Highly efficient core formation in hub-filament systems

Michael Anderson

michael.anderson@astro.cf.ac.uk

Co-authors: Nicolas Peretto, Sarah Ragan, Gary Fuller, Ana Duarte Cabral,

Adam Avison, Alessio Traficante, Yancy Shirley, Gwenllian Williams

CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

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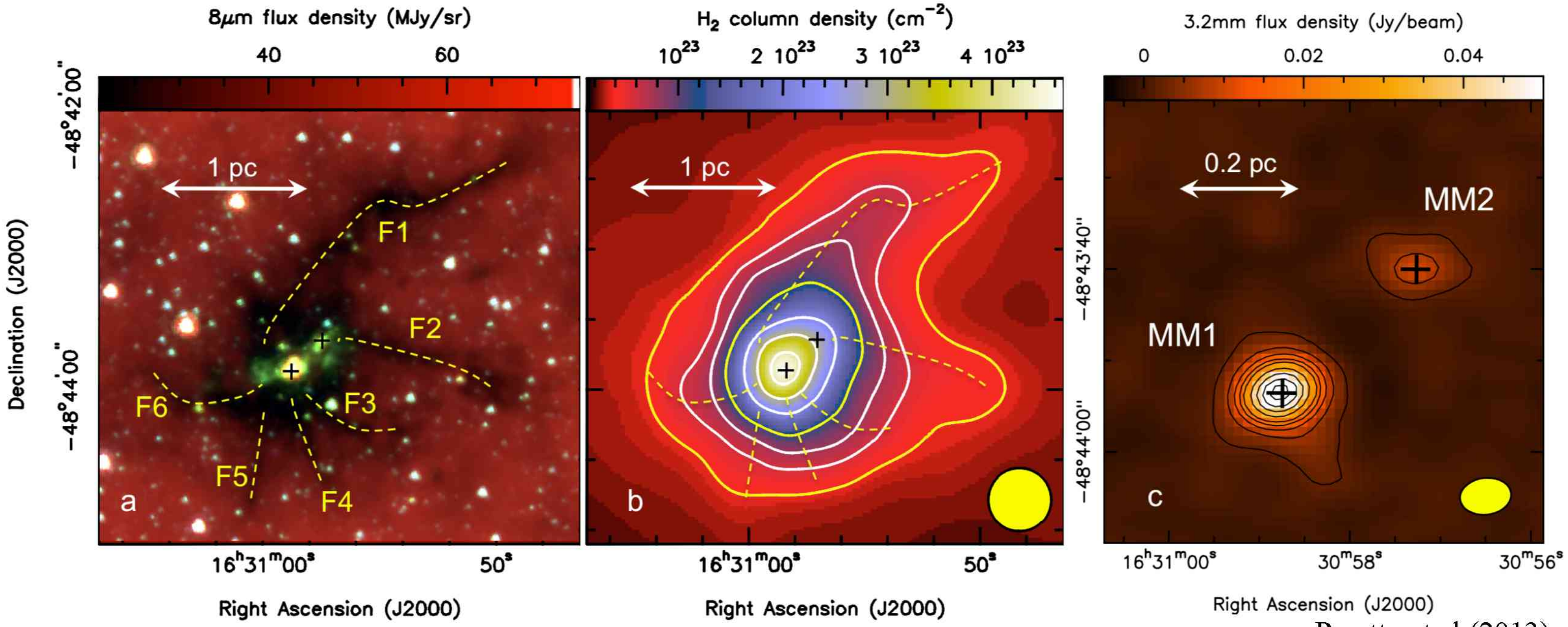
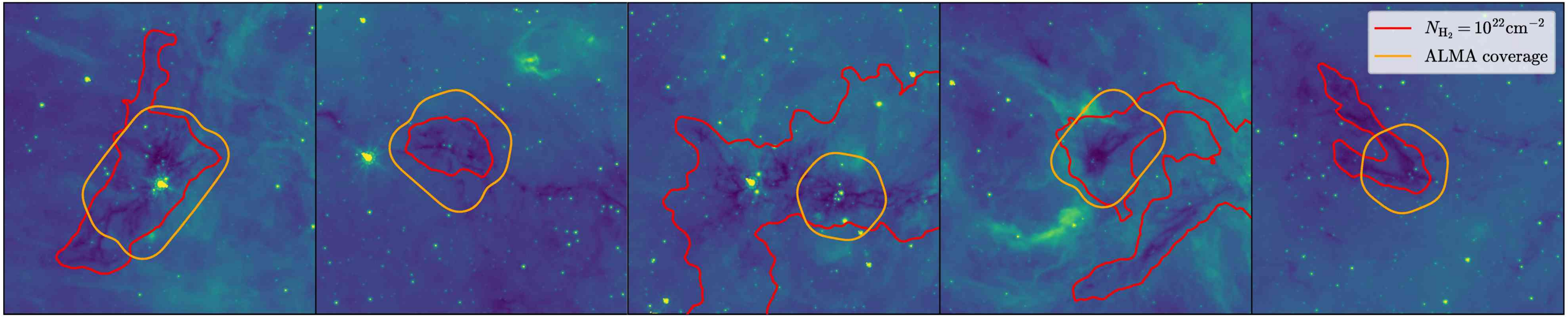
Star Formation in Hub-filament Systems

