

# The Survey of Lines in M31 (SLIM): Investigating the Origins of [CII] Emission

Maria Kapala

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K. Kreckel, A. Lewis, H. W. Rix, E. Schinnerer, F. Walter, D. Weisz**

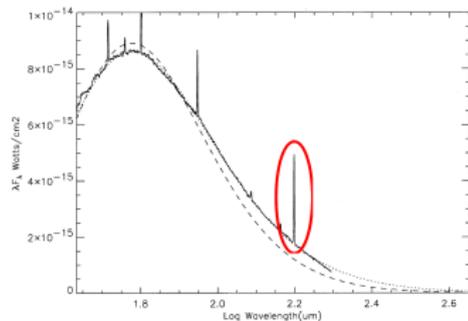


# Outline

- 1 Intro
- 2 Data
  - SLIM - Survey of Lines in M31
  - PHAT - Pan-chromatic Hubble Andromeda Treasury
- 3 Analysis
  - CII from SF regions
  - Stellar populations heating ISM
  - Far-IR line deficit
- 4 Conclusions

Motivation: use [CII] 158  $\mu\text{m}$  emission line

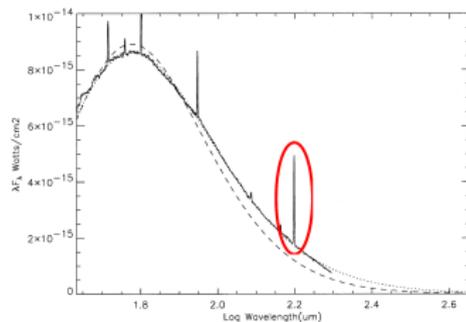
- strong



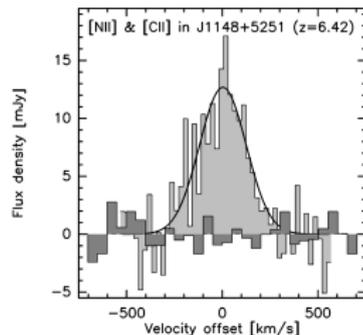
Colbert et al. 1998

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- strong
- easy to observe even in high  $z$



Colbert et al. 1998

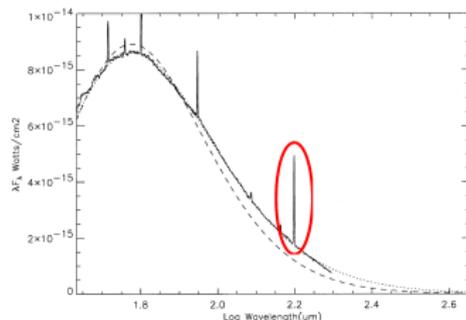


# Motivation: use [CII] 158 $\mu\text{m}$ emission line

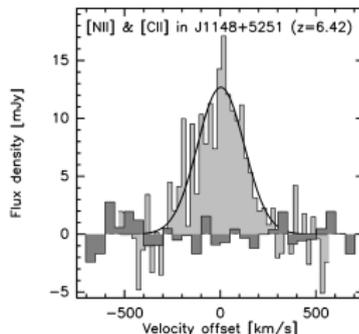
- strong
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Potentially can be used to

- estimate SFR
- probe some of the ISM physical conditions



Colbert et al. 1998



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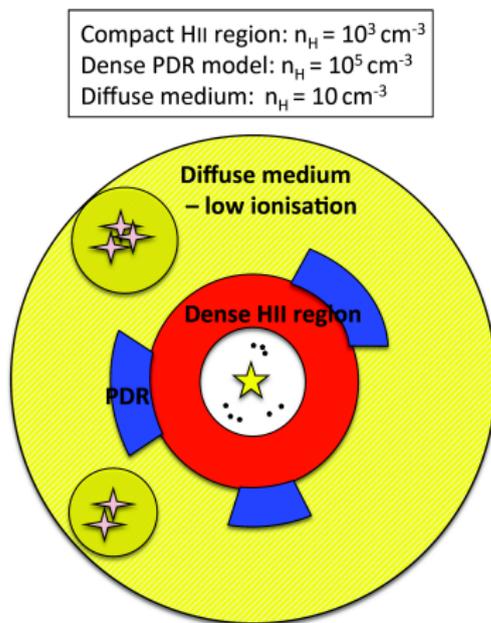
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(photodissociation regions)

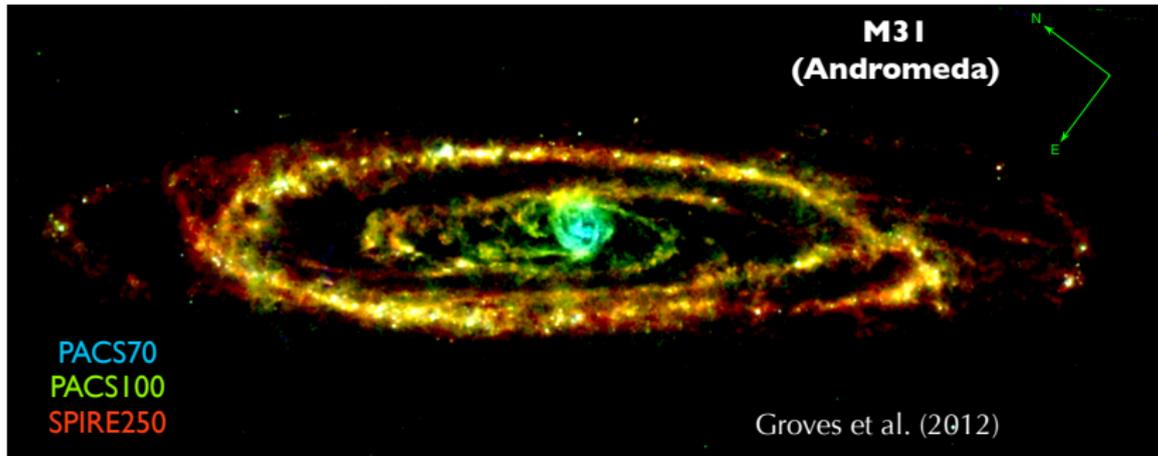
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credit: Diane Cormier

