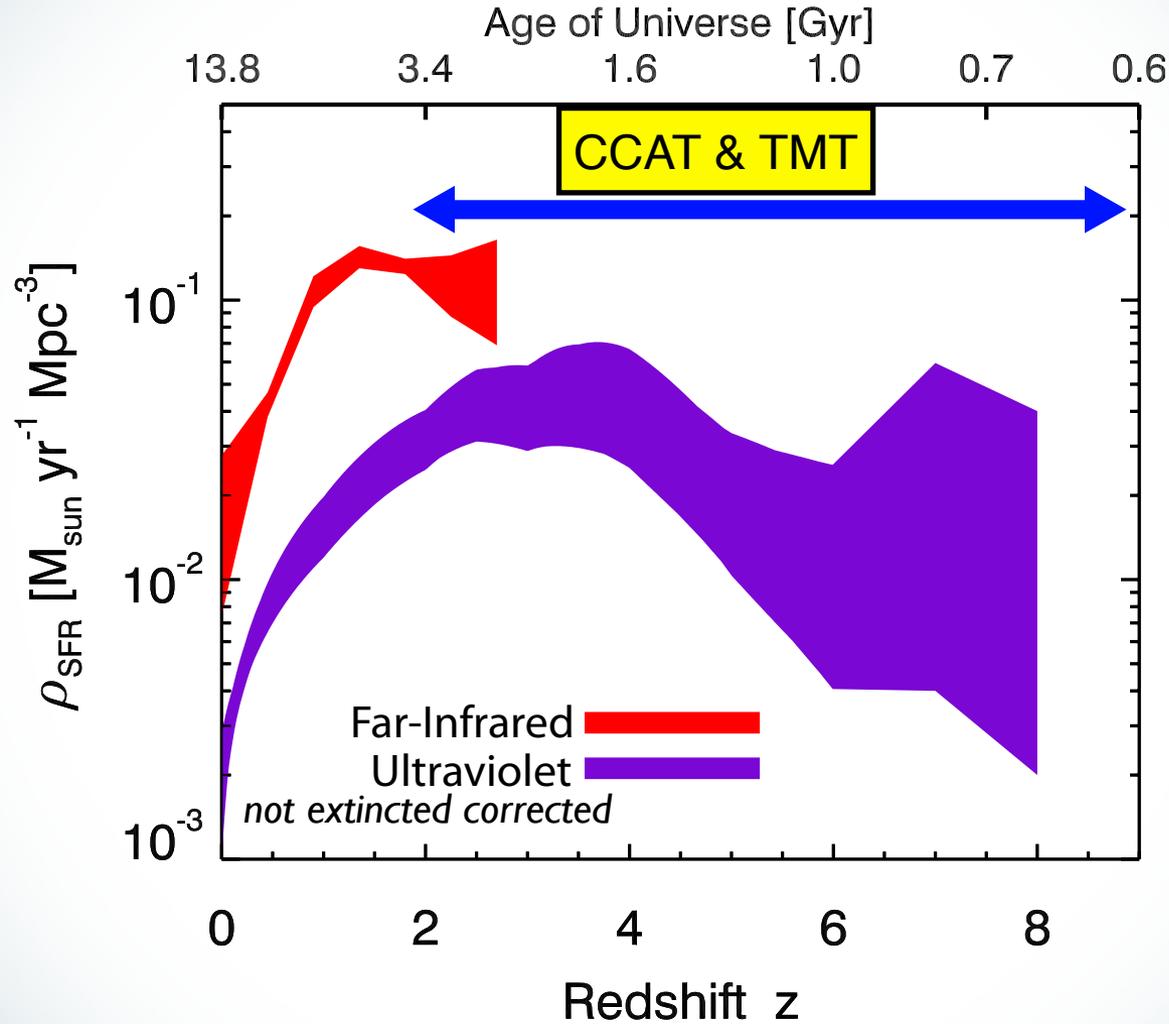


- Median transparency is 2x that of ALMA at $350\mu\text{m}$
- Multi-wavelength observations: $200\mu\text{m}$ to $3000\mu\text{m}$