- Low- and high-mass star forming regions have been seen to exhibit a hub and filament morphology (Myers 2009)
- Infrared dark clouds (IRDCs) are molecular clouds seen as a silhouette against diffuse IR background emission of the Galactic plane
- These hub-filament systems (HFS) could be potential sites for very high-mass star formation
- SDC335 is an example of one such system, which was shown to harbour a $545M_\odot$ core (Peretto et al 2013)



Peretto et al (2013)

Selecting our sample of clouds

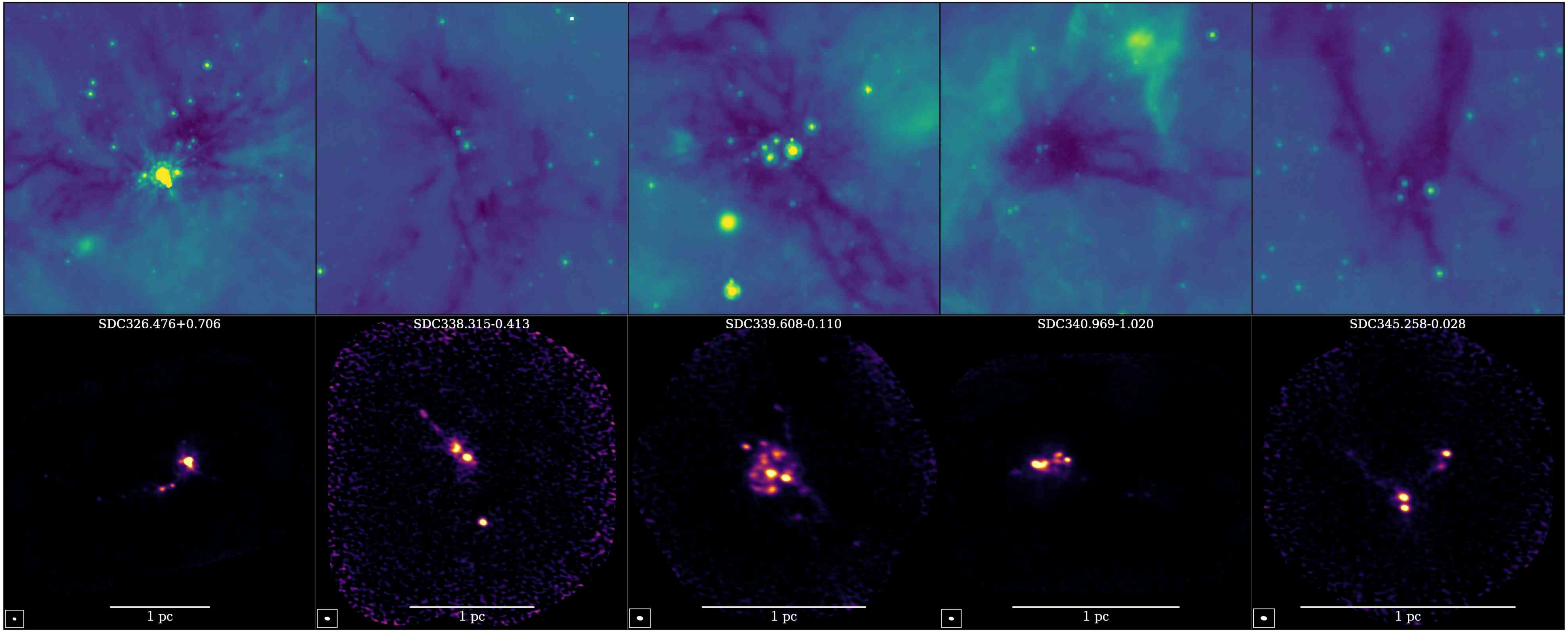


Selected five parsec-scale clouds from the Peretto & Fuller (2009) IRDC catalogue that:

i. Have a hub-filament morphology seen in *Spitzer* 8μm extinction
ii. Must be larger than 40", roughly the *Herschel* 500μm resolution
iii. Have a peak column density $N_{H2} > 10^{23} cm^{-2}$
iv. Are located at a kinematic distance between 2kpc < *d* < 3kpc

ALMA 7m+12m mosaics at 2.9mm (~103.6GHz)

- Median beam size = 2.88"×1.92"
- Median RMS noise = 66μJy/beam
- Distance range = **2.1–2.9kpc**
- Minimum physical scales ~ **0.03–0.04pc**



Dendrogram parameters:

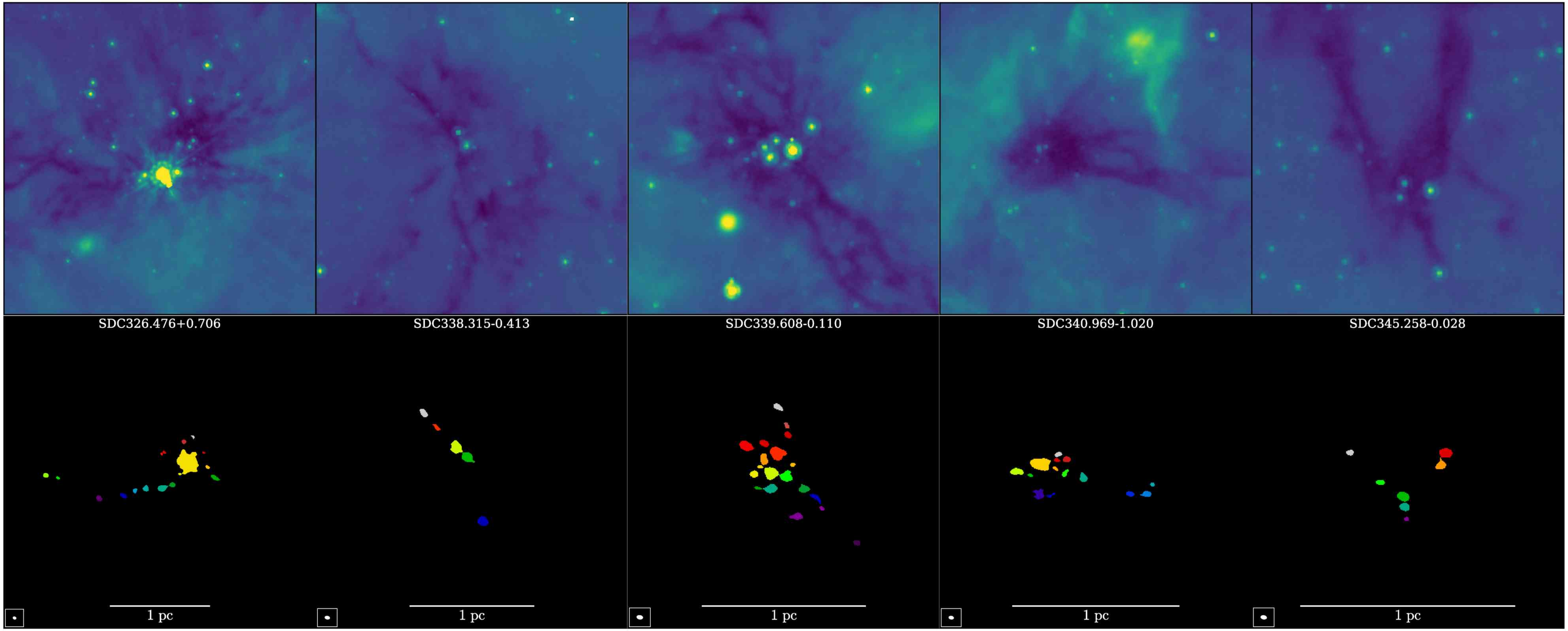
- Minimum detection threshold: $F_{min} = 5 \times \sigma_{RMS}$
- Minimum significance threshold: $\Delta F = 1 \times \sigma_{RMS}$
- Minimum structure size: s_{min} = beam size