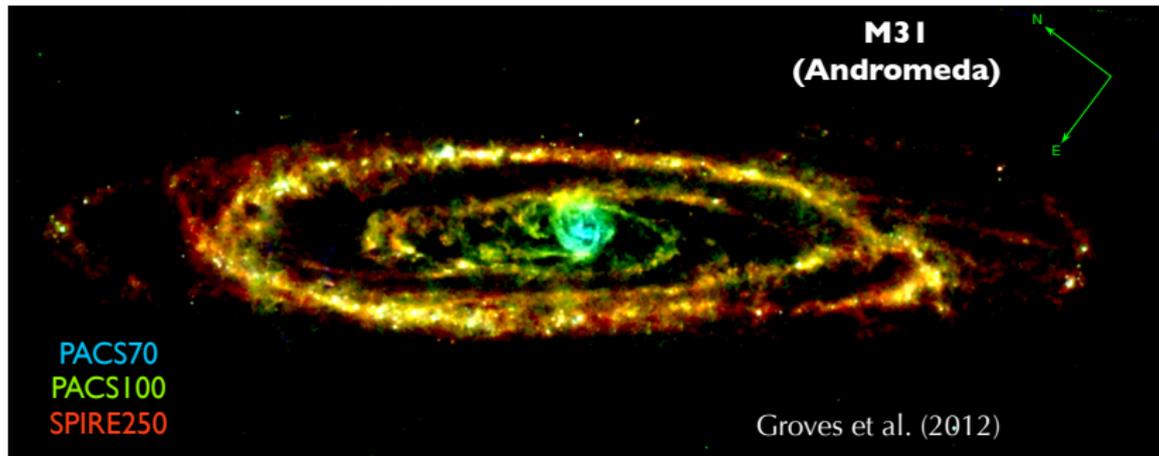
## Solution: pick Andromeda



- proximity → resolution



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- proximity → resolution
- external view → no LOS confusion
- large, star-forming, metal-rich,  $L_*$  galaxy

## Large amount of ancillary data

- Herschel (spectroscopy and photometry)  
70 – 500  $\mu\text{m}$  at a spatial resolution down to  $\sim 45$  pc at 160  $\mu\text{m}$

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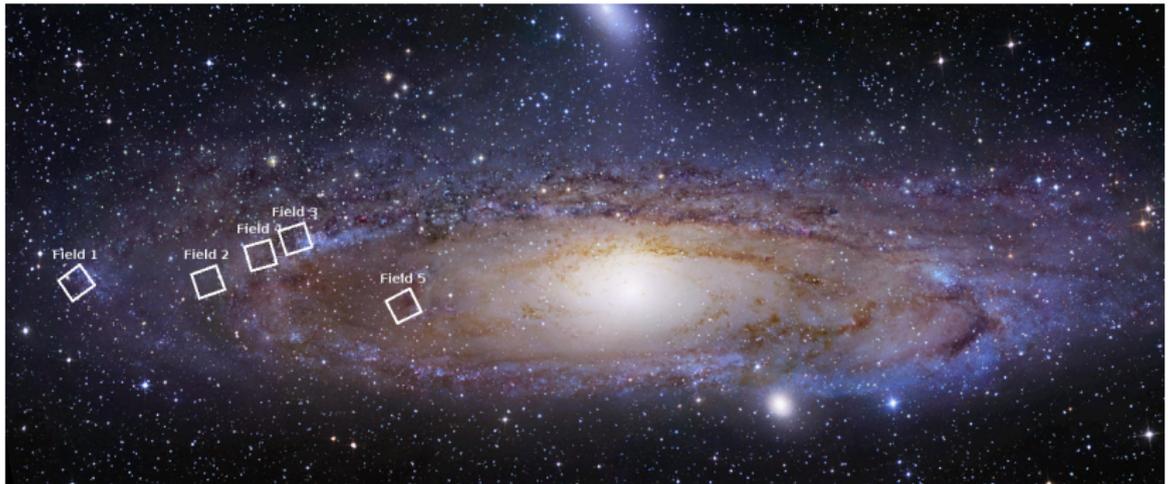
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70 – 500  $\mu\text{m}$  at a spatial resolution down to  $\sim 45$  pc at 160  $\mu\text{m}$
- Calar Alto (PPAK) - optical IFS
- HST (Pan-chromatic Hubble Andromeda Treasury survey)  
properties of individual stars  $> A0$