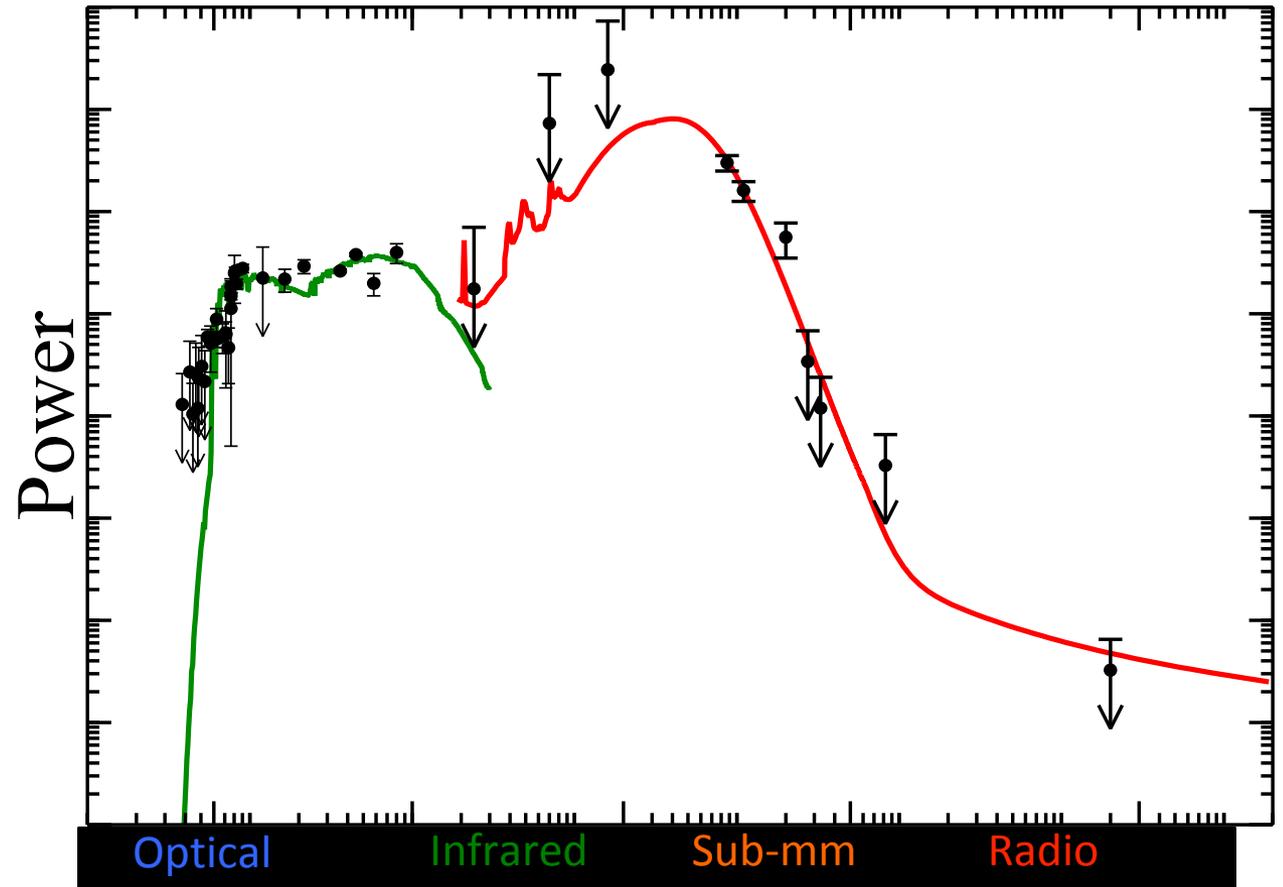
CCAT: Continuum mapping speed



Star Formation History of the Universe



Multi-wavelength Synergy is Essential

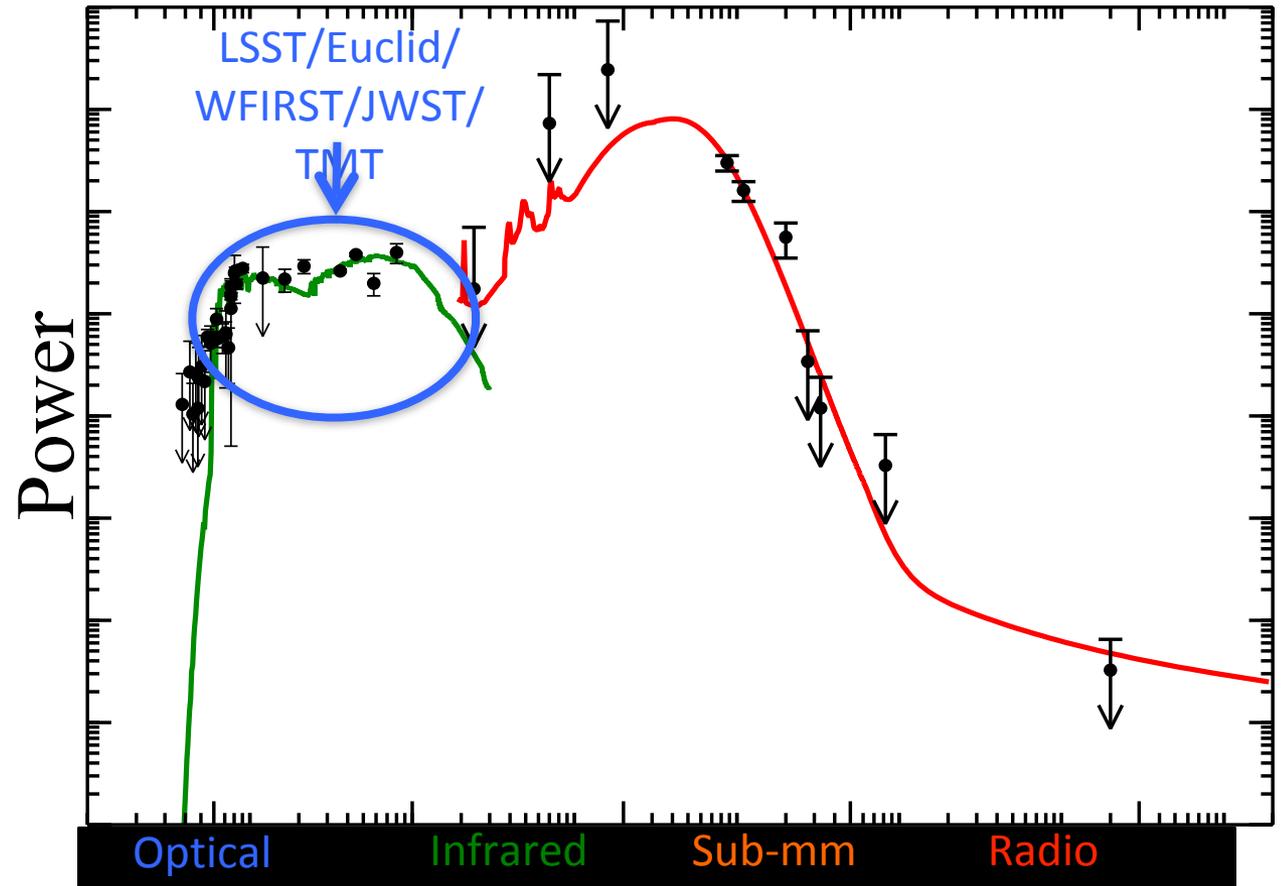


Multi-wavelength Synergy is Essential



Optical/Infrared

- Redshift, Stellar Mass, UV-SFR, Metallicity, Ionization



Multi-wavelength Synergy is Essential

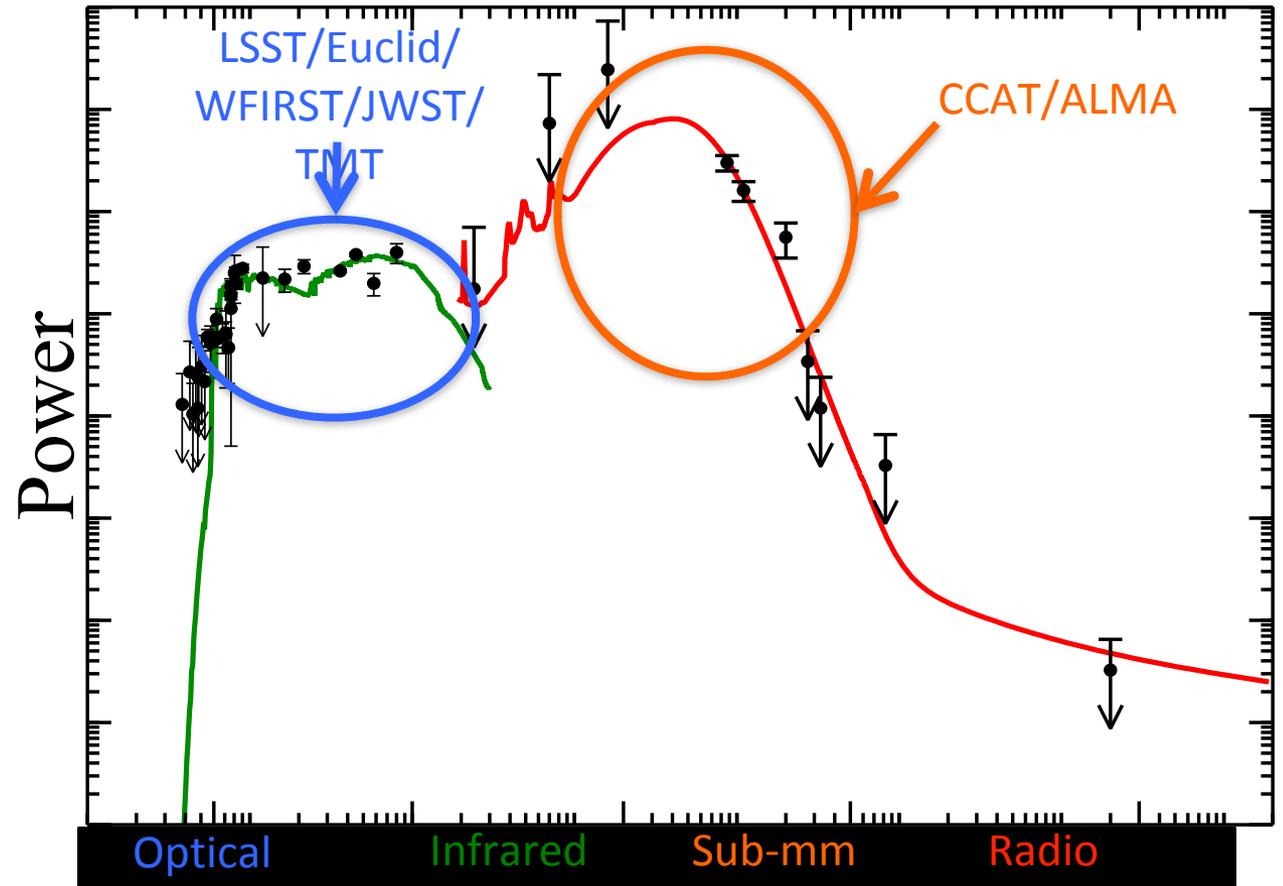


Optical/Infrared

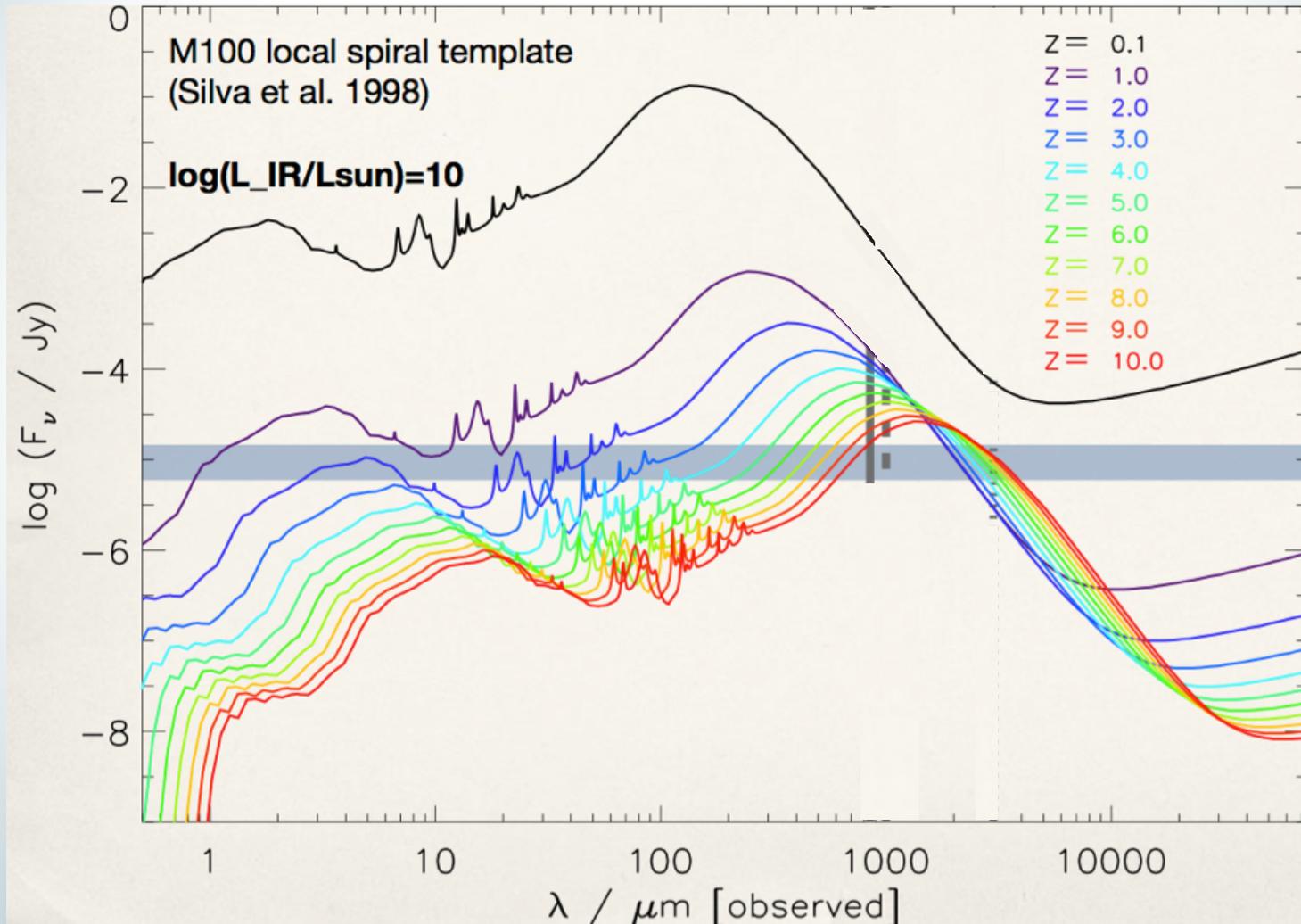
- Redshift, Stellar Mass, UV-SFR, Metallicity, Ionization

