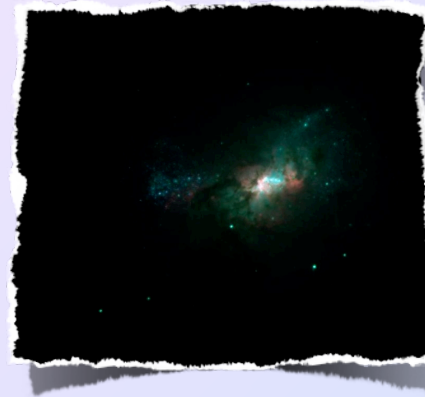


Resolving the molecular environment of Super Star Clusters in Henize 2-10

*G. Santangelo, L. Testi, C.M. Walmsley, L. Gregorini, S. Leurini,
R. Cesaroni, L. Vanzi, D. Wilner*

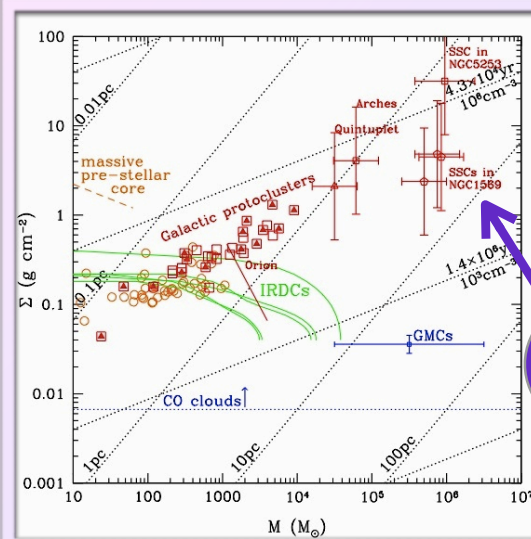
- Analysis of the starburst region in the dwarf galaxy Henize 2-10
- A first attempt to resolve the parent molecular clouds associated with the SSCs
- Comparisons with a Galactic massive SF region G19.61-0.23



Star formation near and far

- Galaxy Galactic and extragalactic high mass star formation occurs in clusters
- Galaxy Cluster masses vary greatly even within the Milky Way (most massive Galactic clusters $\sim 10^4 M_{\odot}$)
- Galaxy Galactic clusters are “dwarf” compared to the young extragalactic clusters, i.e. Super Star Clusters (SSCs, in merging systems and some irregular galaxies) with masses up to $10^6 M_{\odot}$
- Galaxy Diversity between local and distant star formation \leftrightarrow diversity between the molecular clouds?
- Galaxy Continuum emission and molecular gas tracers

Star formation near and far



Tan (2007)

* Expectation: molecular clouds associated with the SSCs: $10^6 M_{\odot}$ and few tens of parsec sizes

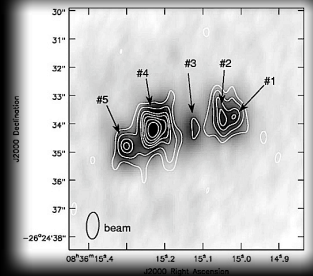
Vast difference in the linear resolution → our characterization is mostly based on integrated quantities

The available low resolution molecular observations do not resolve the sites of individual SSCs

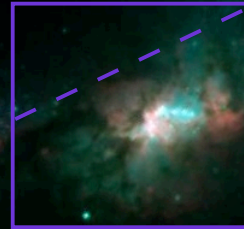
Integrated molecular gas

Henize 2-10

H α → 656 nm
V-band → 550 nm
I-band → 814 nm

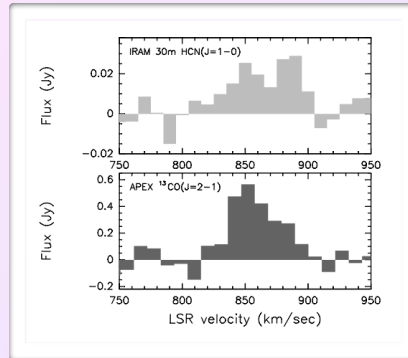


VLA 7mm contours on 3.6cm grey scale (Johnson & Kobulnicky 2003)