and others

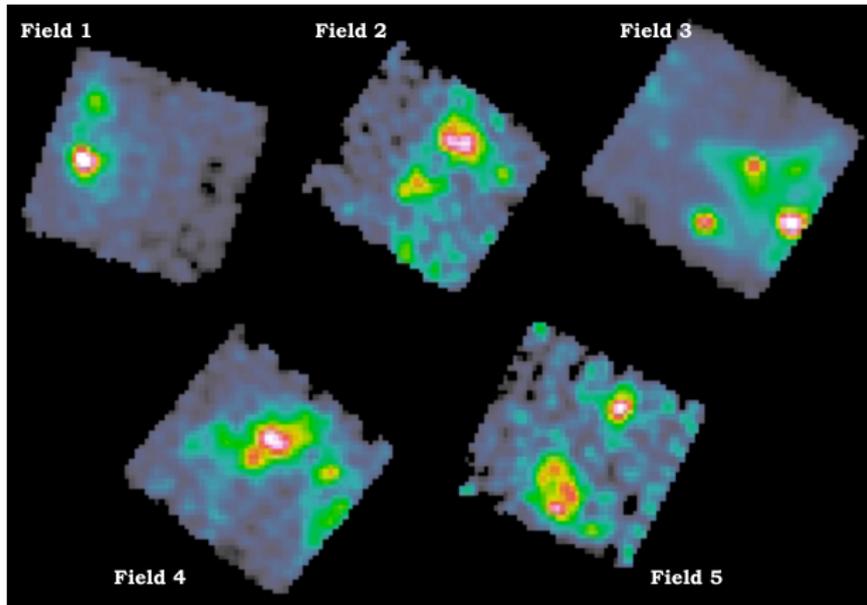
# SLIM coverage

## Andromeda galaxy



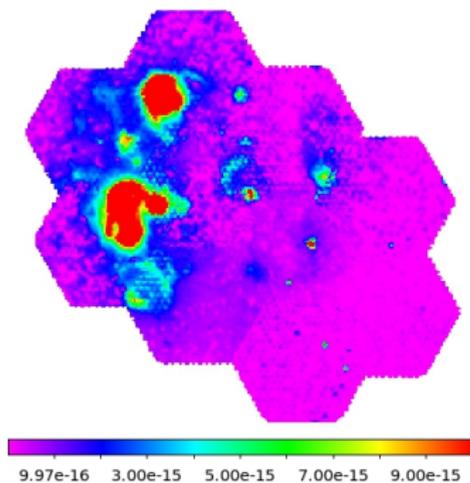
## Herschel PACS regions

# Herschel [CII] maps

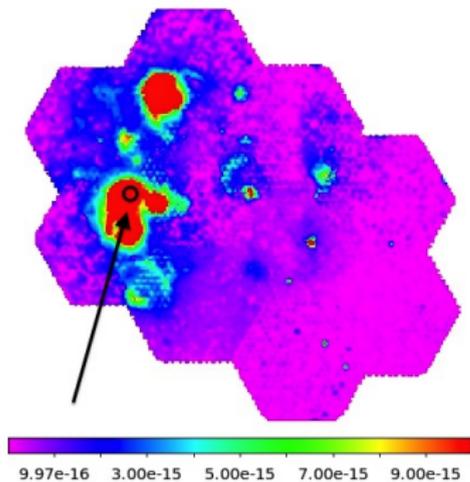


PI Karin Sandstrom

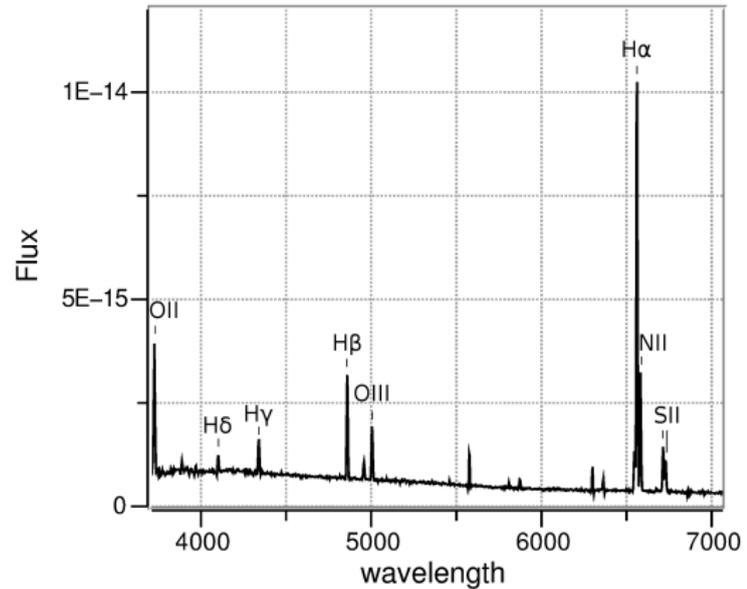
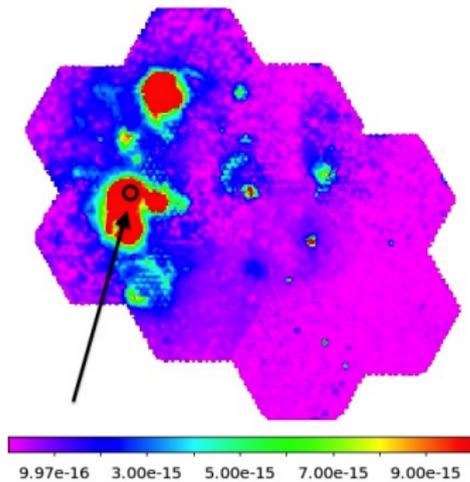
# PPAK IFS data in field 1



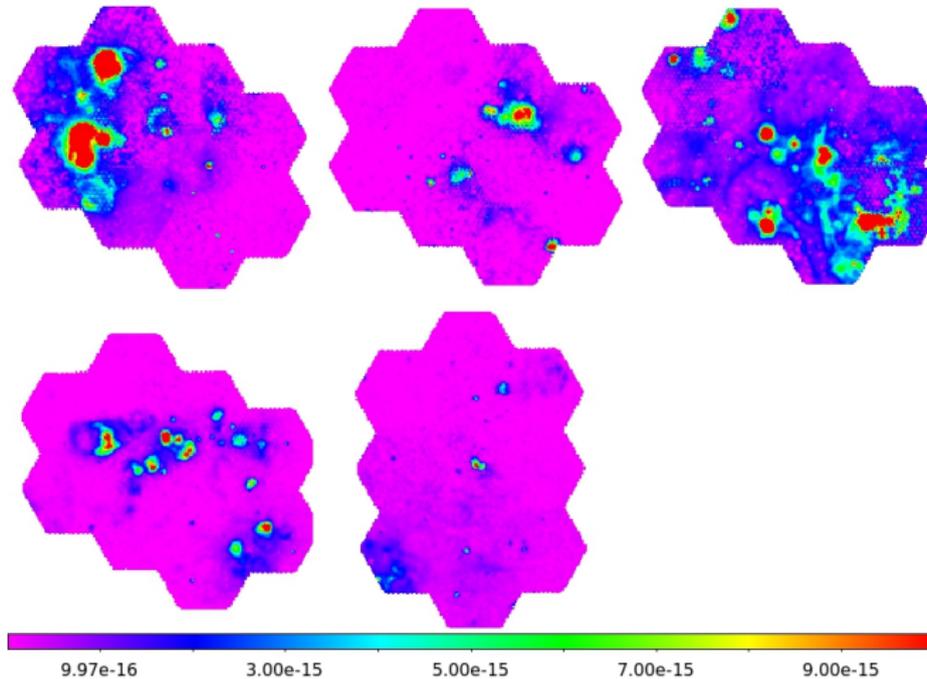
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# PPAK H $\alpha$