Sub-mm

- Gas Mass, Dust Mass, Submm-SFR, Metals, Ionization



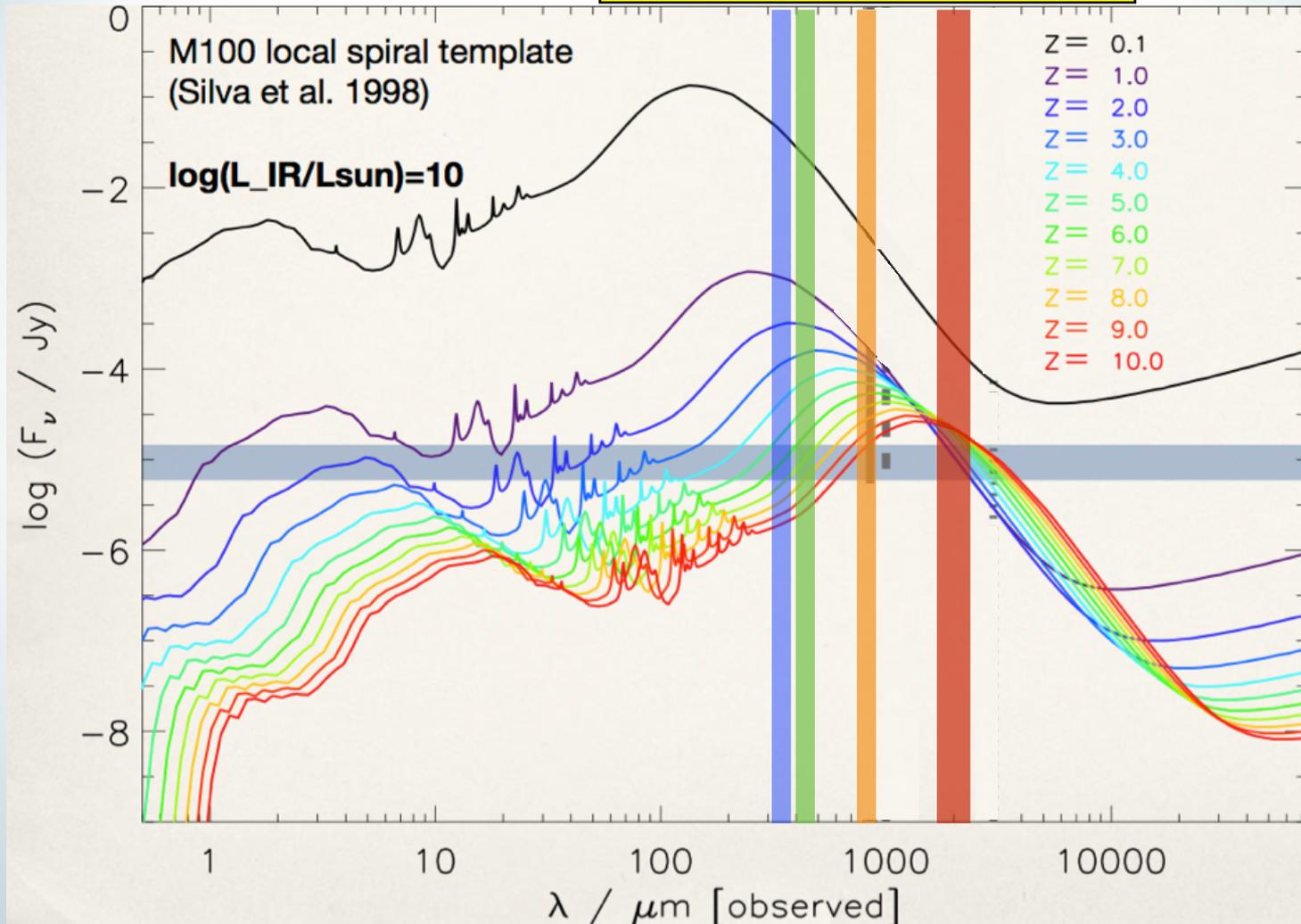
High-redshift dusty galaxies : SED



High-redshift dusty galaxies : SED



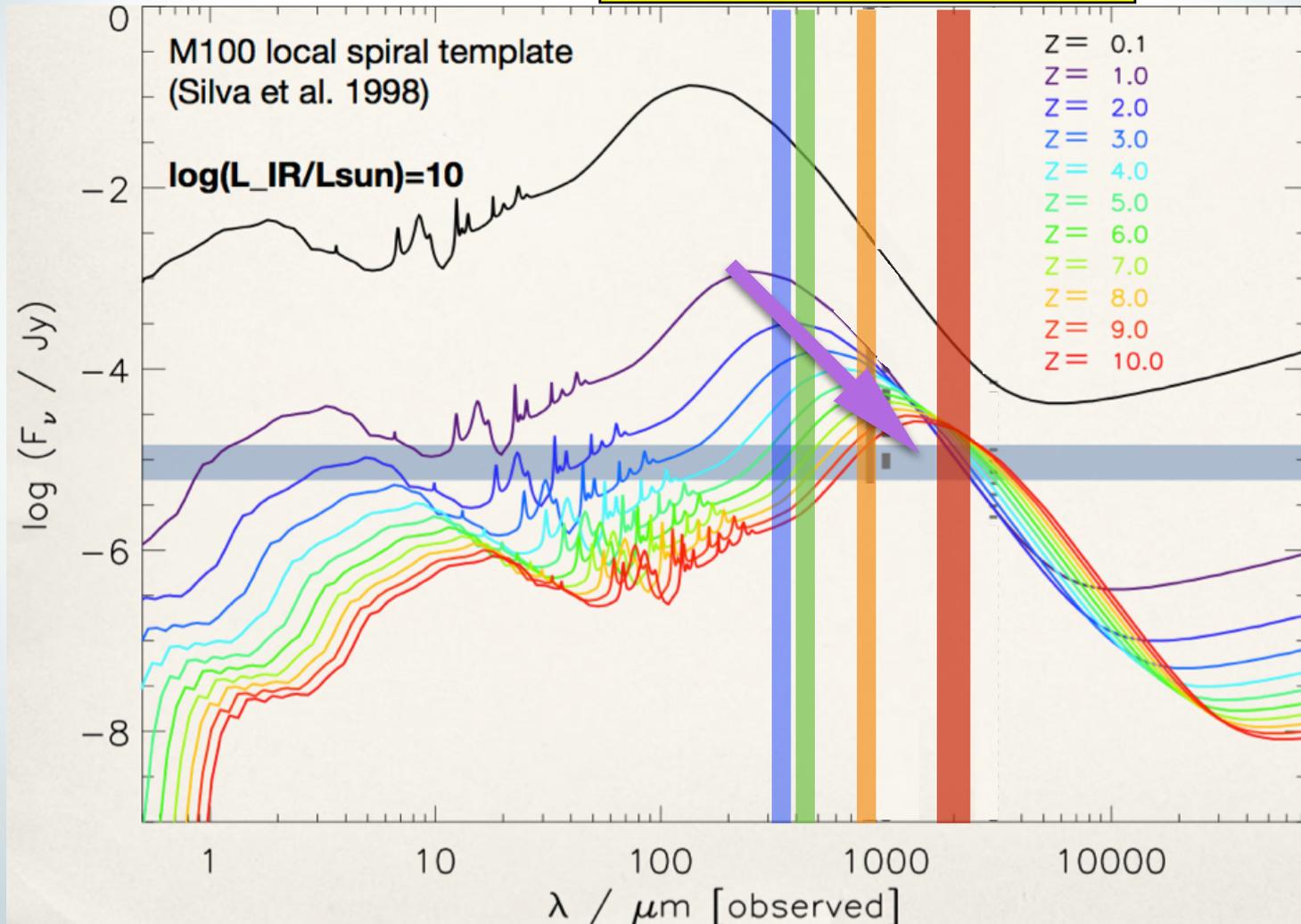
CCAT First Light Camera



High-redshift dusty galaxies : SED



