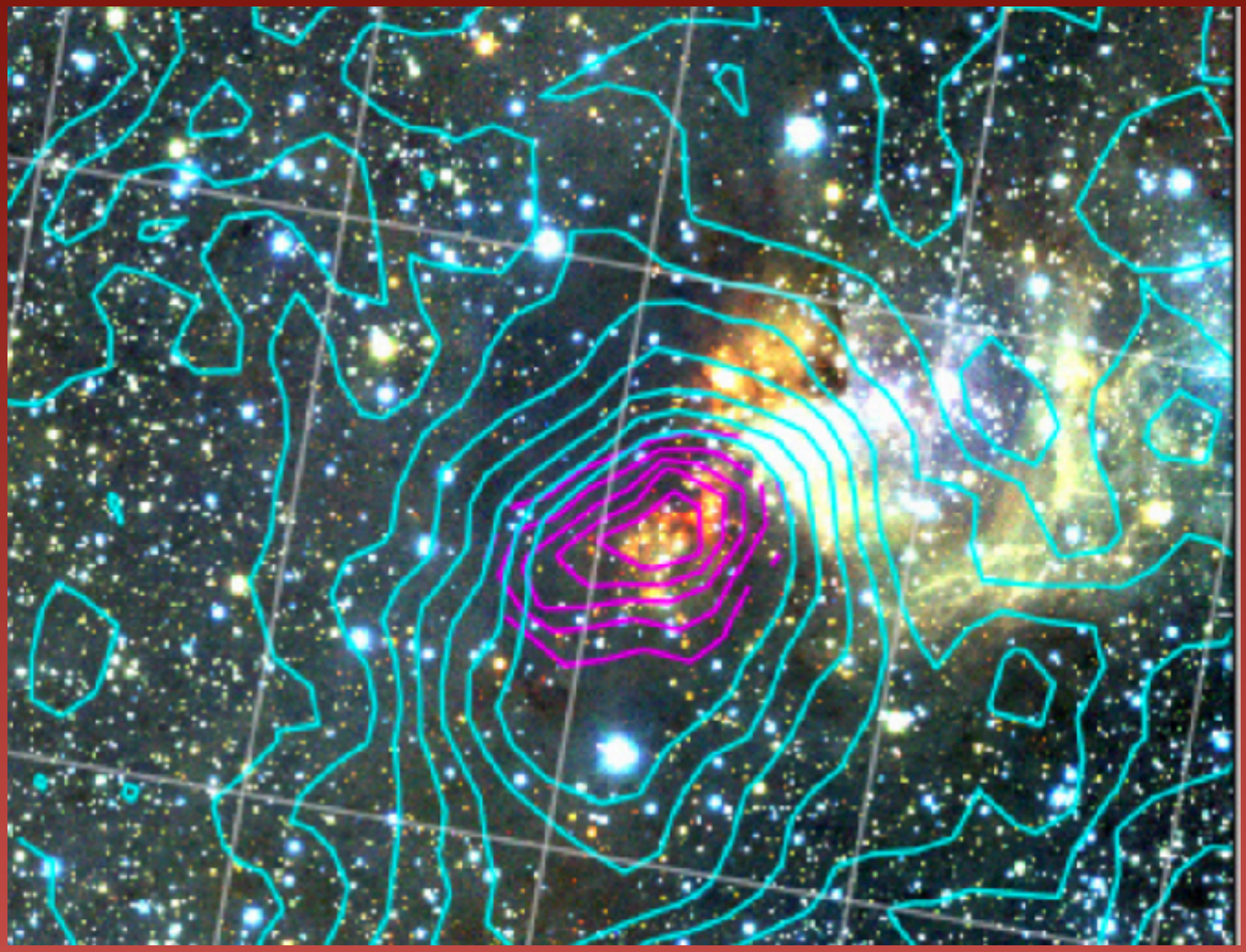
A potential massive star cluster in the making



Morten Andersen
Peter Barnes, Jonathan Tan, Guido de Marchi, Jouni Kainulainen

How massive star clusters are formed is poorly known

- Very short time scale, relatively rare and distant
- Is formation fast or slow? (relative to the ff time)
- Few good candidates. Once exposed from molecular clump they are “old”

However, star formation has to have begun

- Excludes objects like e.g. “the brick” in the Galactic Center region
- Sign of ongoing collapse

Good candidate identified

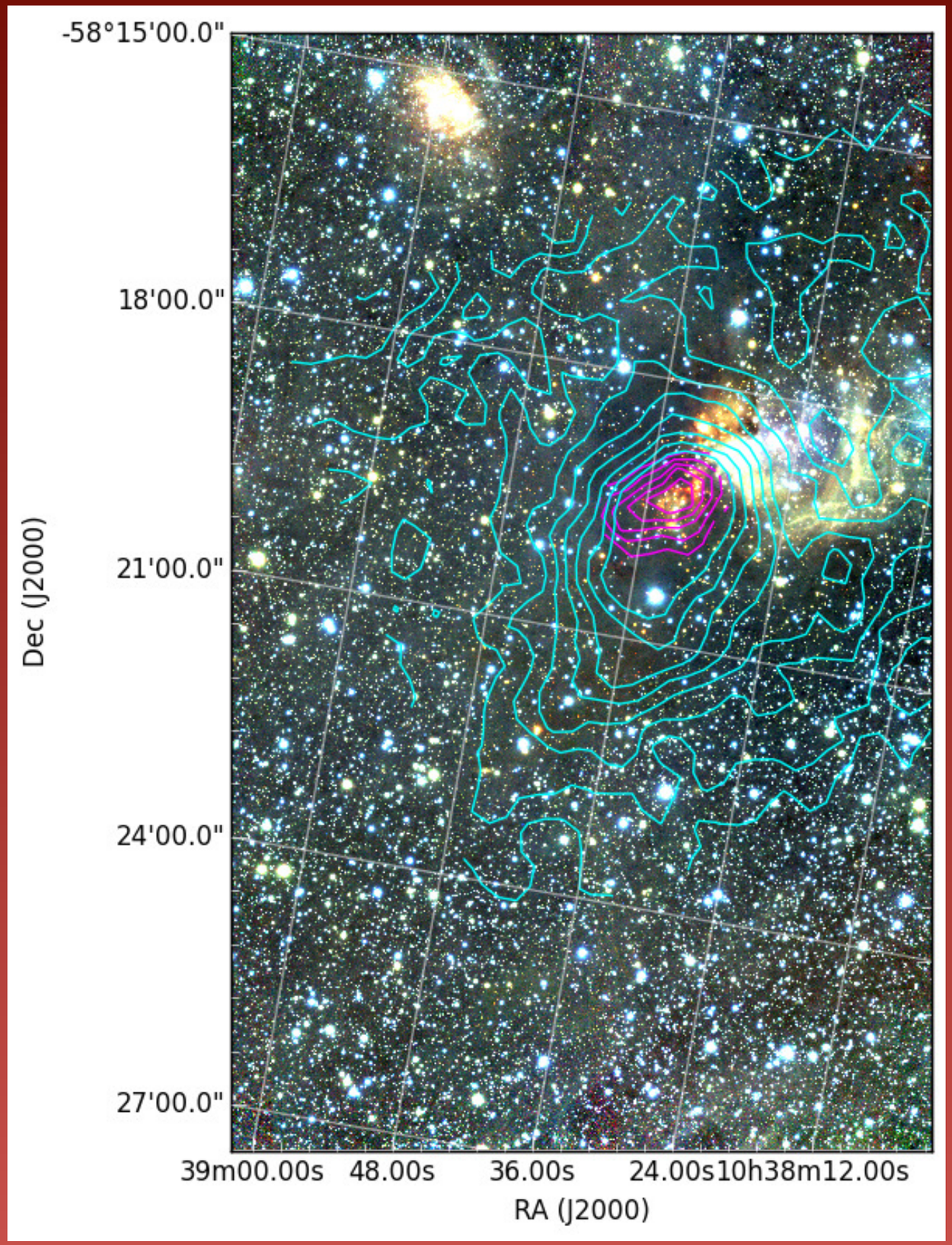
- Identified in the CHaMP survey (Barnes et al.)
- Large molecular infall; sign on star formation
- Large mass (> 1000 Msun of gas) in order to create ONC-like object
- Sufficiently close (2.3 kpc) to resolve the region
- Part of the general Carina complex