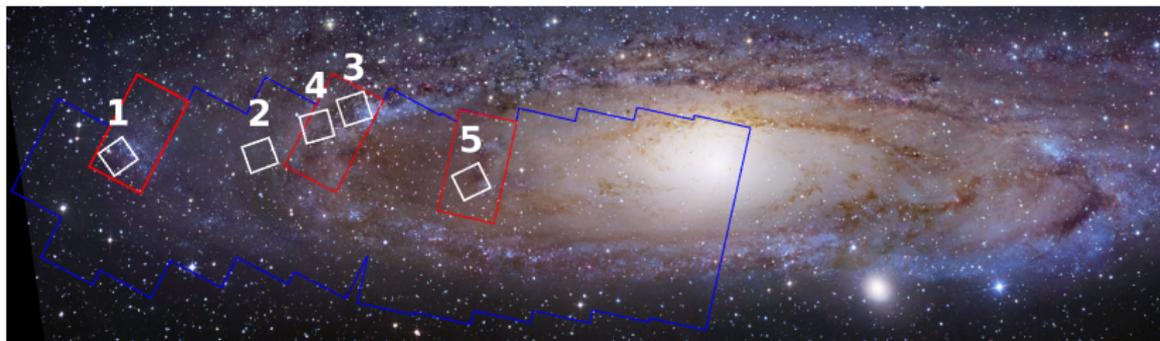


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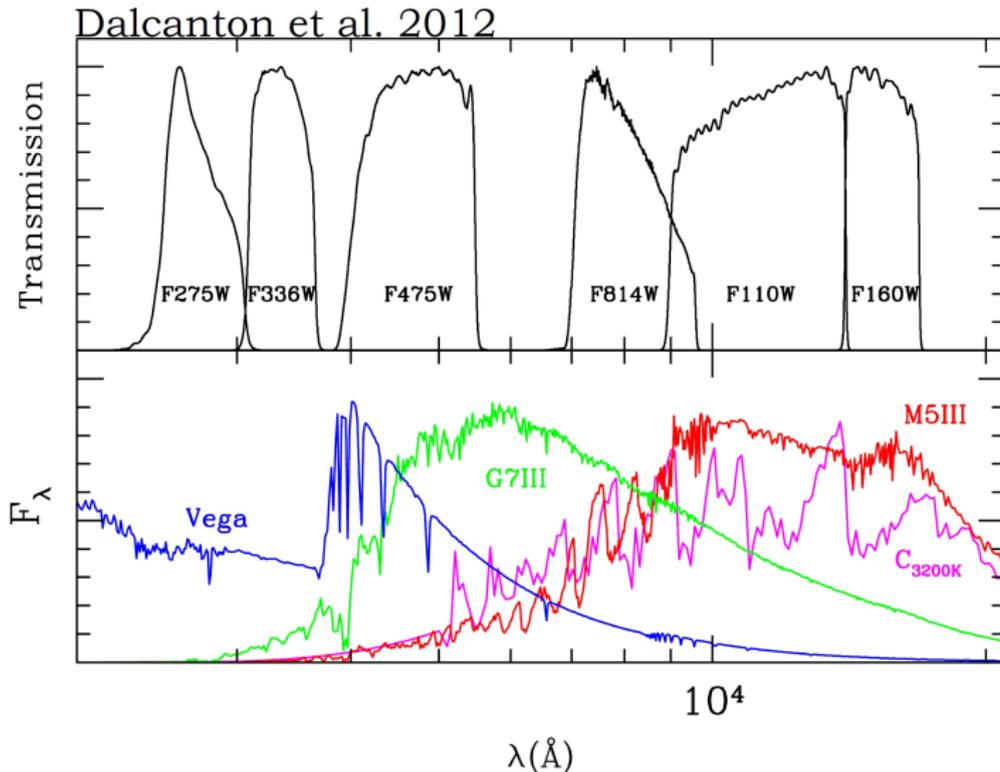
# PHAT coverage

## Andromeda galaxy

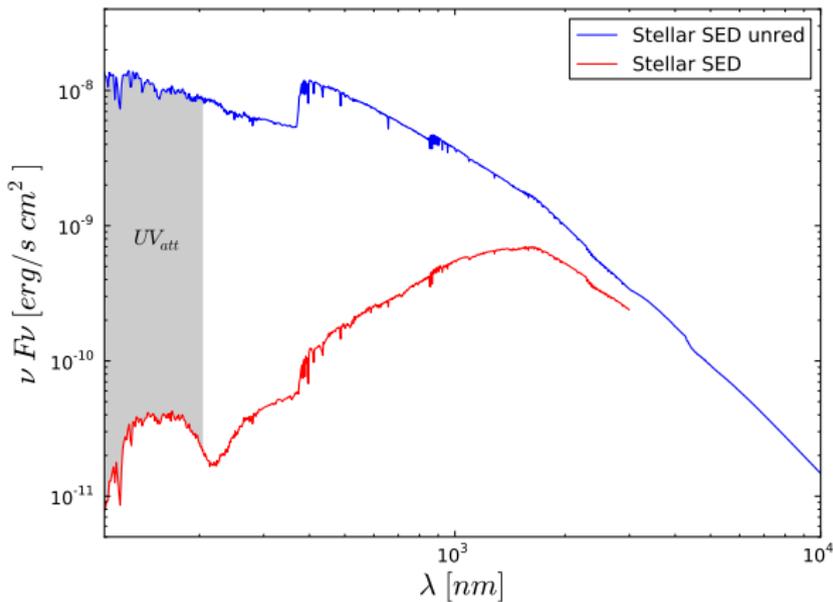


PHAT footprint (blue), current stellar catalogs coverage (red) and Herschel regions (white boxes)