- * Blue compact galaxy - 9 Mpc
- * Powerful episode of star formation
- * Central part resolved in several compact sources: UC HII regions powered by young super massive clusters (few Myr)
- * Each Super Star Cluster: $M > 10^5 M_{\odot}$
- * Exceptionally rich molecular environment
- * Metallicity: almost solar value

Observations



- * IRAM 30m: HCN(1-0) - 28'' res.
- * APEX: $^{13}\text{CO}(2-1)$ - 28'' res.
- * Association of the SSCs with high density molecular tracers
- * The galaxy is undergoing vigorous star formation: an ideal target to study extragalactic starburst phenomenon

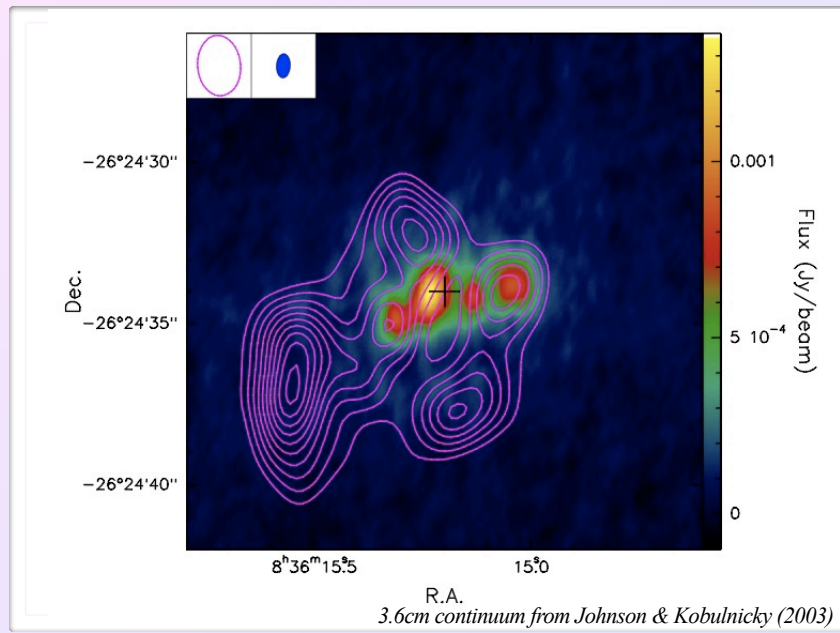
SMA OBSERVATIONS (Feb. & Mar. 2008):

- * CO(2-1) [$1.''3 \times 1.''9$ res. \rightarrow about 60×80 pc]
- * Extended and compact configurations
- * rms = 20 mJy/beam per 5 km/s channel

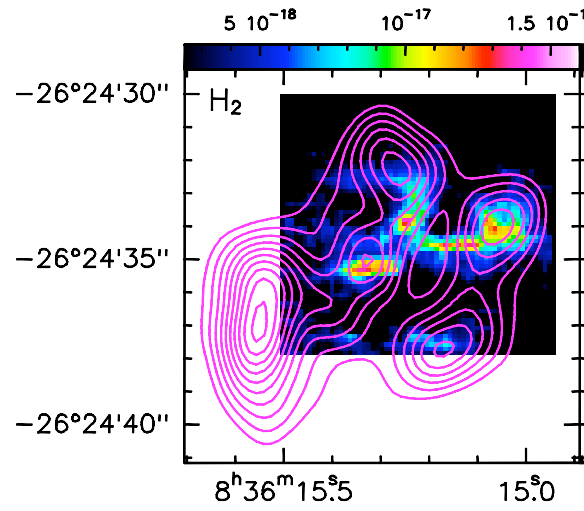
(Santangelo et al. 2009)