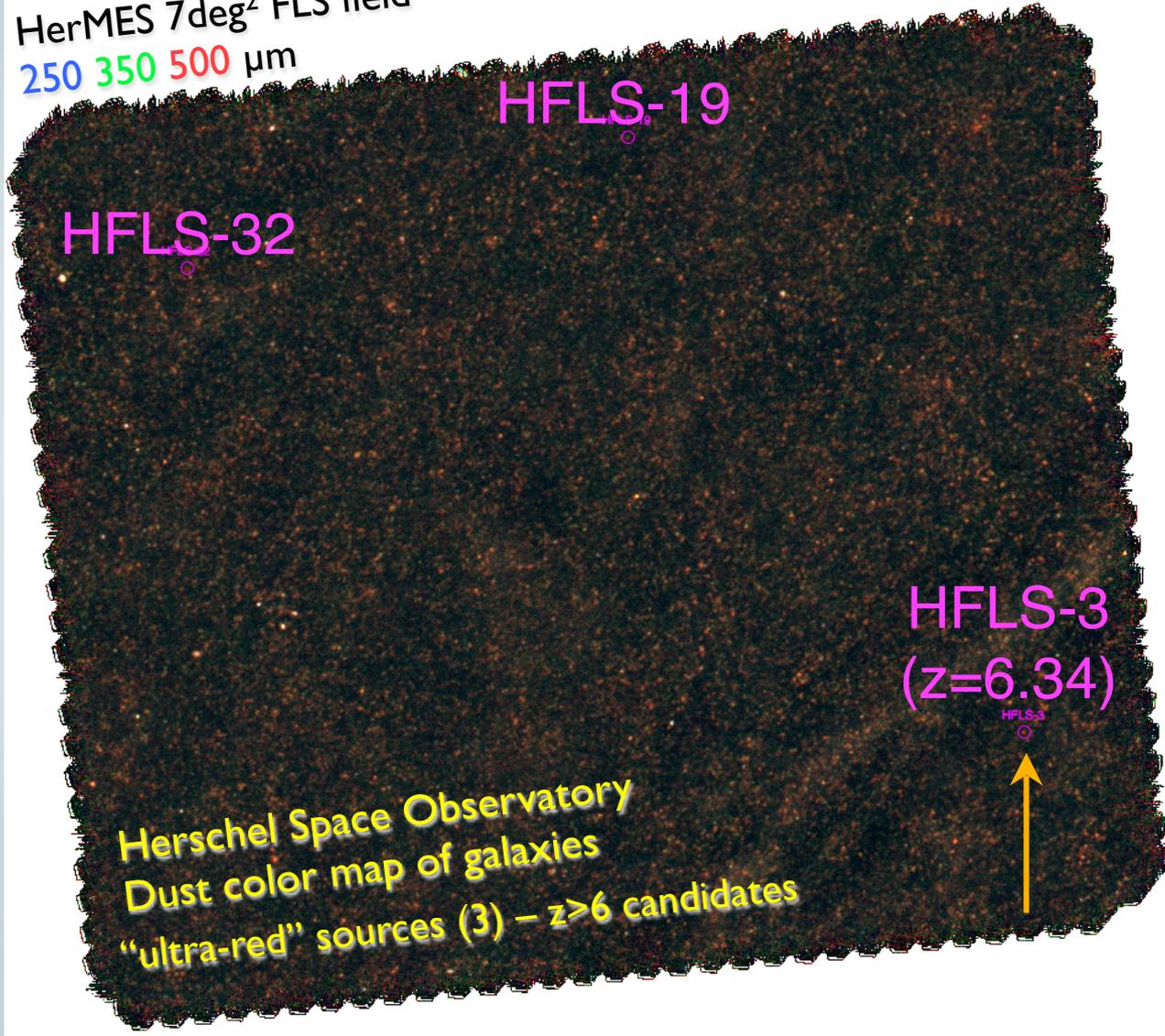
CCAT First Light Camera



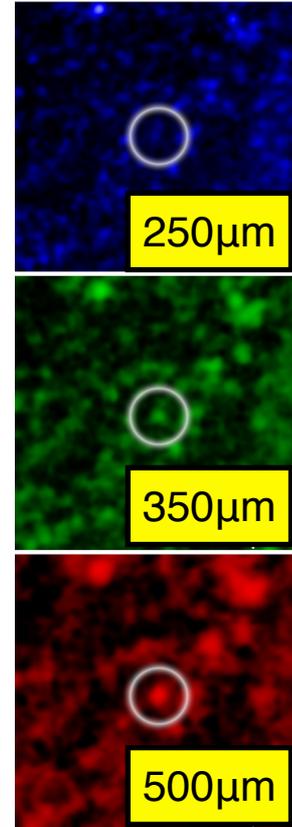
High-redshift dusty galaxies



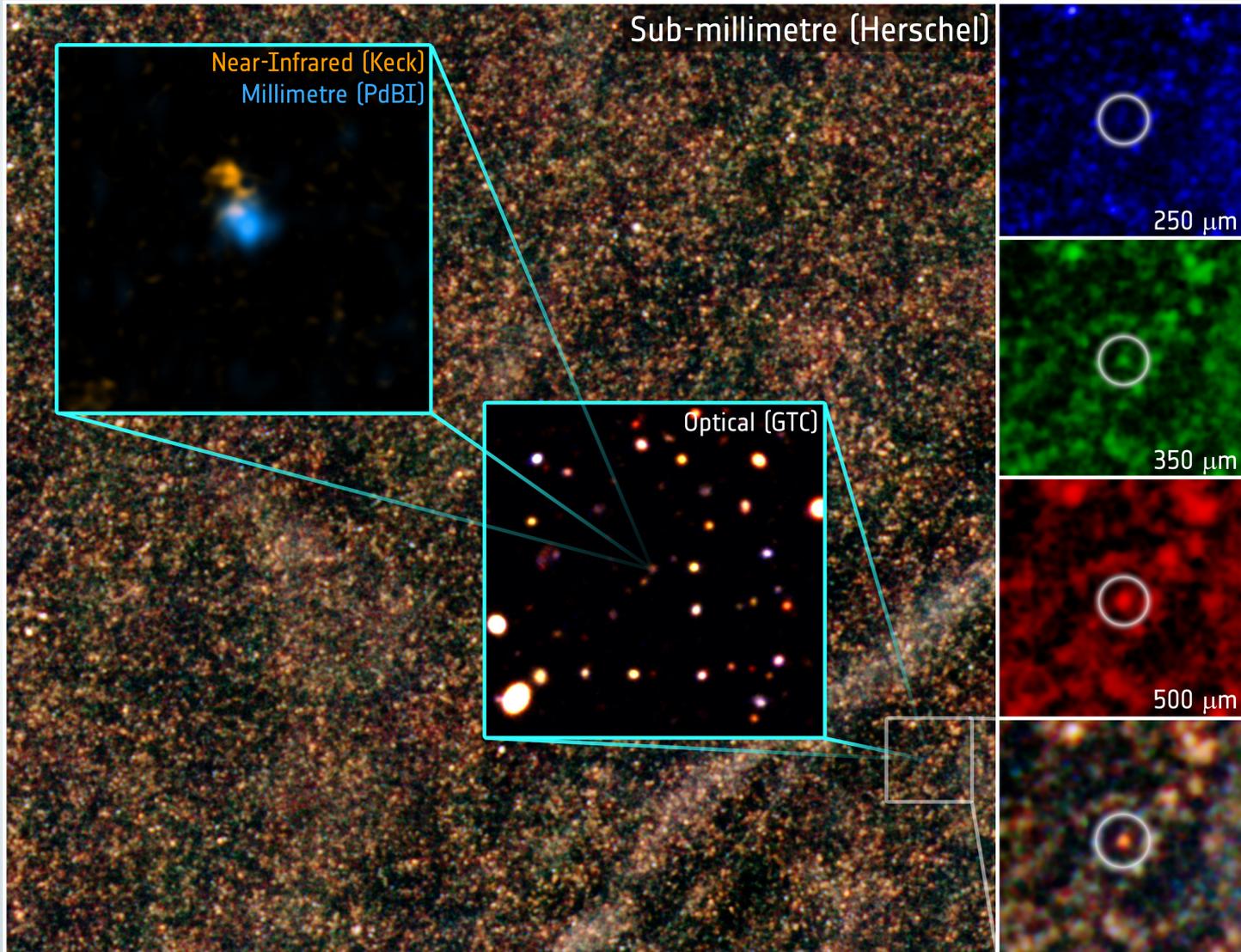
HerMES 7deg² FLS field
250 350 500 μm



HFLS-3



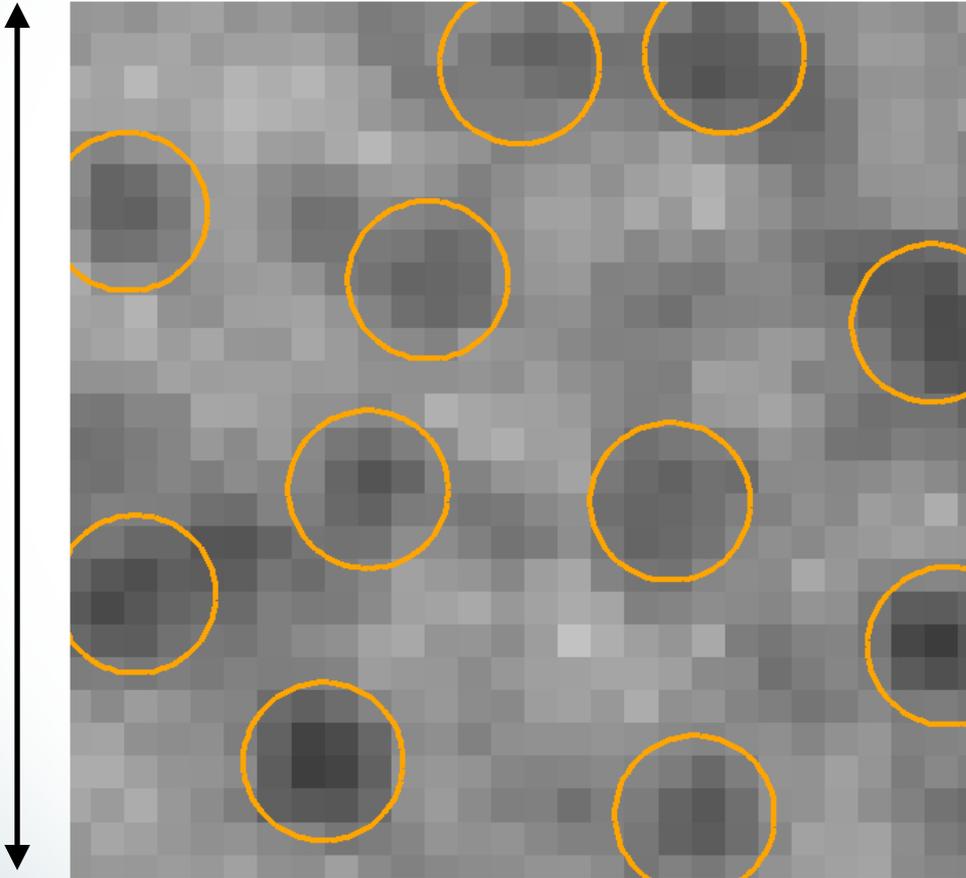
High redshift dust galaxies



Why CCAT?