## PHAT stellar SEDs fits

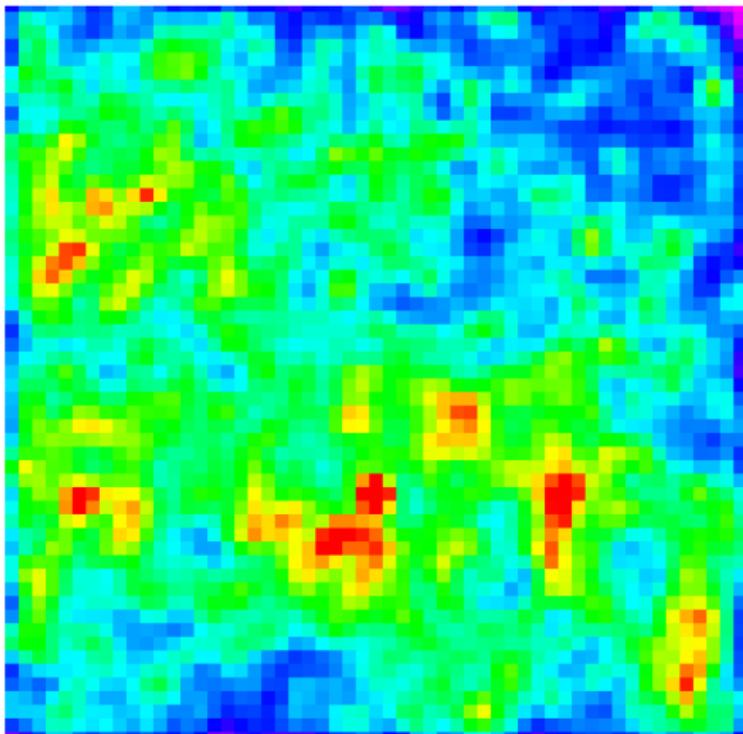


## Stellar SED in field 3

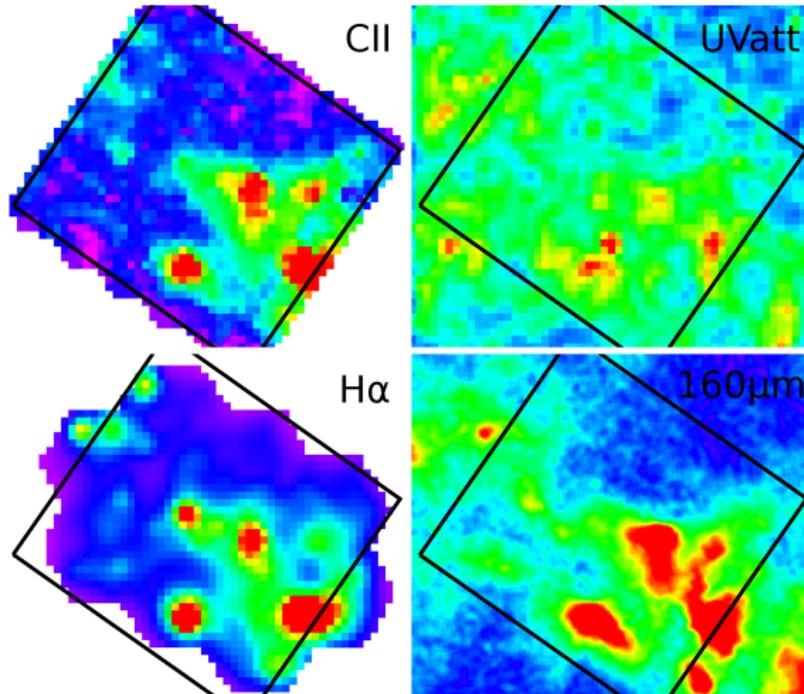


stellar catalogs: K. Gordon

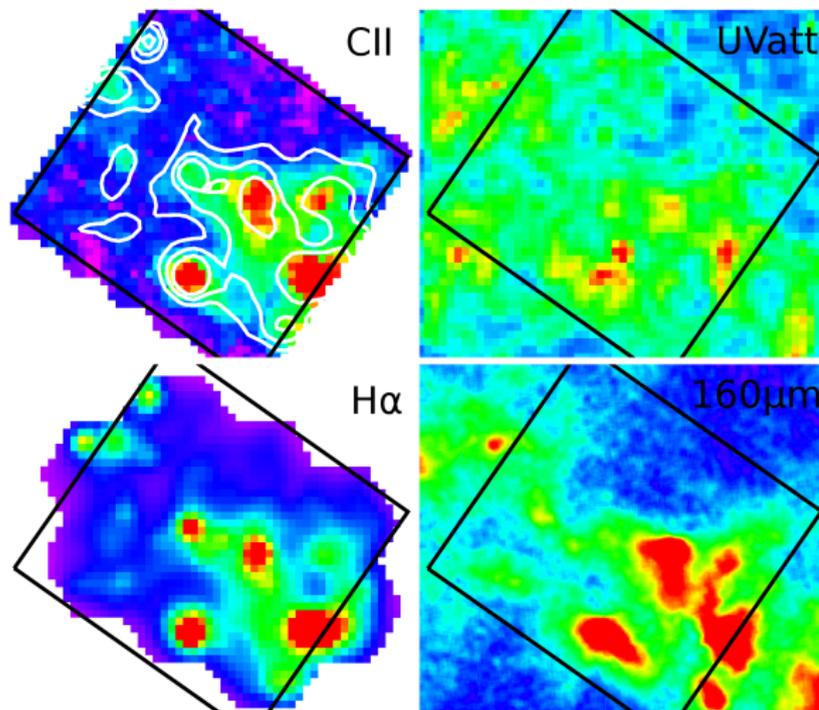
# Stellar $UV_{att}$ in field 3



# ISM tracers in field 3

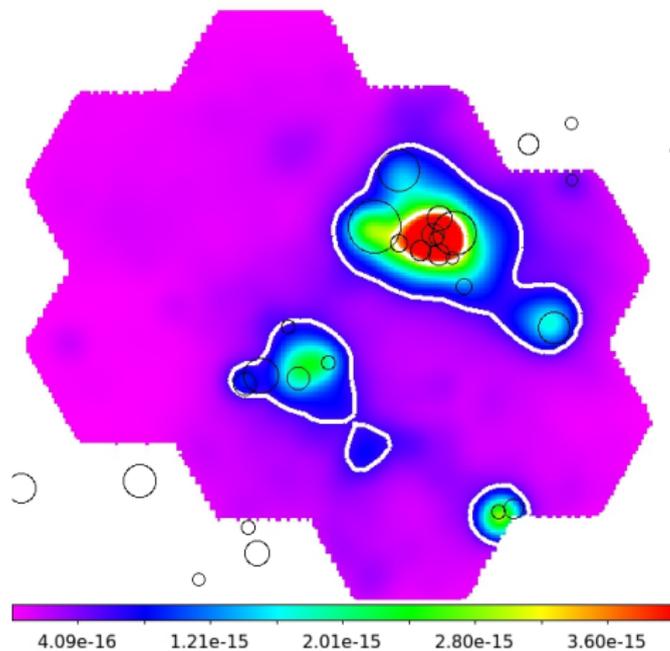


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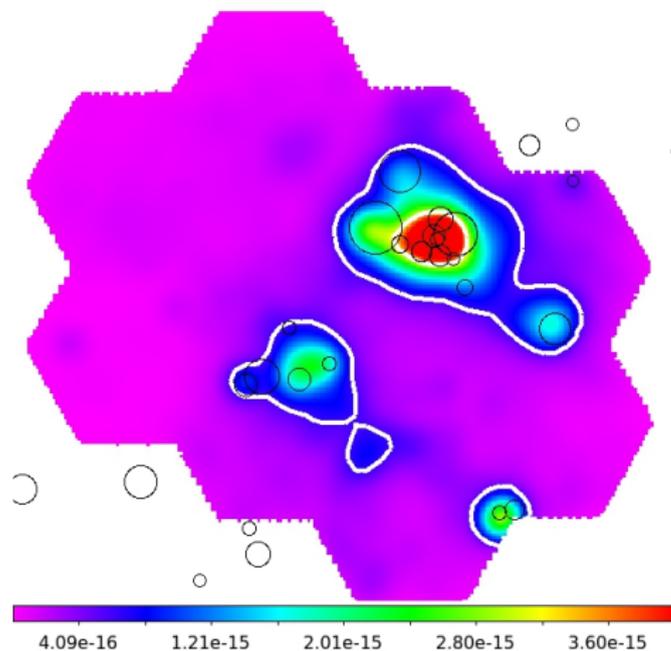