SMA observations

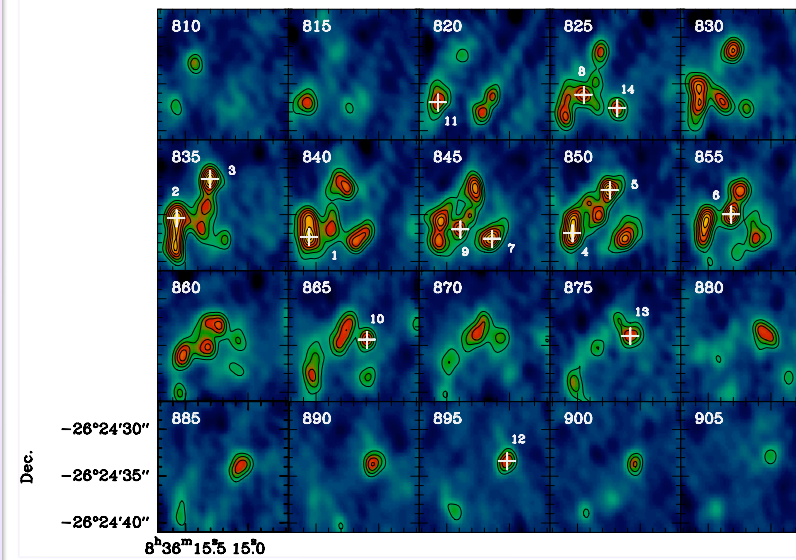


SMA observations



H₂ emission from Cresci et al. in prep.

SMA observations

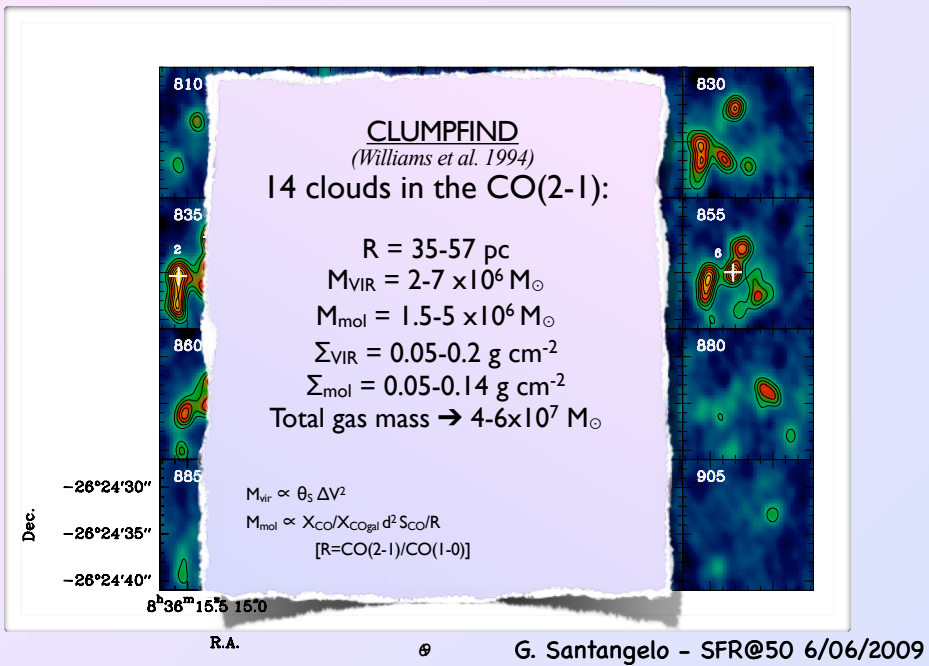


R.A.

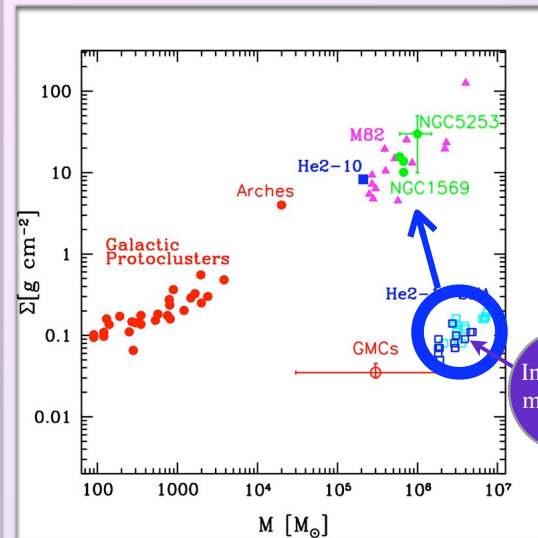
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G. Santangelo - SFR@50 6/06/2009