We extracted **60 cores** from the 2.9mm continuum.

Fixed core dust temperature: $T_{dust} = 25K$

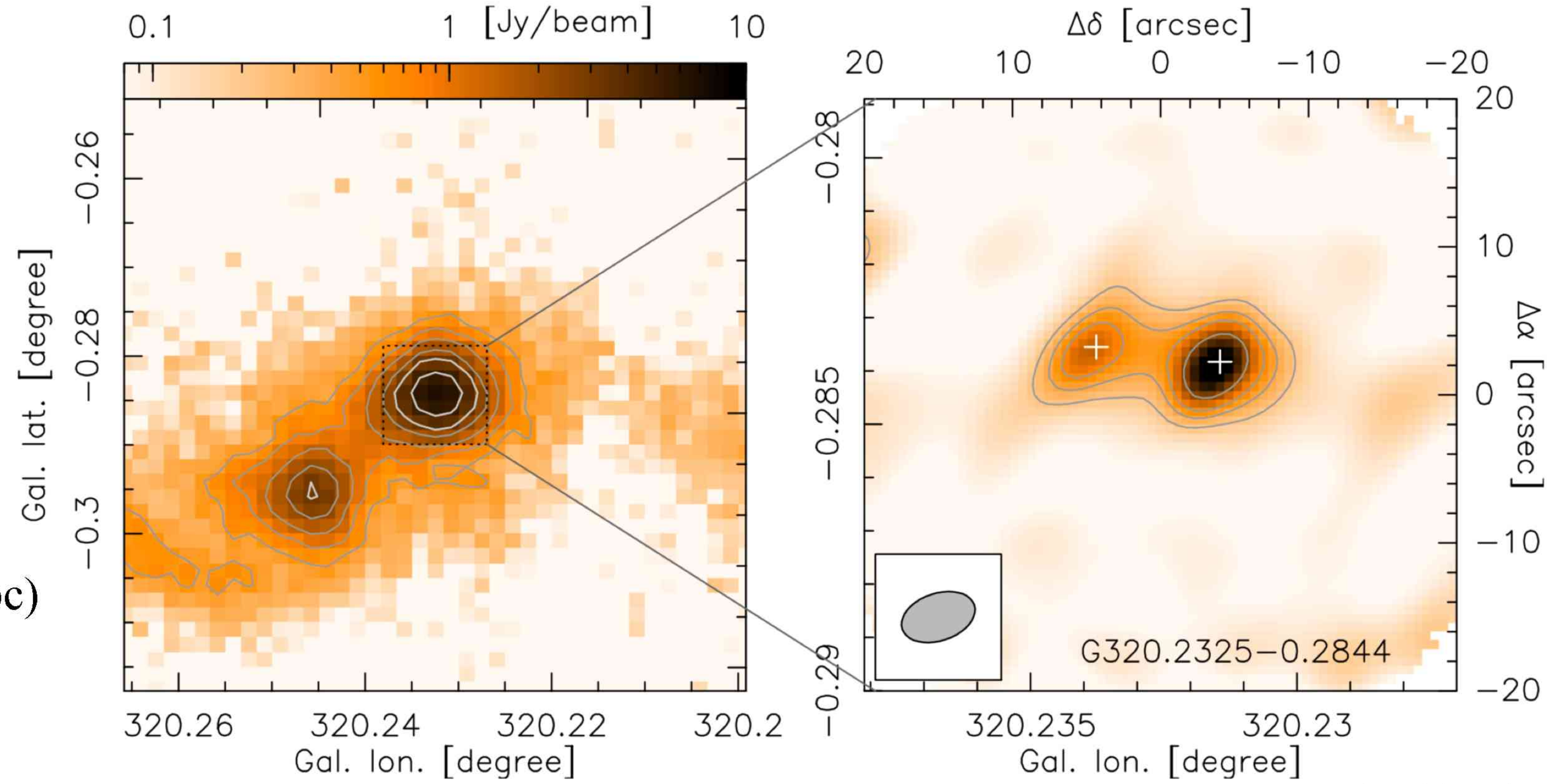
Dust opacity: $\kappa(\lambda) = 10^{-3} cm^2 g^{-1}$