Contours: H $\alpha$

## [CII] emission from SF regions in field 2



HII regions - Azimlu et al. 2011

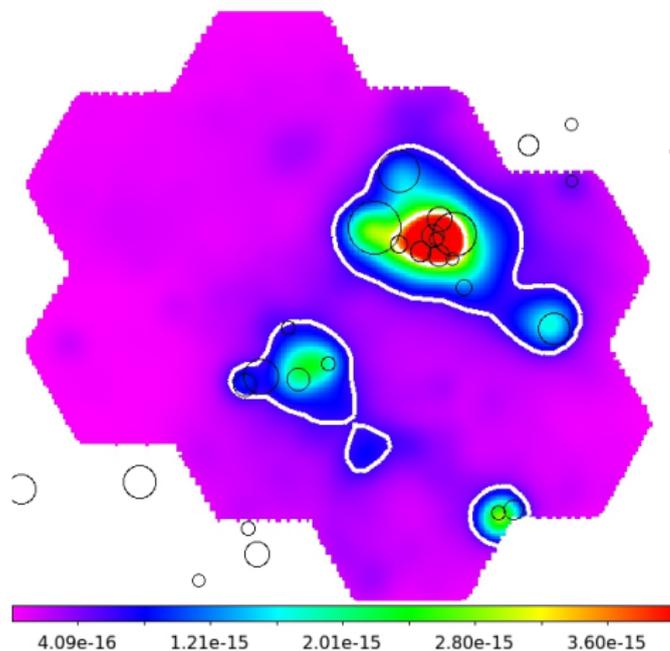
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level:  $3.25 \cdot 10^{-15}$   
5.3% from 1.2% area

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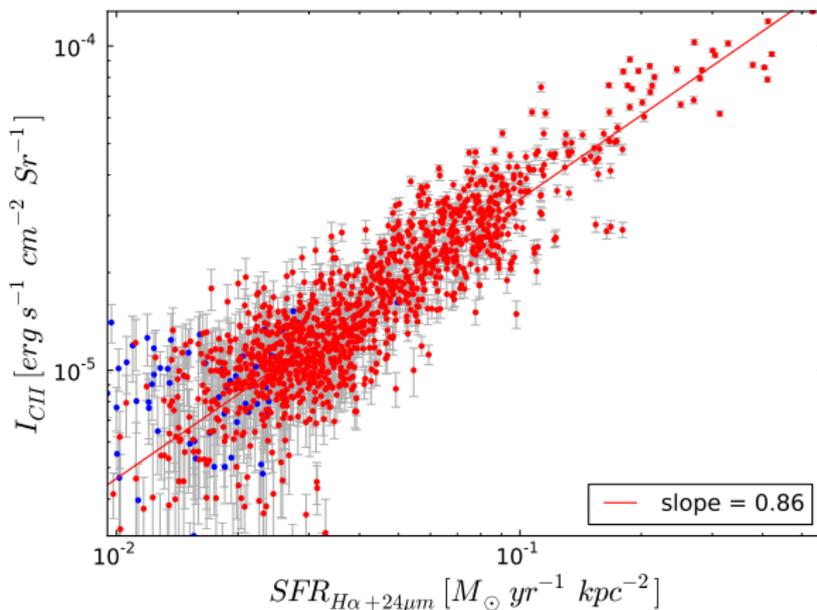