SMA observations



Identification of the clouds

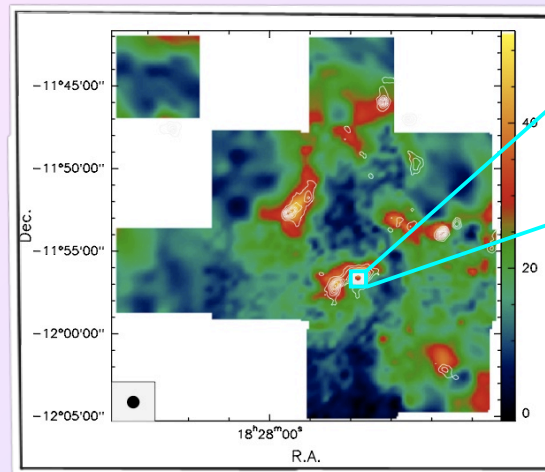


- * Clouds in Henize 2-10 in the same area as Galactic GMCs, but at higher pressure than in our Galaxy
- * Limited resolution
→ Σ may be considerable underestimate
- * Clusters in He2-10 might form from small pc-scale clouds at higher pressure than the rest of the GMC
- * First step to resolve the parent molecular clouds out of which the SSCs may form
- * Higher resolution and higher density tracers are needed

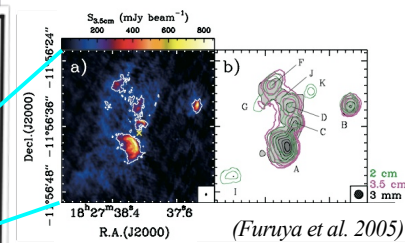
G19.6I-0.23

Active region of massive SF: 12.6 kpc, $L_{\text{bol}} = 2 \cdot 10^6 L_{\odot}$

Extensively studied: observed masers, molecular tracers and grouping of UC HII regions indicating OB star cluster



(Santangelo et al. in prep.)

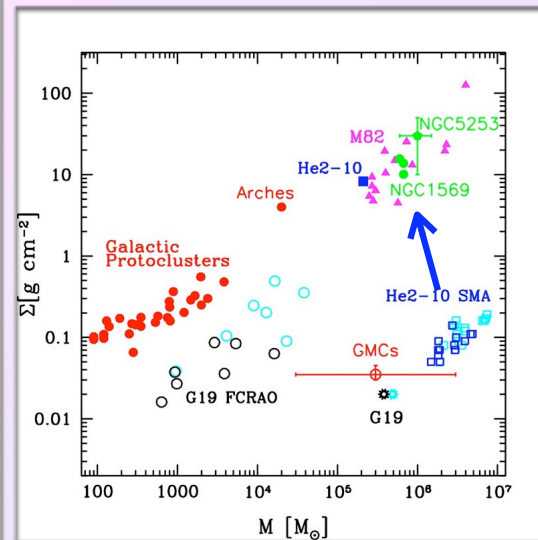


(Furuya et al. 2005)

FCRAO-14m obs. (2000/2001):

- * $^{13}\text{CO}(1-0)$, $\text{C}^{18}\text{O}(1-0)$, $\text{C}^{17}\text{O}(1-0)$
- * 46'' res \rightarrow 2.8 pc
- * Large scale: 23'x23' \rightarrow one cloud in Henize 2-10!

Identification of the clouds



- * Total G19 emission: same area as GMCs but less extreme properties than the clouds in Henize 2-10
- * Resolved CO clumps in G19: Σ larger \rightarrow angular resolution problem for Henize 2-10, the clouds might go up when resolved

Summary and Conclusions

- Analysis of the starburst region in the dwarf galaxy Henize 2-10:
 - Single dish observations confirm the association of the SSCs with dense molecular gas in Henize 2-10
 - Interferometric observations reveal a rich population of molecular clouds
- A first attempt to resolve the parent molecular clouds associated with the SSCs in Henize 2-10 and possible evidence that these clouds are very massive and dense
- Comparisons with a Galactic massive SF region G19.61-0.23
- Higher angular resolution and higher density molecular tracers might give the final answer....new generation of telescopes!