Herschel 350 μm

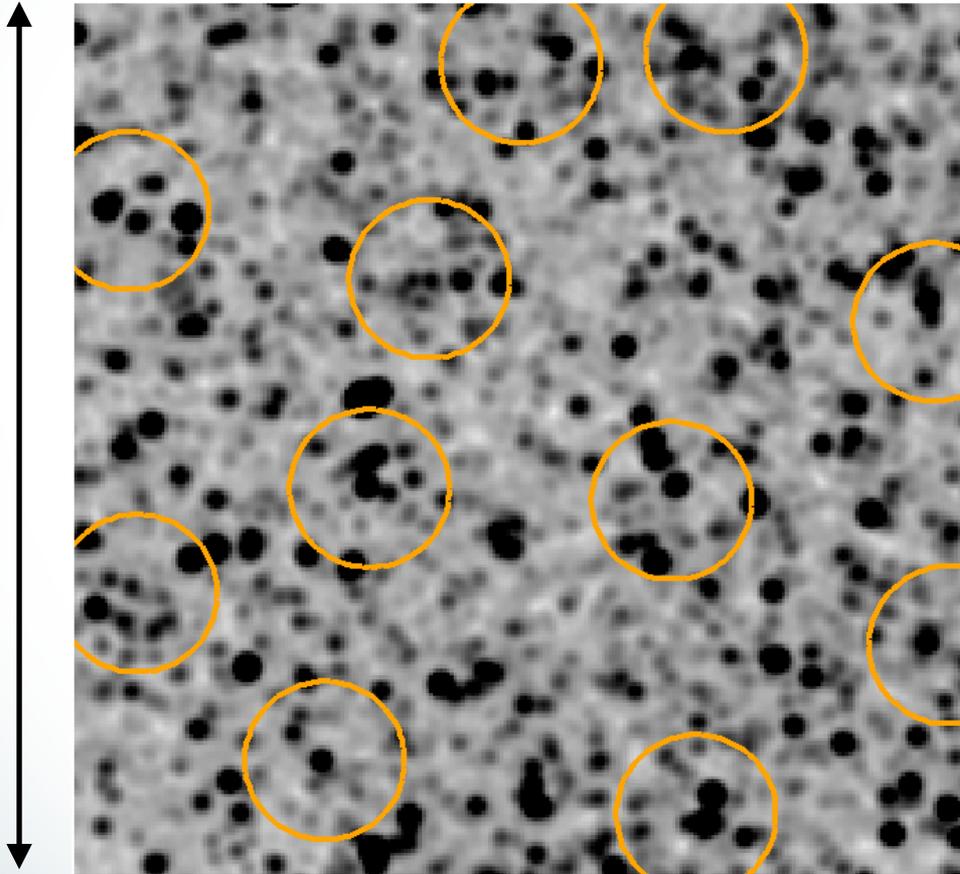
4 arcmin



Why CCAT?