level:  $3.25 \cdot 10^{-15}$   
5.3% from 1.2% area

level:  $6 \cdot 10^{-16}$   
37% from 15% area

HII regions - Azimlu et al. 2011

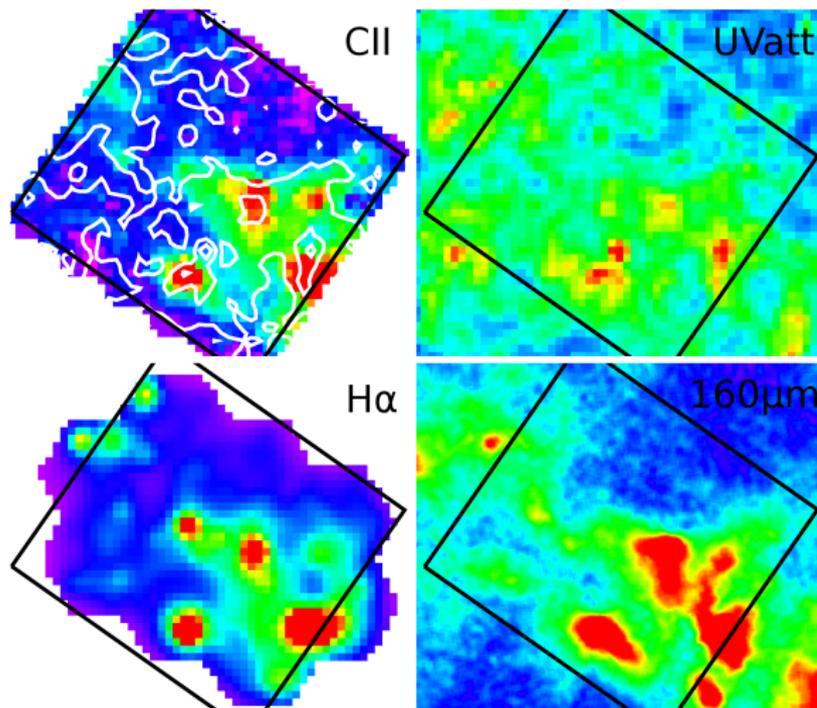
## CII &amp; SFR correlation in field 3



$$\langle SFR \rangle = 0.023 M_{\odot} \text{yr}^{-1} \text{kpc}^{-2}$$

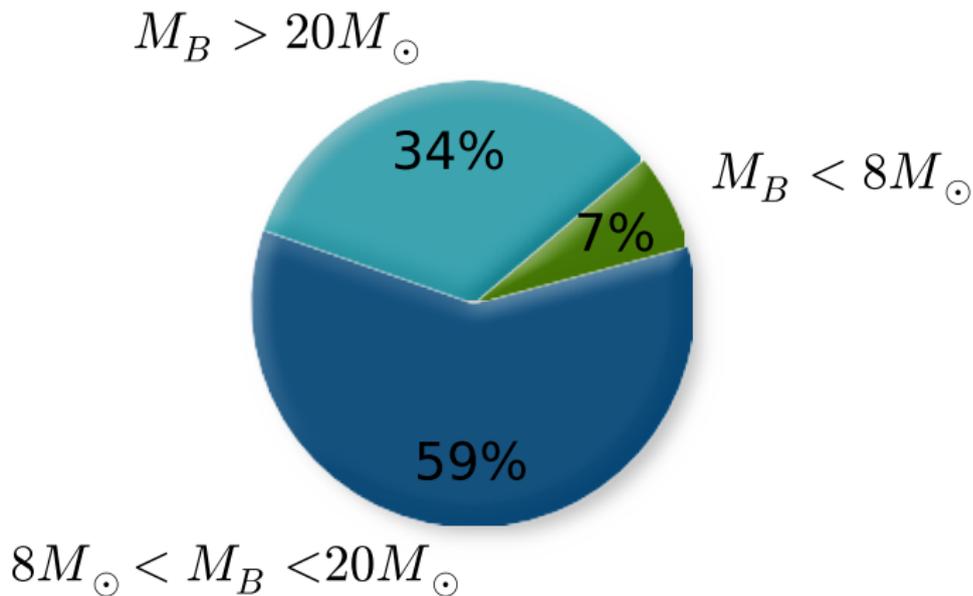
SFR formula: Calzetti et al. 2007

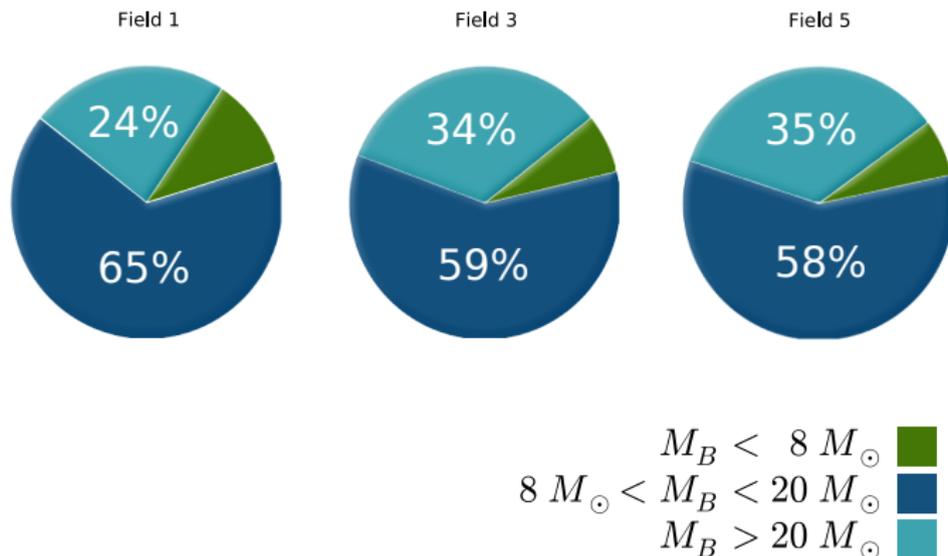
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Contours: UV<sub>att</sub>

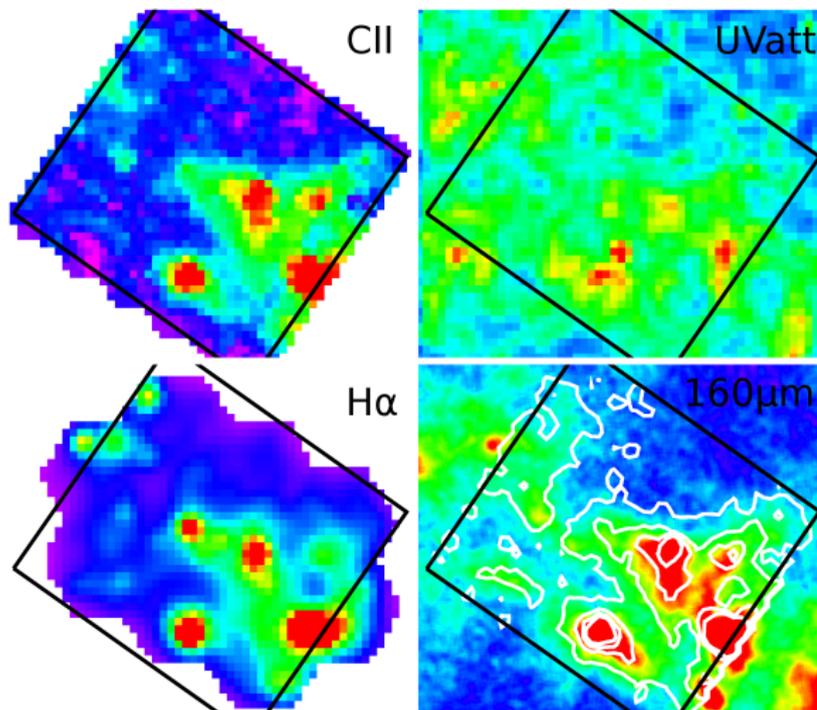
## Stellar populations UV input to ISM in field 3