Large molecular infall

- HCO+ line analysis suggest infall of 0.03 Msun/yr
- Total mass uncertain, at least 2000 Msun (dust)
- Could be up to 10^4 Msun (line data)
- Few red sources identified in shallow observations

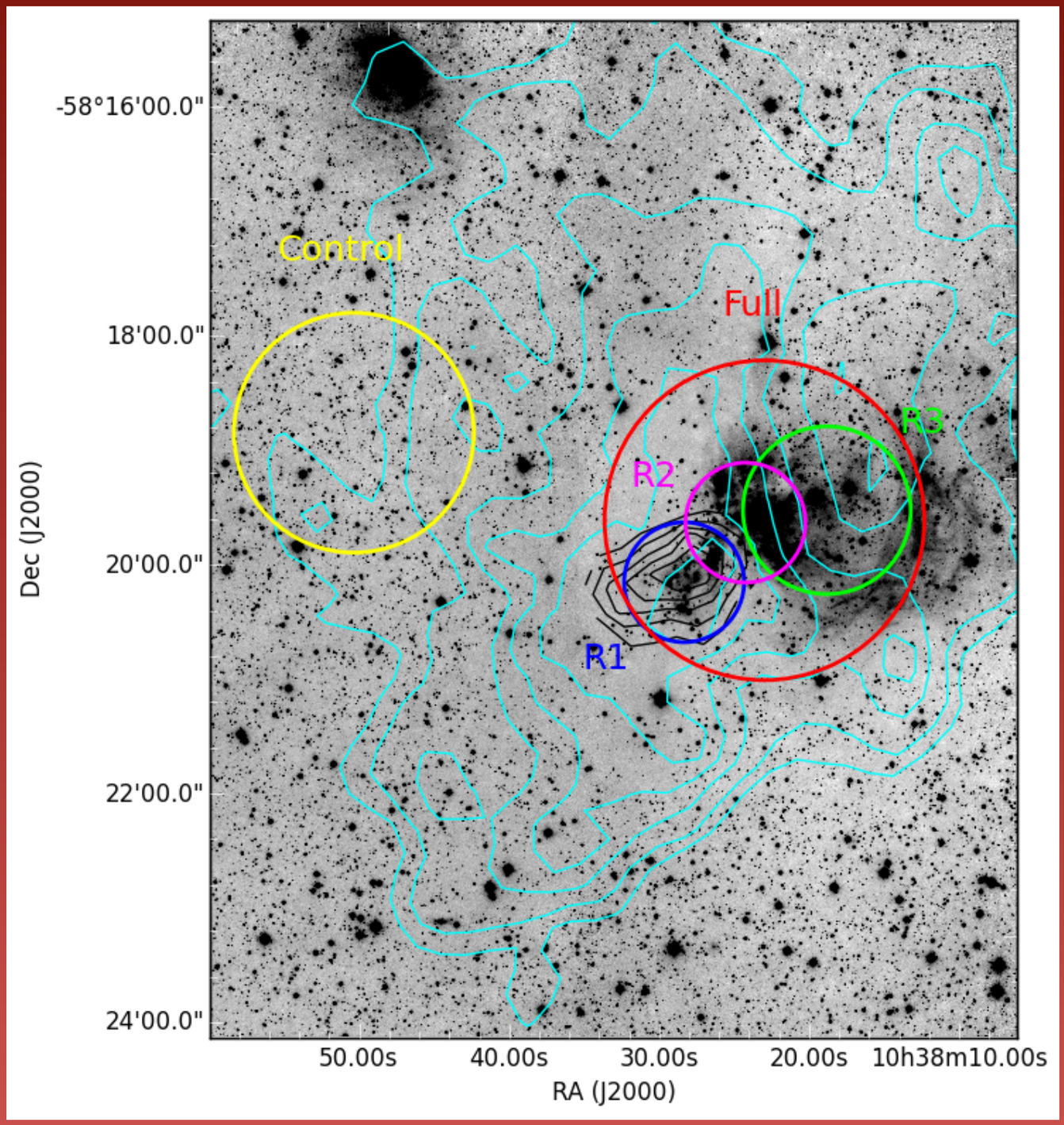
Deep large field of view near-infrared imaging to reveal the stellar population

- VLT HAWK-I JHKs imaging. ~0.5” seeing.
- Total area covered is 8’*12.7’ (5.5*8.5pc)
- 50% Complete down to Ks=19 mag
- Corresponding to below 0.25 Msun (For Ak <2)