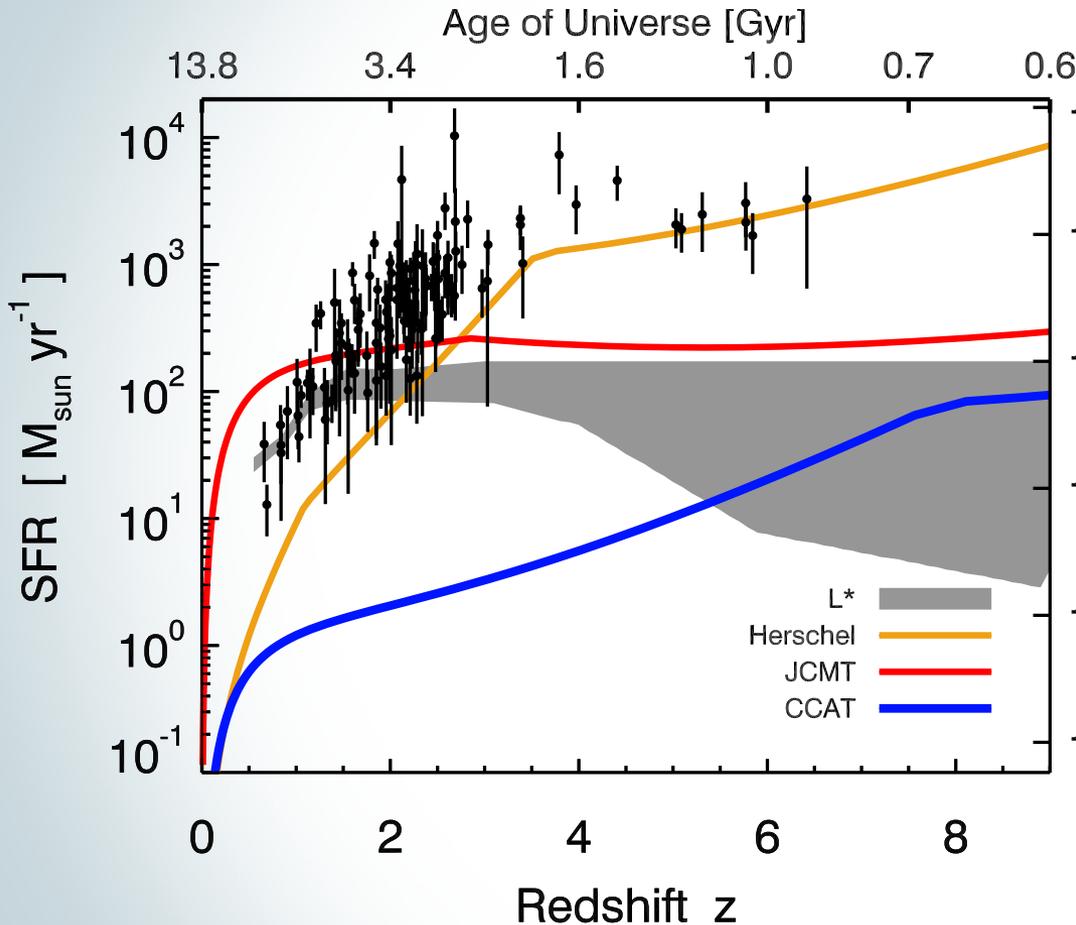
CCAT $350\mu\text{m}$

4 arcmin



≈ 1000 hour, 1 deg^2

Star formation history of the universe



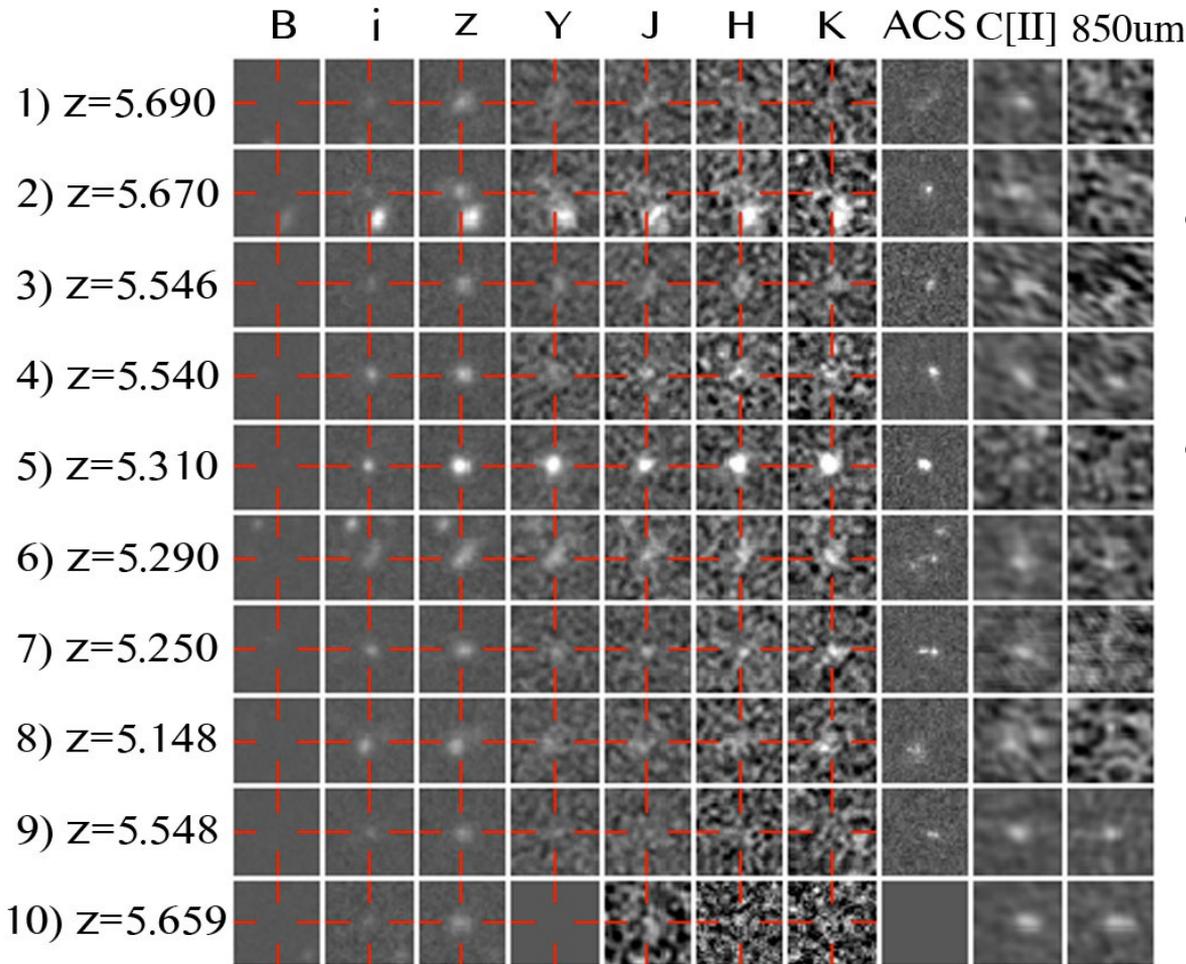
CCAT

- Trace the evolution of gas and dust in galaxies, obscured SFR

TMT

- Image the evolution of stellar disk, unobscured SFR, and intergalactic medium

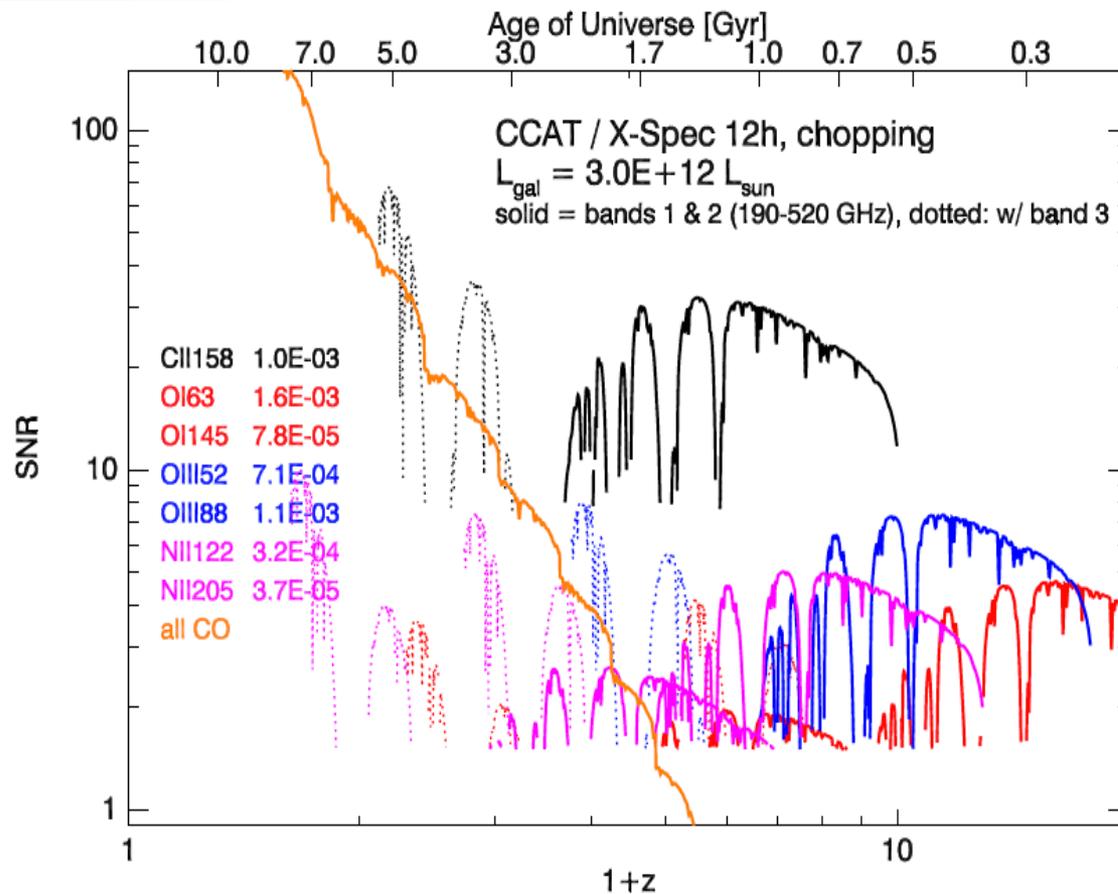
Submillimeter Spectroscopy



- C⁺ is submillimeter equivalent of H alpha
- Sometimes easier to detect than continuum

Capak et al. (2014)

CCAT Spectroscopy

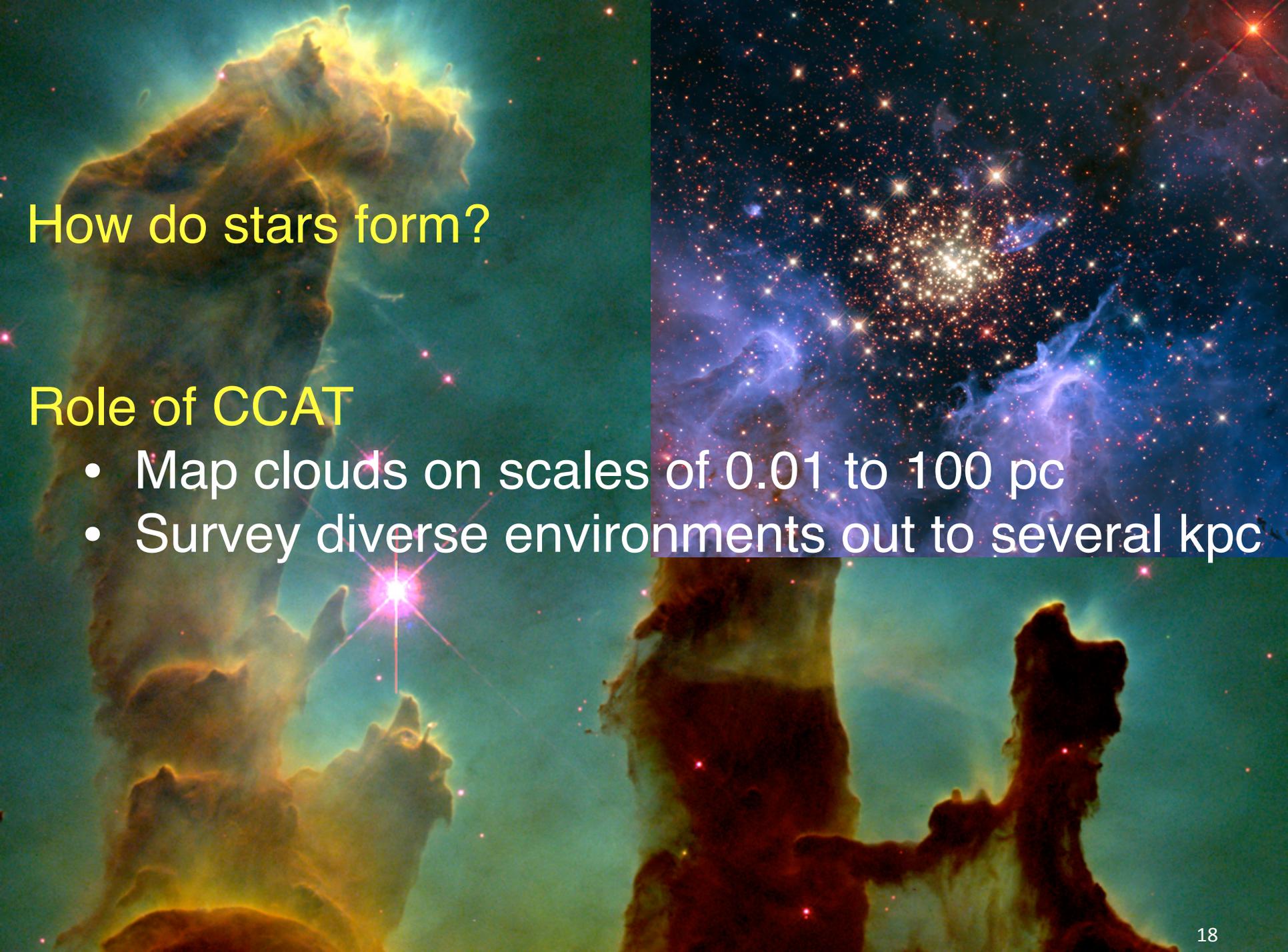


CCAT

- “Blind” survey for C+ using multi-object spectrometers

TMT

- Follow-up of detected sources to probe early formation of galaxies

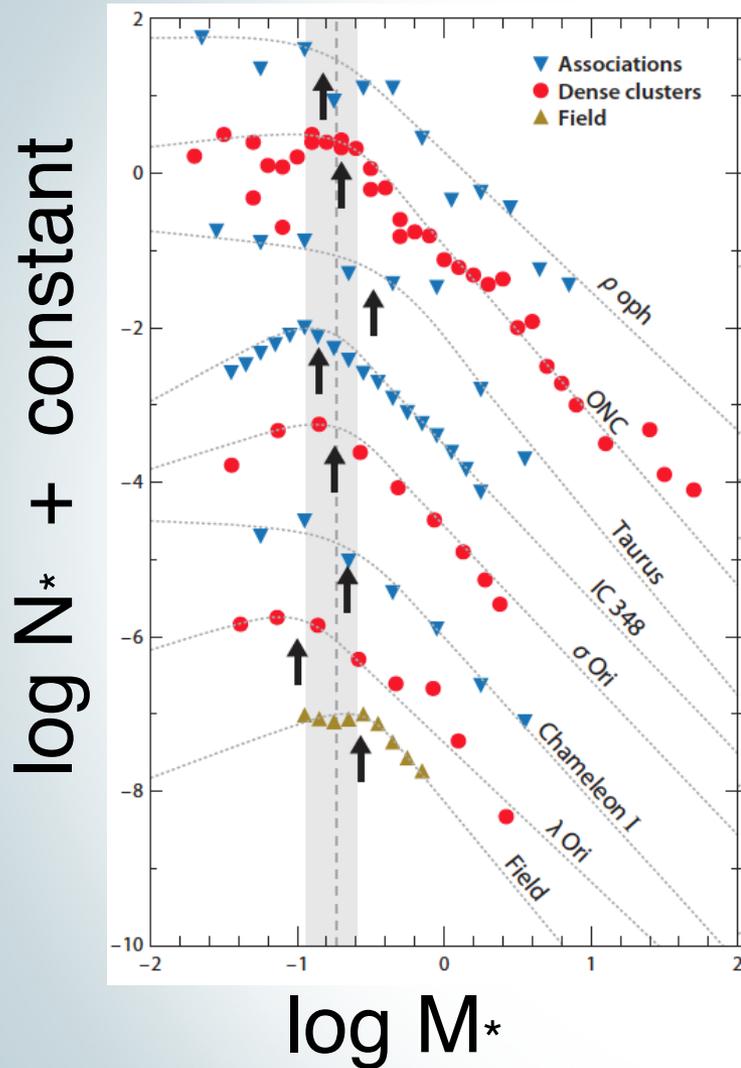


How do stars form?