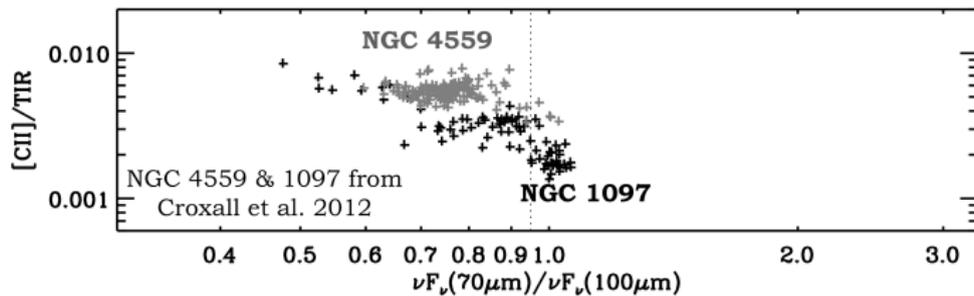
This demonstrates that on  $\sim$  kpc scales in Andromeda, massive B stars dominate the UV field as in the solar neighborhood.

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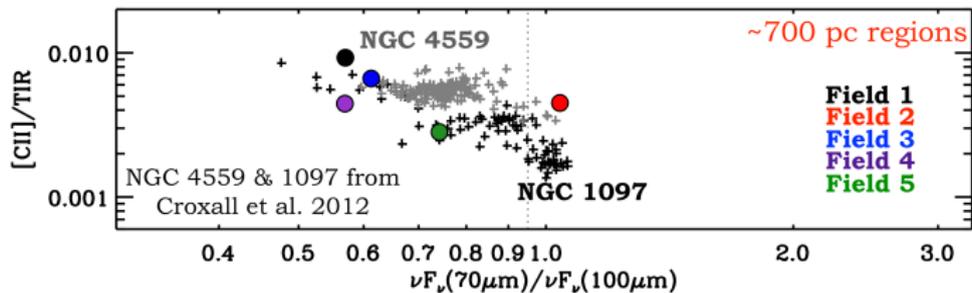


Contours: [CII]

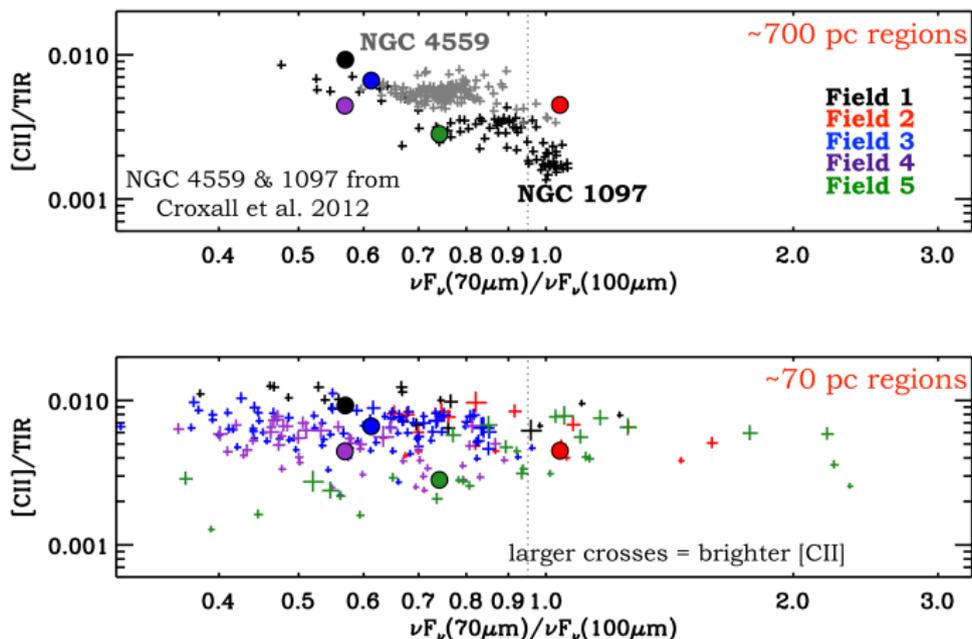
## No far-IR line deficit



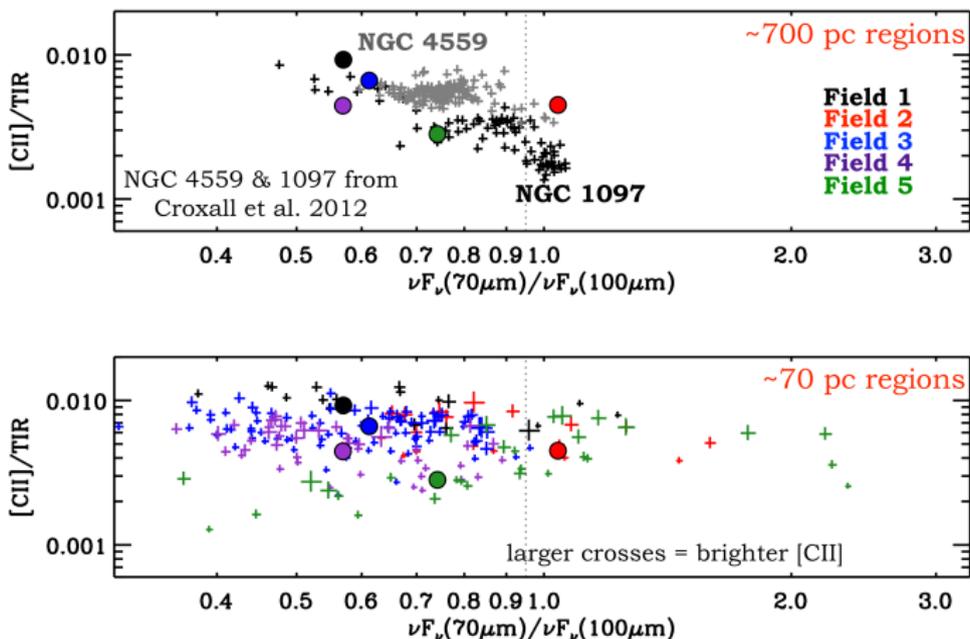
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$$(O/H)/(O/H)_{\odot} = 0.77, 0.94, 0.99, 0.98, 1.25$$

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Not entire [CII] comes from SF regions