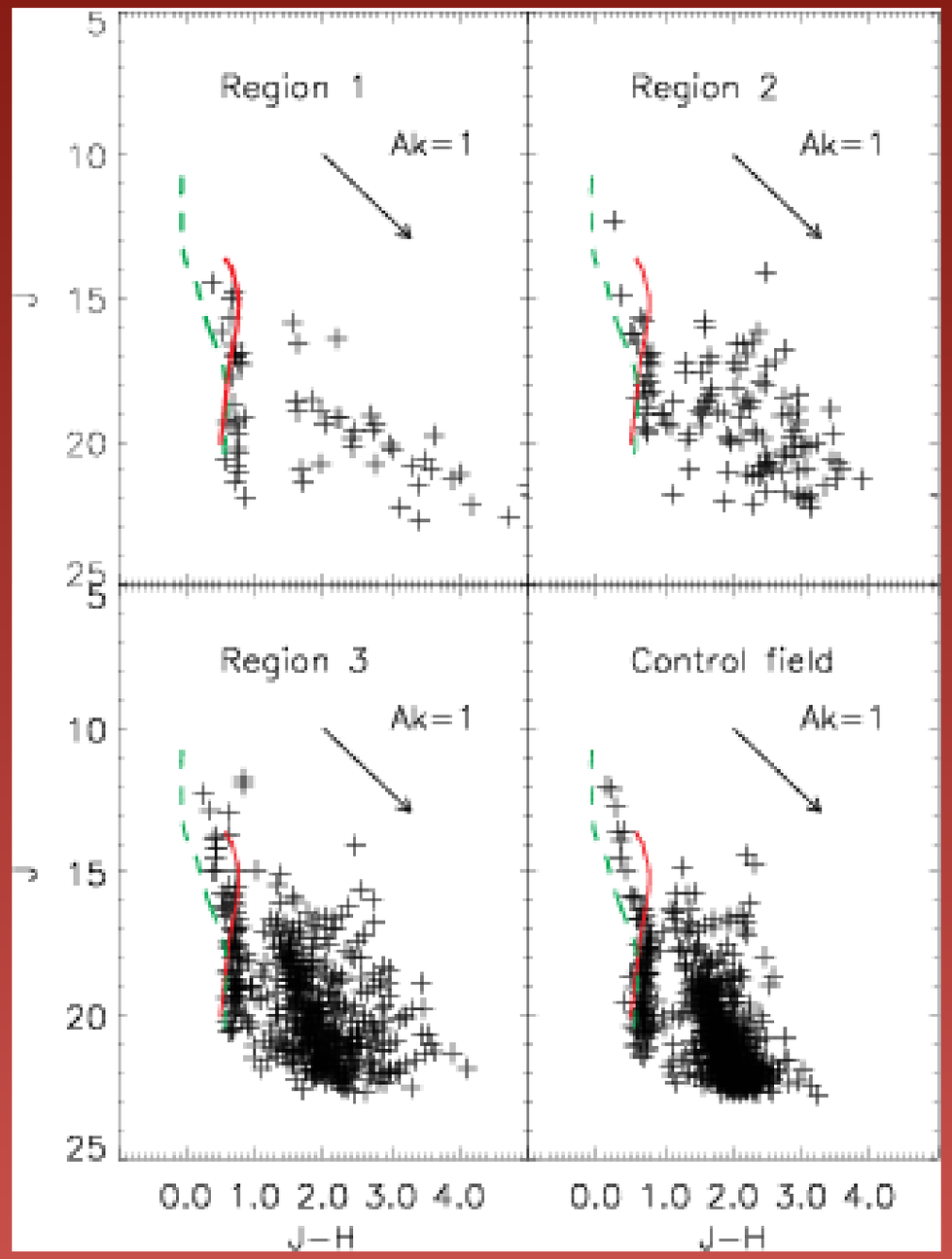


Andersen et al. 2017, ApJ

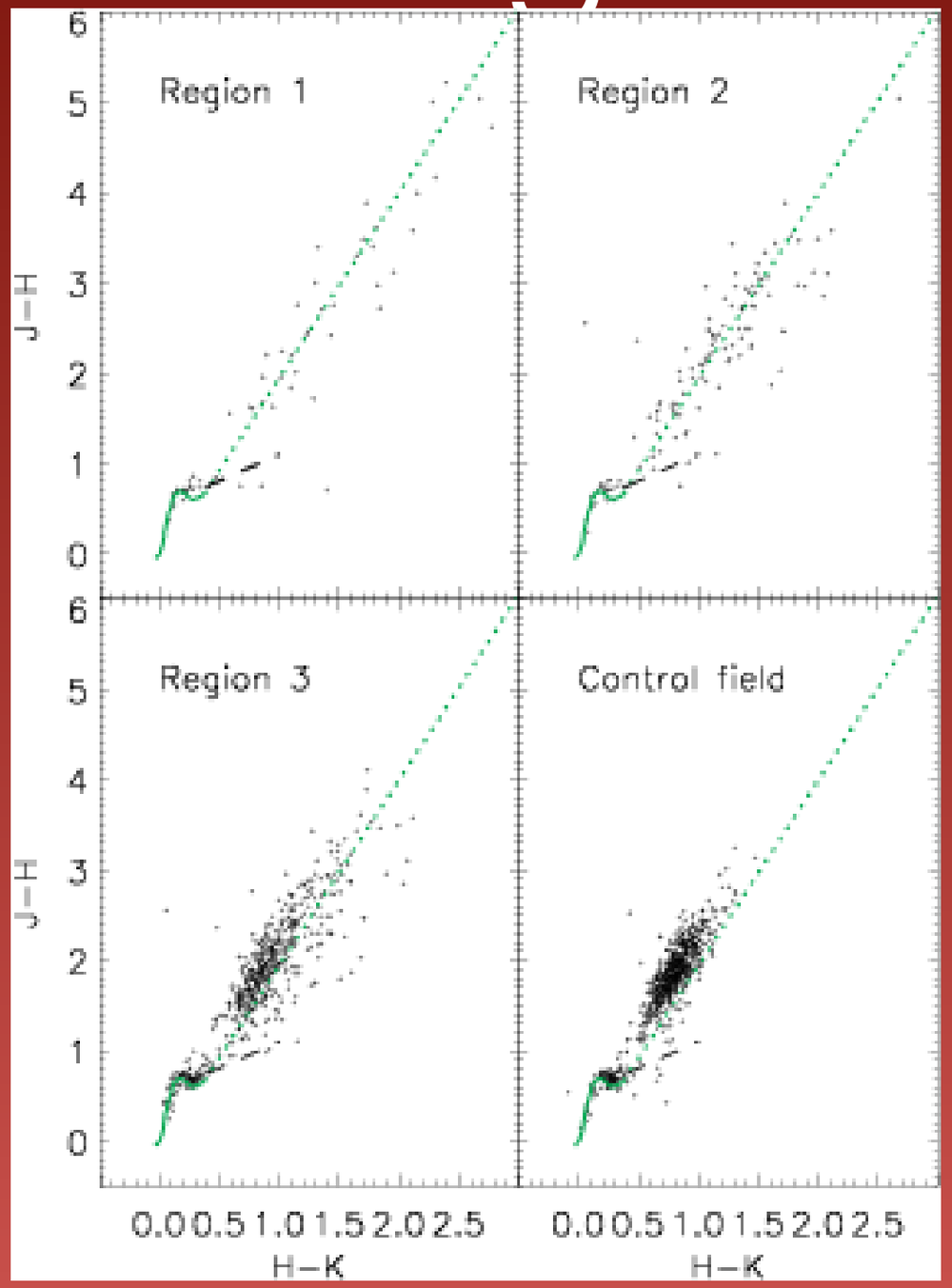
Three main regions identified



Large differences in extinction



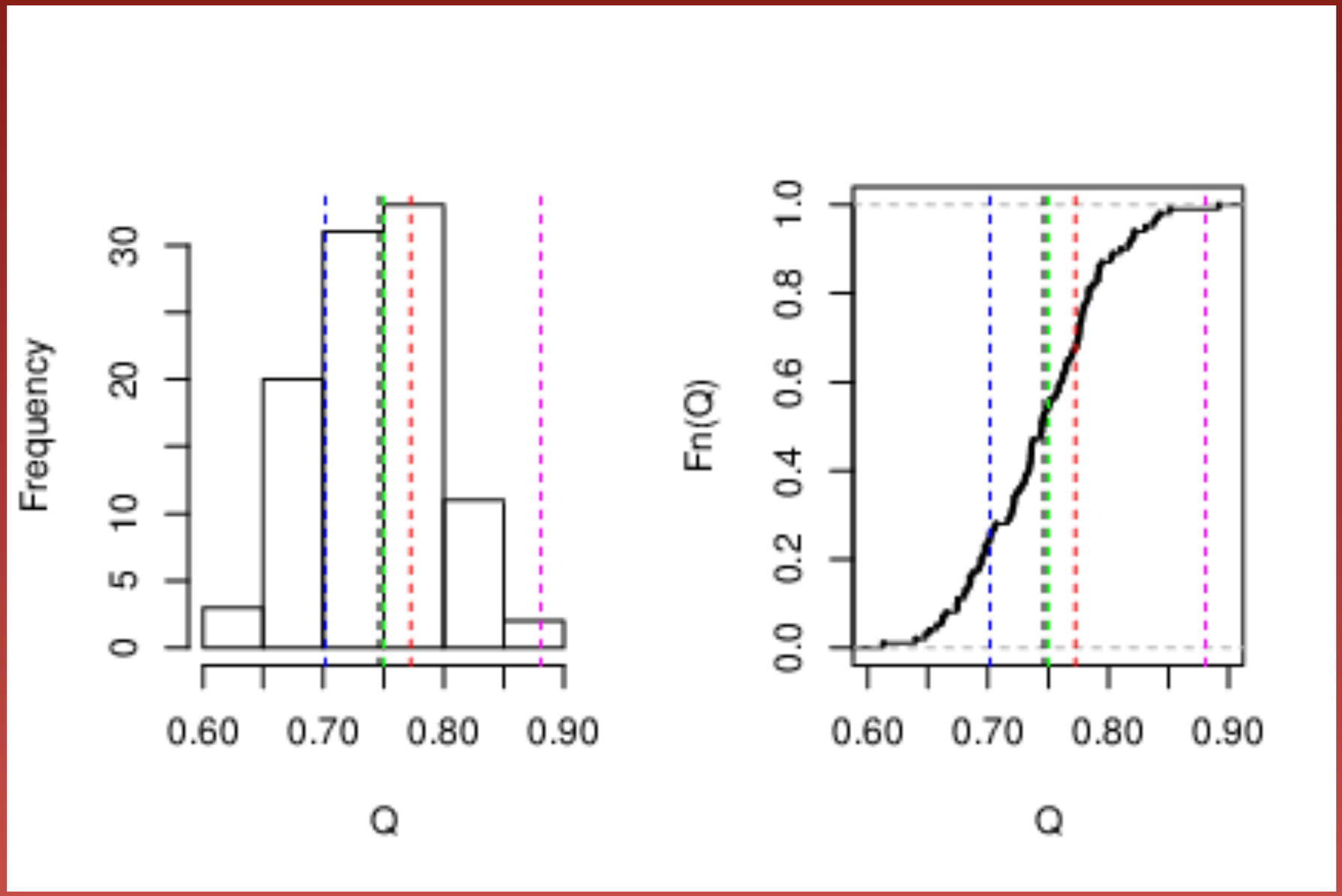
Large disk fractions



Disk fractions 27-44%

(small fraction in control field)