Role of CCAT

- Map clouds on scales of 0.01 to 100 pc
- Survey diverse environments out to several kpc

Stellar Initial Mass Function (IMF)



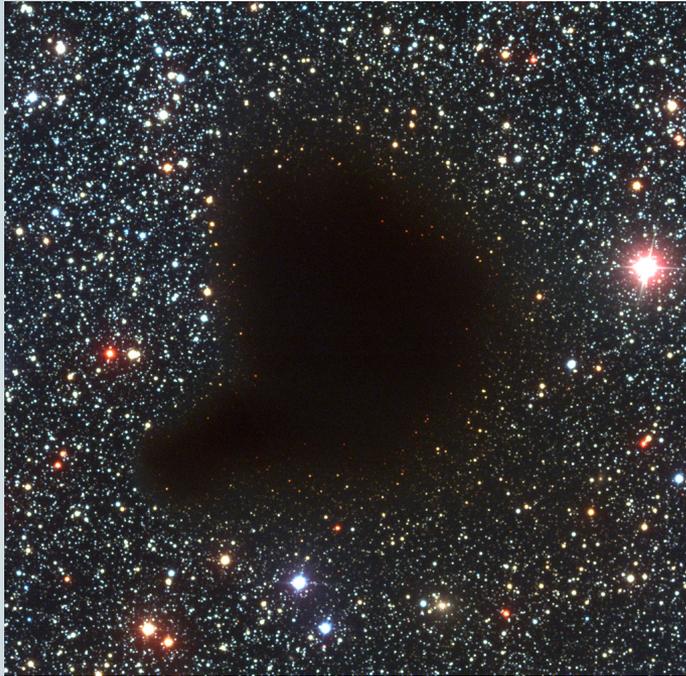
Bastian et al. (2010)

- Fundamental for understanding evolution of galaxies and clouds
- What determines the IMF shape?
- Why is the IMF shape “Universal”?

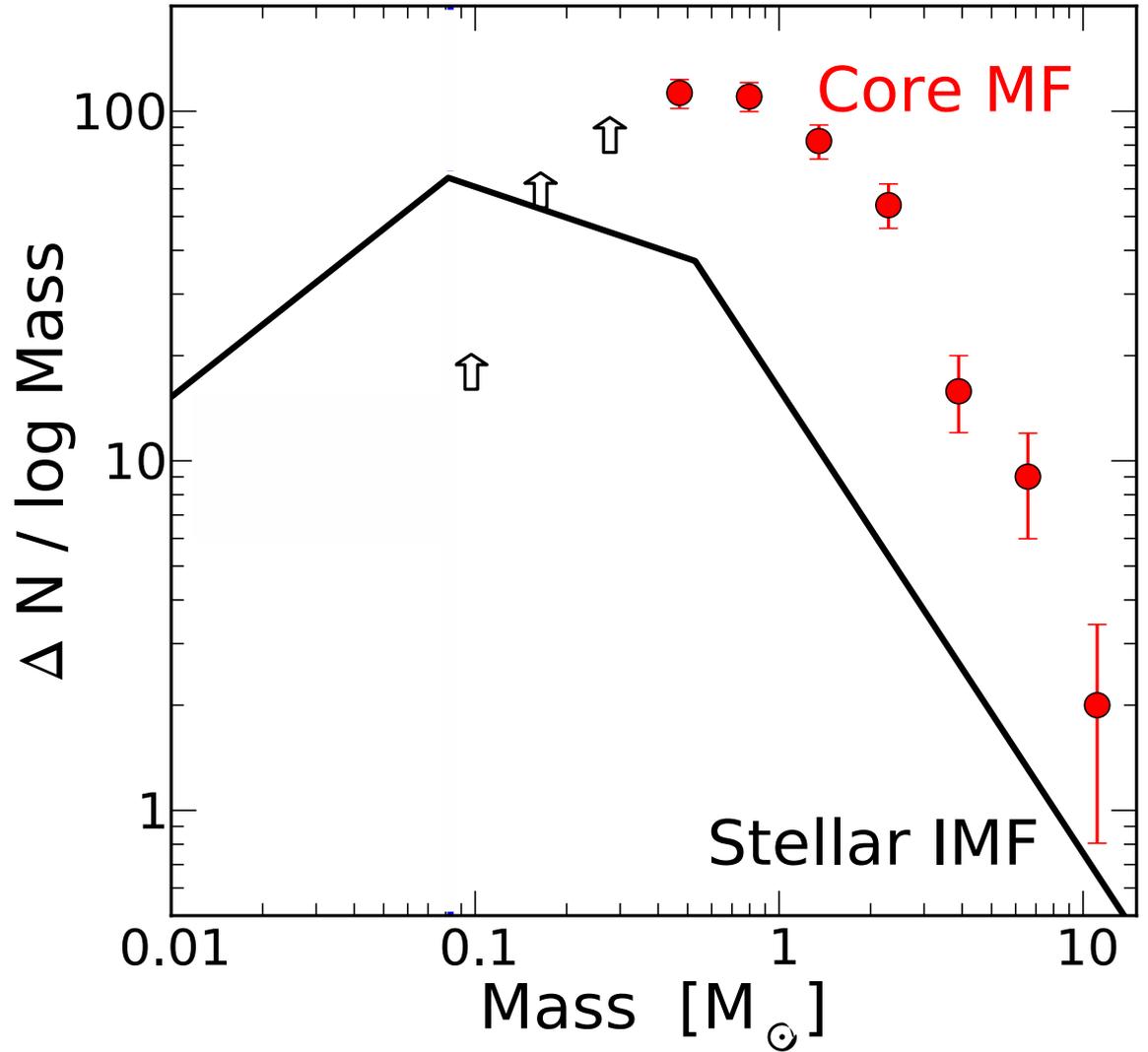


Core Mass Function in Aquila

B68 dense core

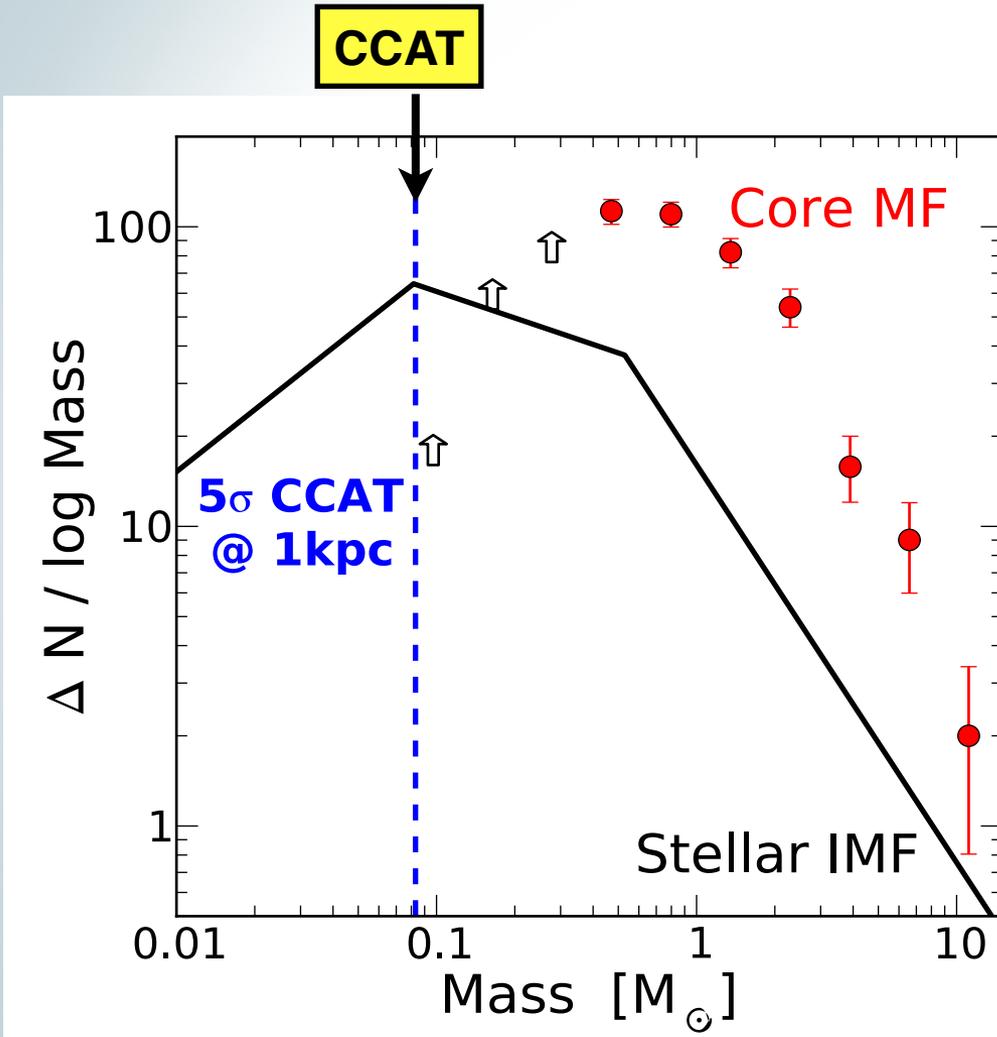


140"
0.1 pc



André et al. (2010)

Core Mass Function with CCAT



CCAT: 50x lower cirrus and extragalactic confusion noise than Herschel

Sensitivity limit (5σ):
 $0.08 M_{\odot}$ at 1 kpc
for 1 deg² in 20 hours

André et al. (2010)

Is the IMF imprinted in the cloud structure?



CCAT

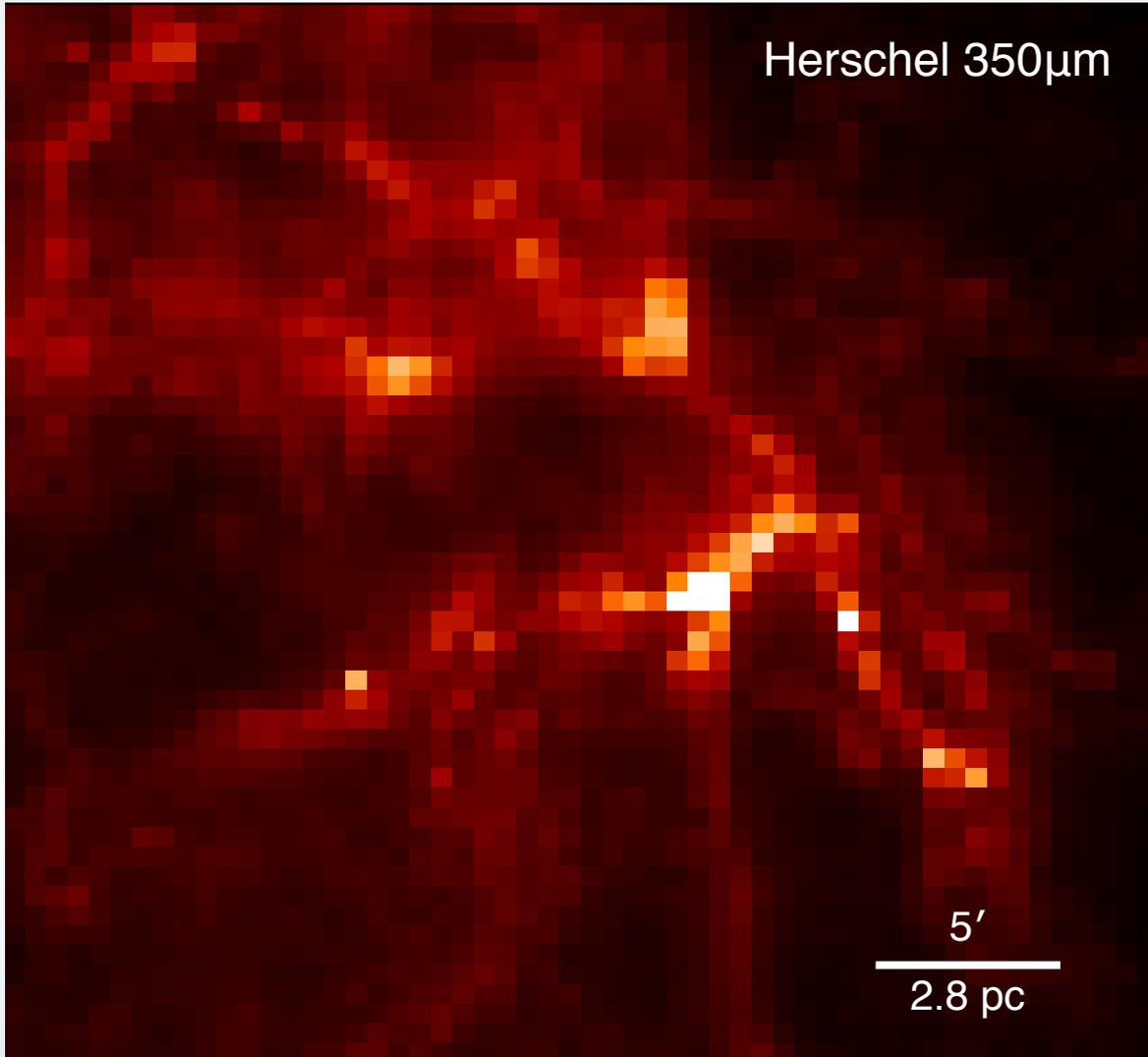
- Measure peak/shape of CMF in different environments



TMT

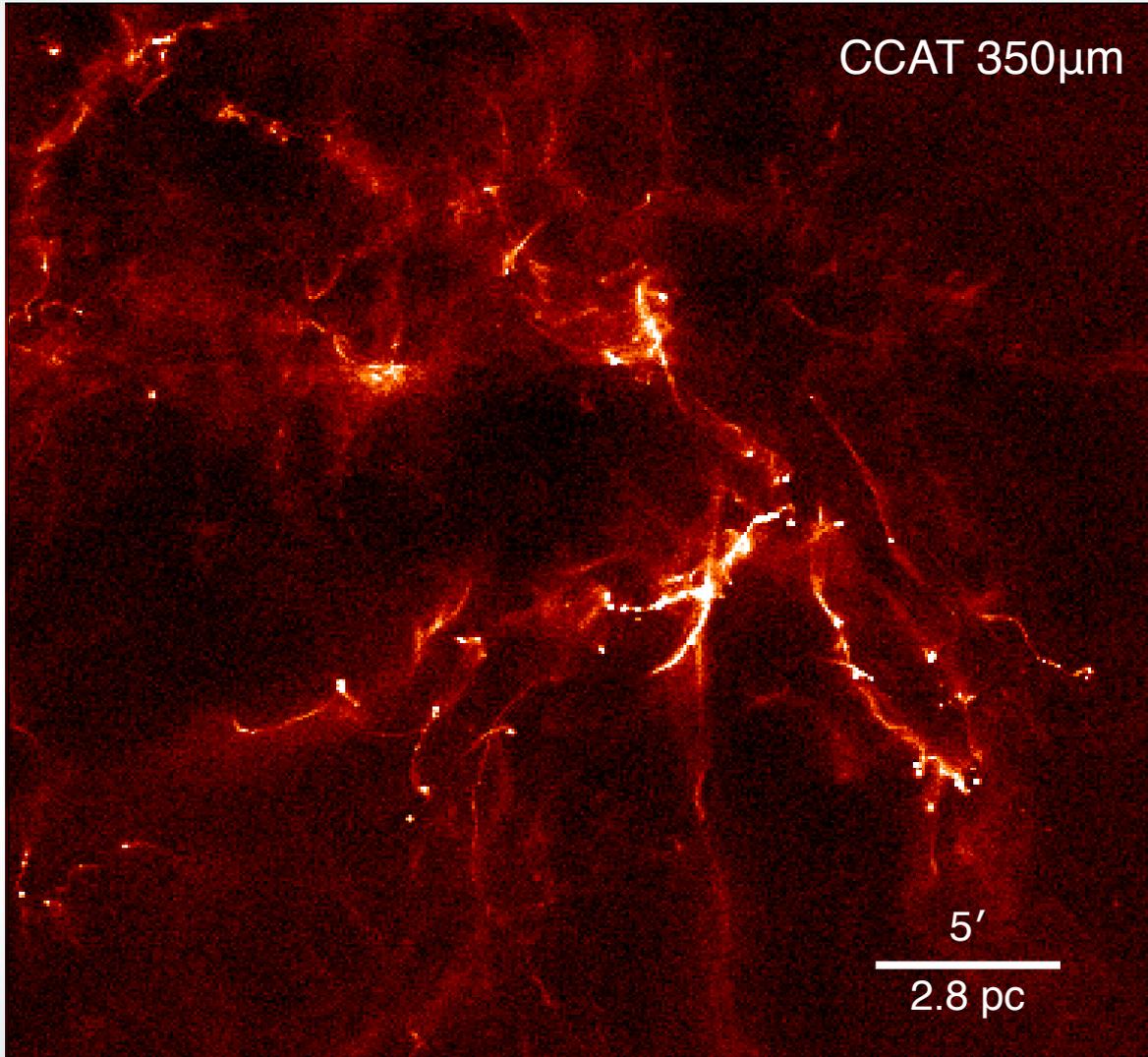
- Measure IMF in different environments
- How universal is the IMF shape?

CCAT vs. Herschel



Simulated continuum maps of molecular clouds

CCAT vs. Herschel



Simulated continuum maps of molecular clouds

Synergies between CCAT and TMT



Star formation history of the universe

CCAT

- Measure obscured star formation and evolution of ISM

TMT

- Measure unobscured star formation and stellar content

Origin of the Stellar IMF

CCAT

- Measure clump mass function vs. environment

TMT

- Measure stellar IMF vs. environment