Sub-structure or centrally concentrated?



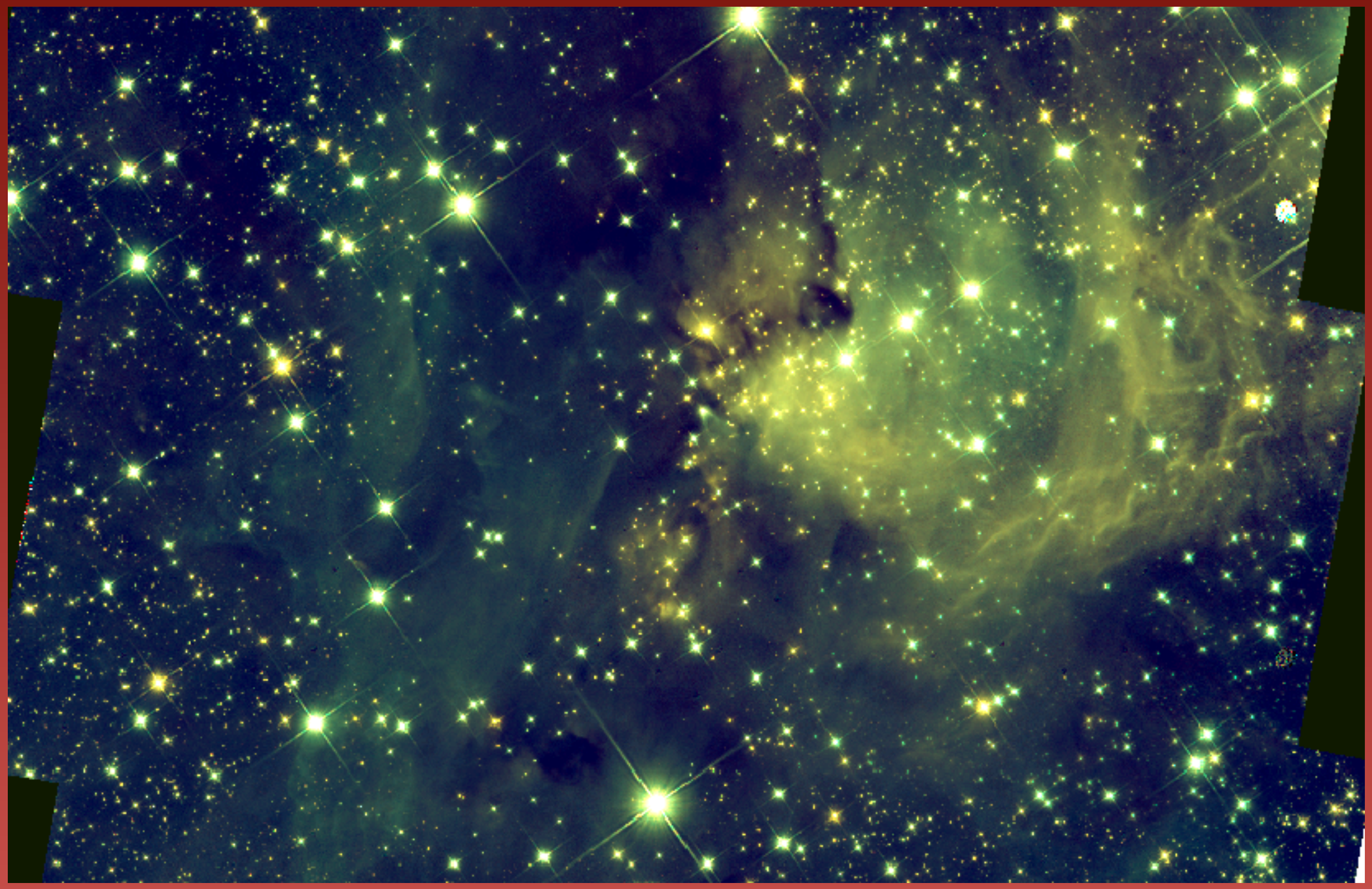
Stellar mass compared to gas mass still low

- At least 2000 Msun of gas in the region
- currently ~> 250 Msun in stellar content (not complete)
- Infall still ongoing so expected the total stellar mass increases

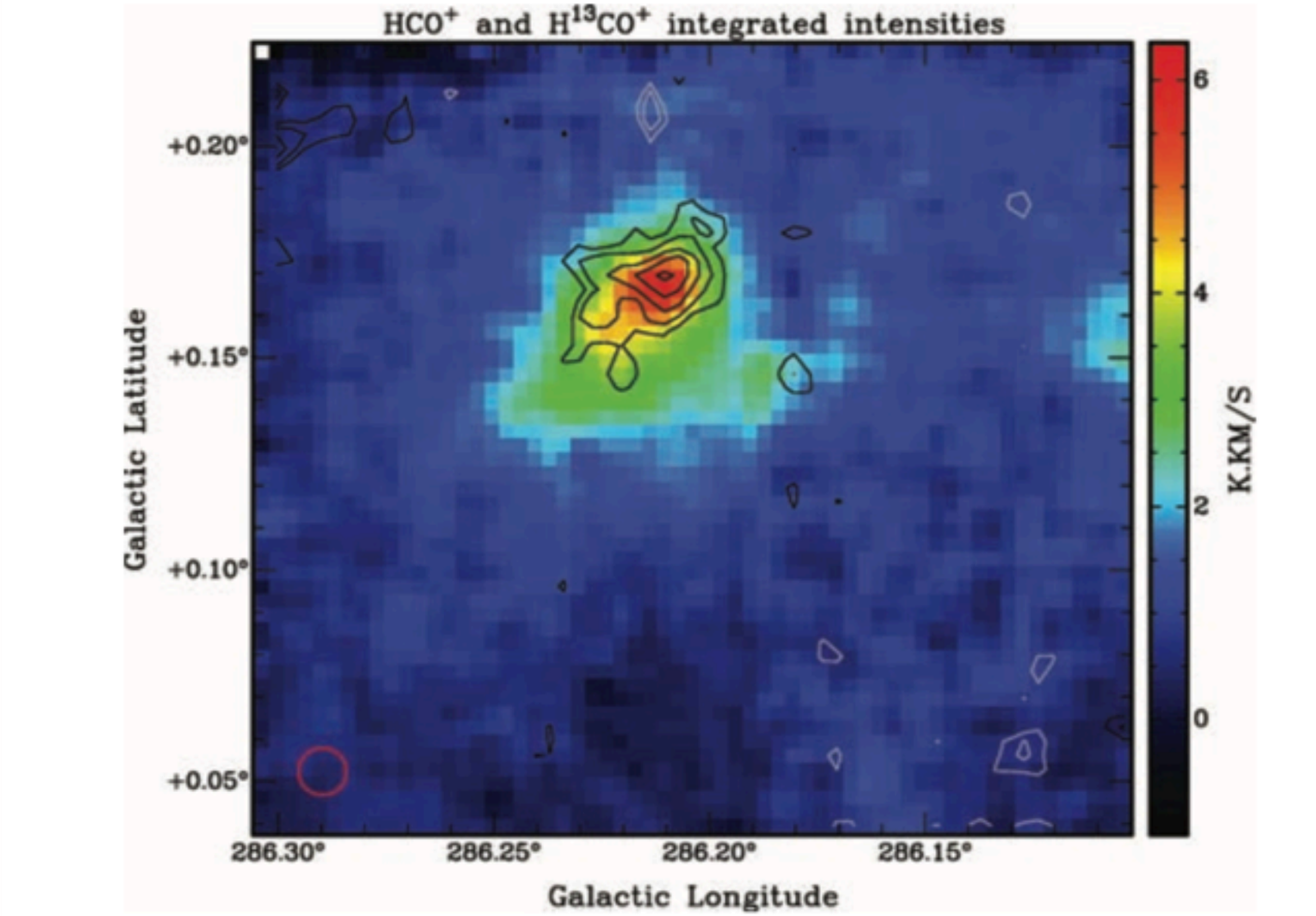
Proper motions revealing sub-clustering

- Multi-epoch HST WFC3 observations
- Can reveal proper motions down to few km/s
- (also provide deeper J band photometry)
- Will provide better completeness in the extinct regions
- Data analysis ongoing

J+H HST



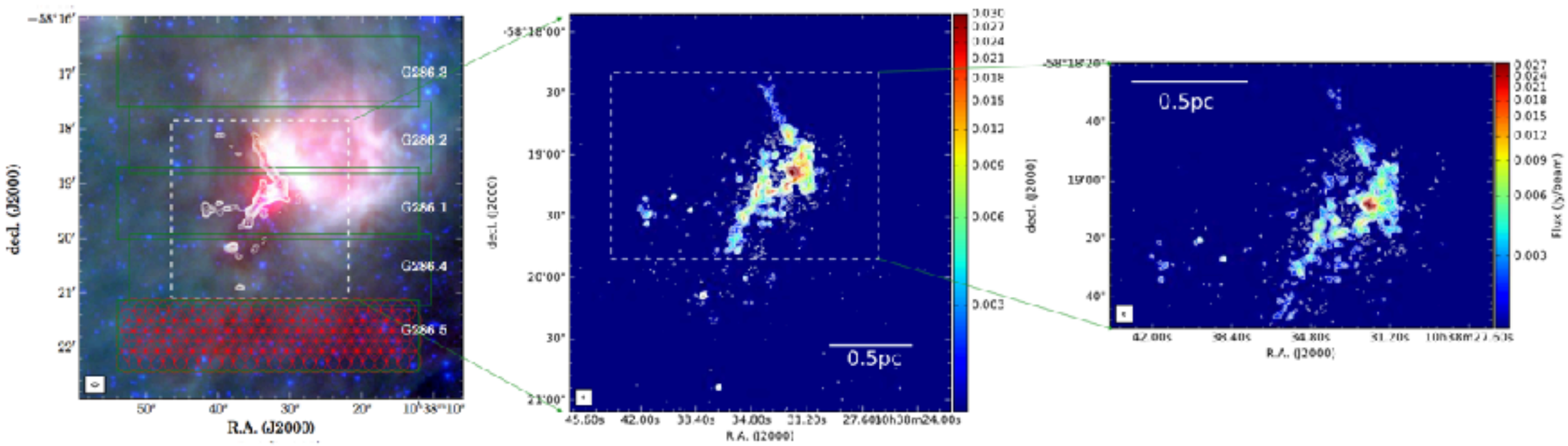
Revealing the molecular core spectrum with ALMA



Barnes et al. 2010

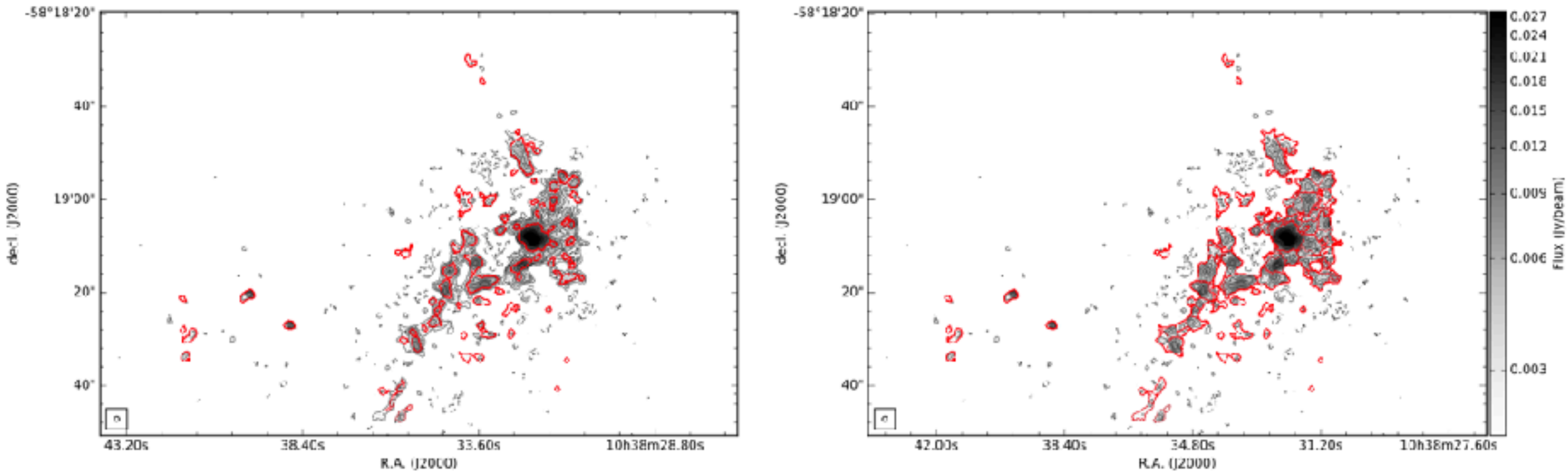
Single dish not able to resolve the clump

Revealing the molecular core spectrum with ALMA



Cheng et al., 2018, ApJ

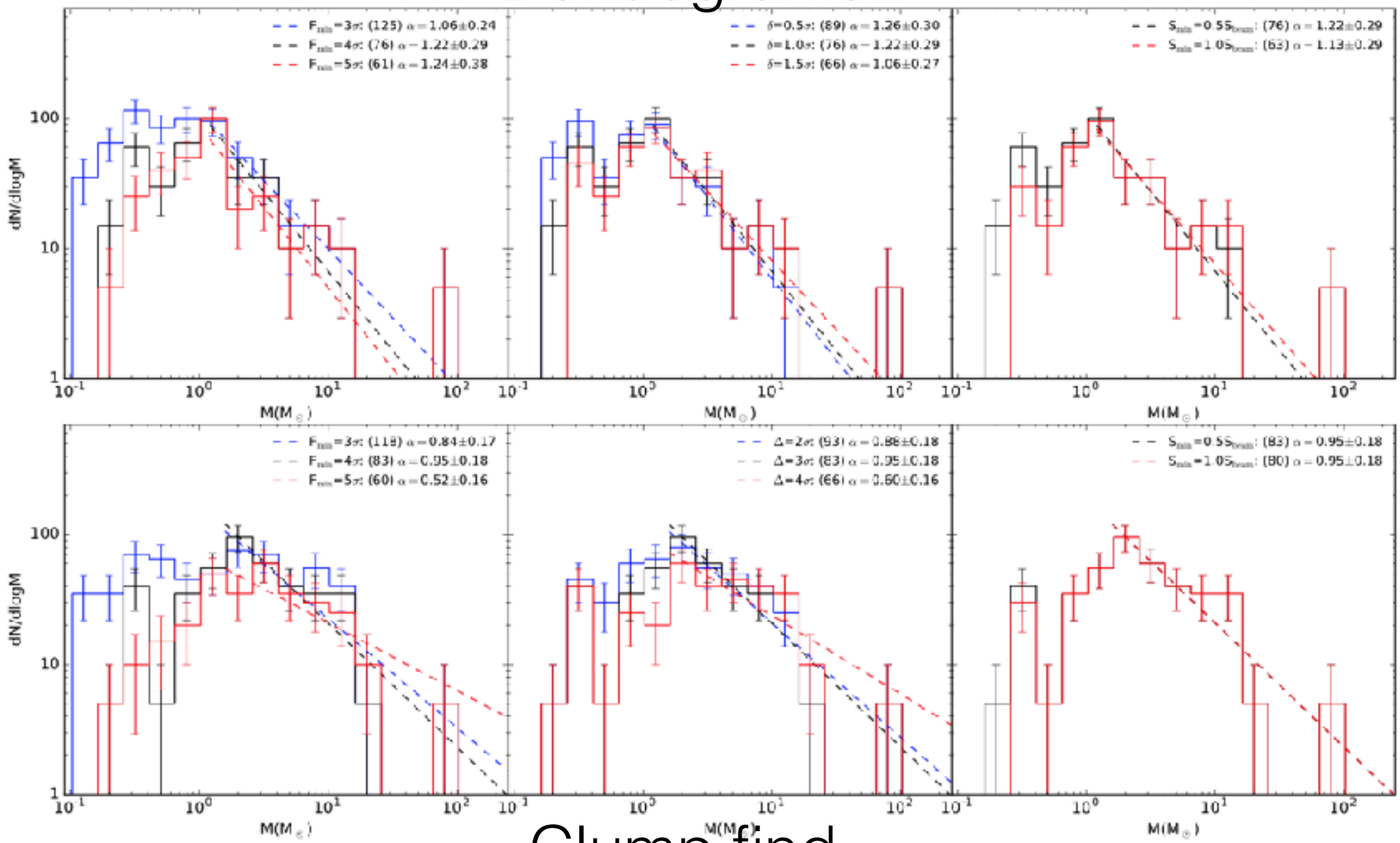
Quite some sub-structure



Cheng et al., 2018, Apj

Core Mass Functions

Dendograms



Clump find

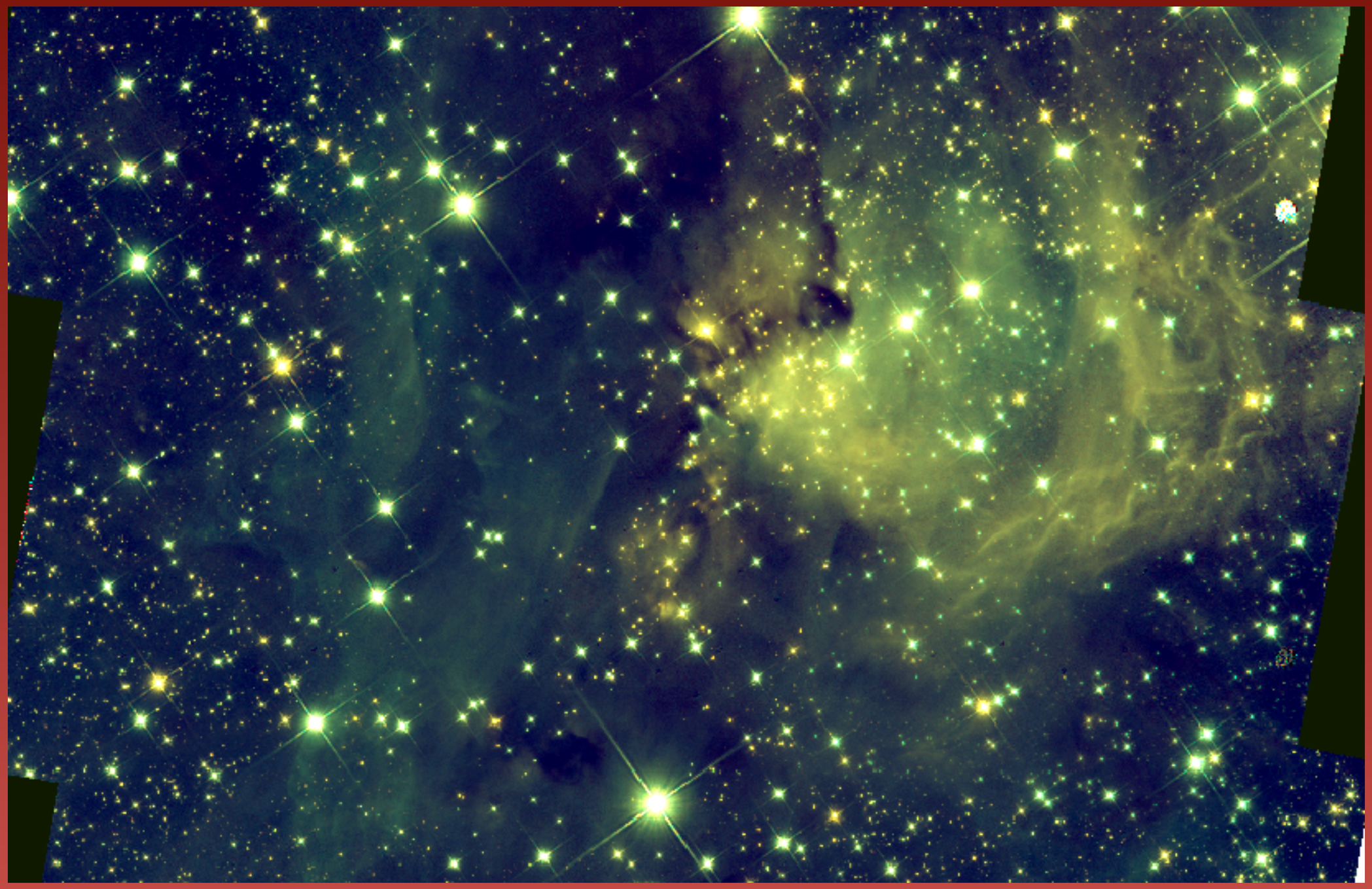
Cheng et al., 2018, ApJ

Future work

- Large part of stellar population highly extinct
- Natural seeing ground-based obs. reached their limit
- J+H from HST (obtained)
- K band from Multi conjugate Adaptive Optics

Cheng et al., submitted

Future work

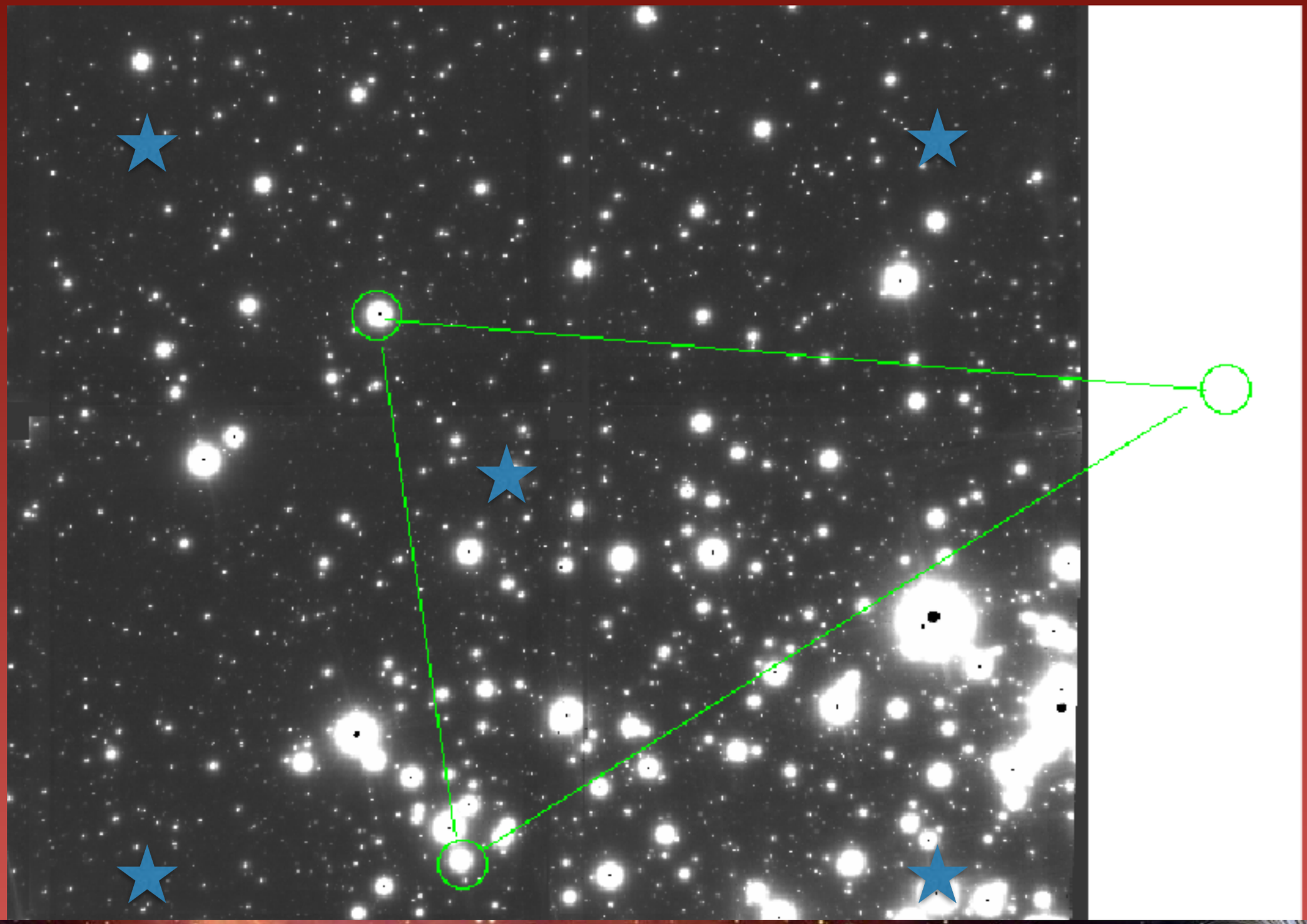


J+H HST

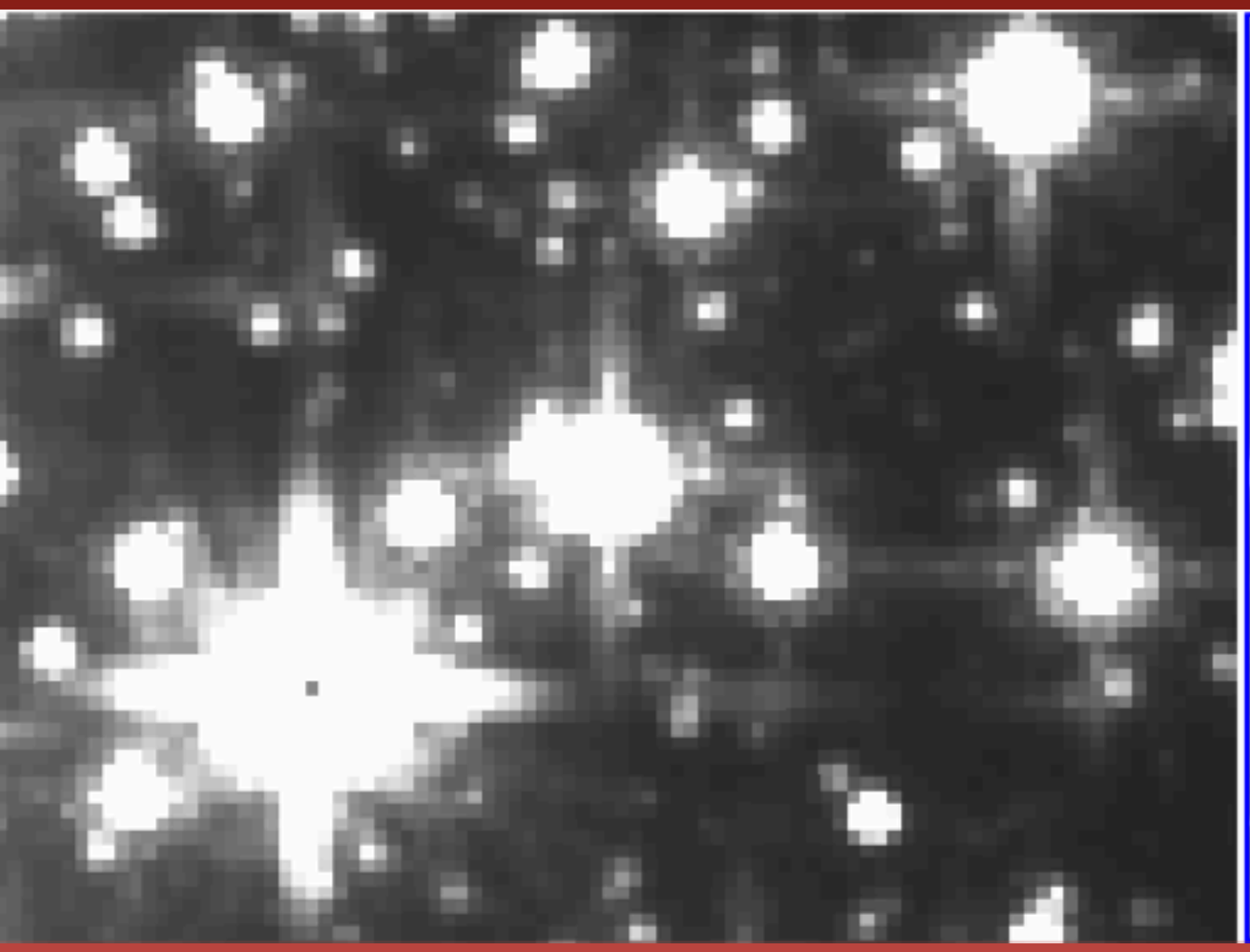
GeMS/GSAOI K band imaging:

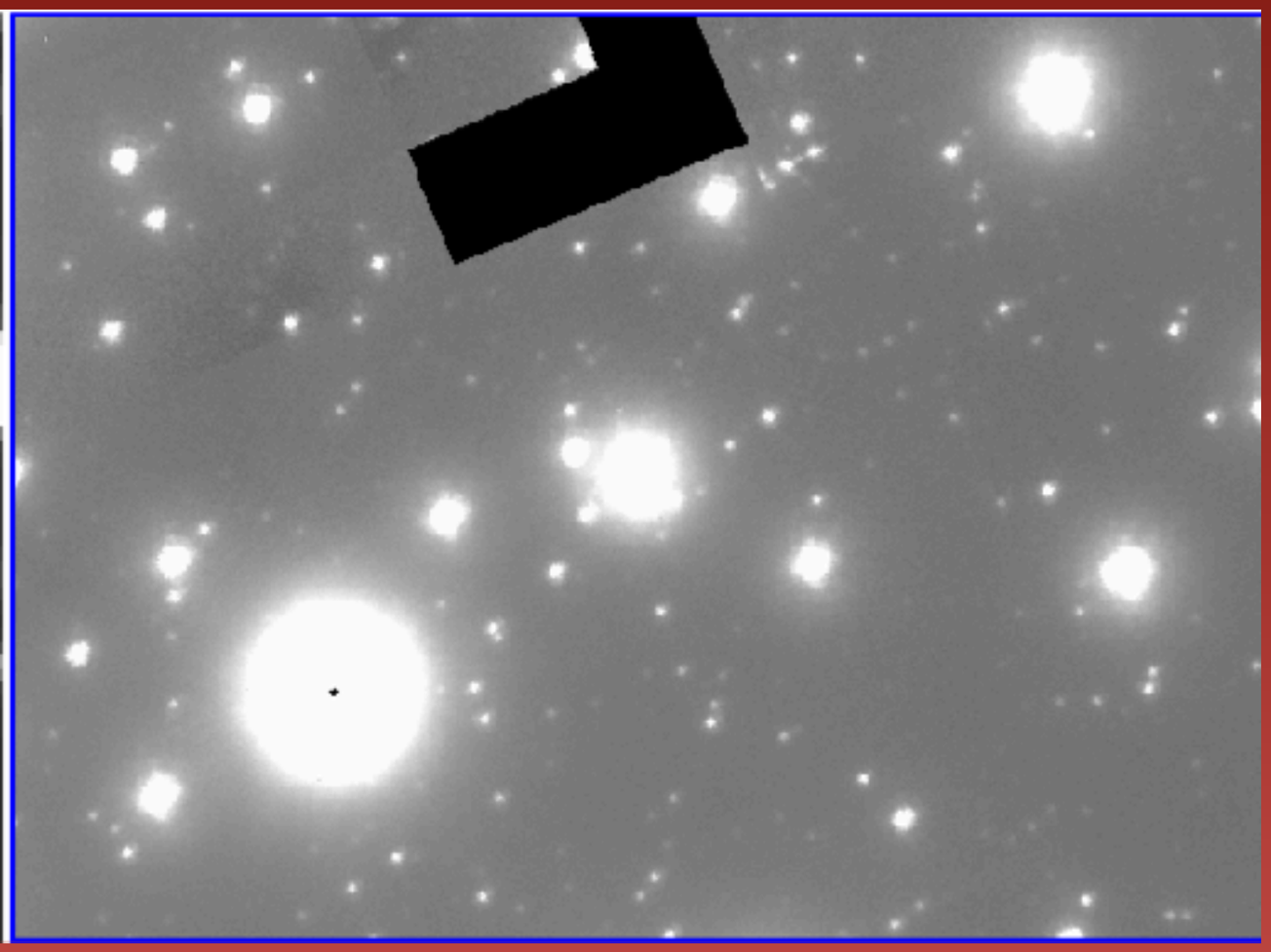
- GeMS: Multiconjugate Adaptive Imaging System at GS
- 5 laser spots enable correction over almost 2’ FOV
- 1-3 Natural Guide stars needed
- Can provide Strehl ratios of 5% (J), 10%(H), 15% (K)
- PSF across the field is very stable for an AO system
- GSAOI: NIR imager, FOV 90”, pixel scale 20mas

NGS configuration on the observed mosaic



GSAOI K band imaging:





Westerlund 1, HST H left, GSAOI Ks band right

Lawrence & Andersen et al. in prep

Summary

- Obtained deep JHK VLT photometry of G286+0.17
- Probing the stellar content below 0.2 Msun
- High disk fraction for all the clusters (27-44 %)
- Tentative signs for sub-structure in the stars in the infalling clump
- Gas mass still 10 times the stellar mass