Mass sensitivity (at $5 \times \sigma_{RMS}$): $M_{min} = 0.6 M_{\odot}$



Csengeri et al (2017) core sample

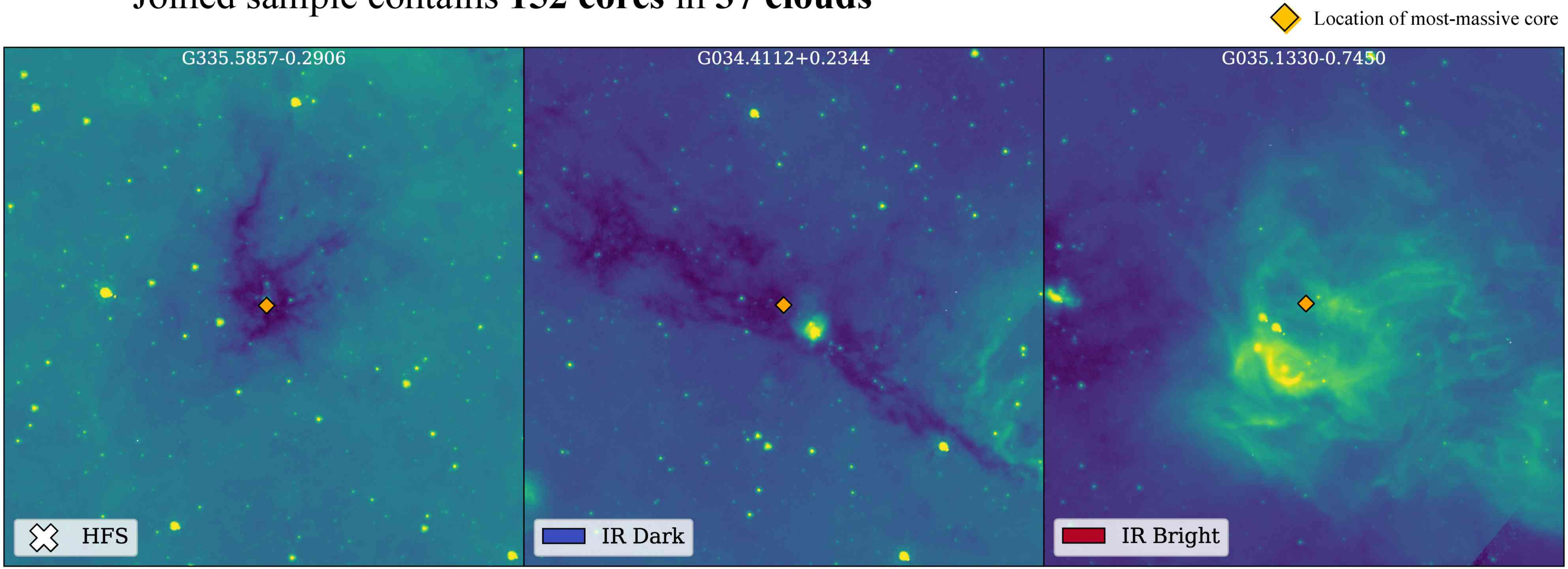
- ALMA 7m survey of 35 massive IR-quiet clumps from ATLASGAL
- Observed at 878μm (341.4GHz)
- Mean beam size = 3.79"
- Median RMS noise = 54mJy/beam
- Distances between **1.3kpc < *d* < 4.2kpc**
- Typical minimum spatial scale = **0.06pc**
- Mean mass sensitivity = 11.2M$_\odot$ (at 2.6kpc)
- **100 cores** detected over **35 clouds**



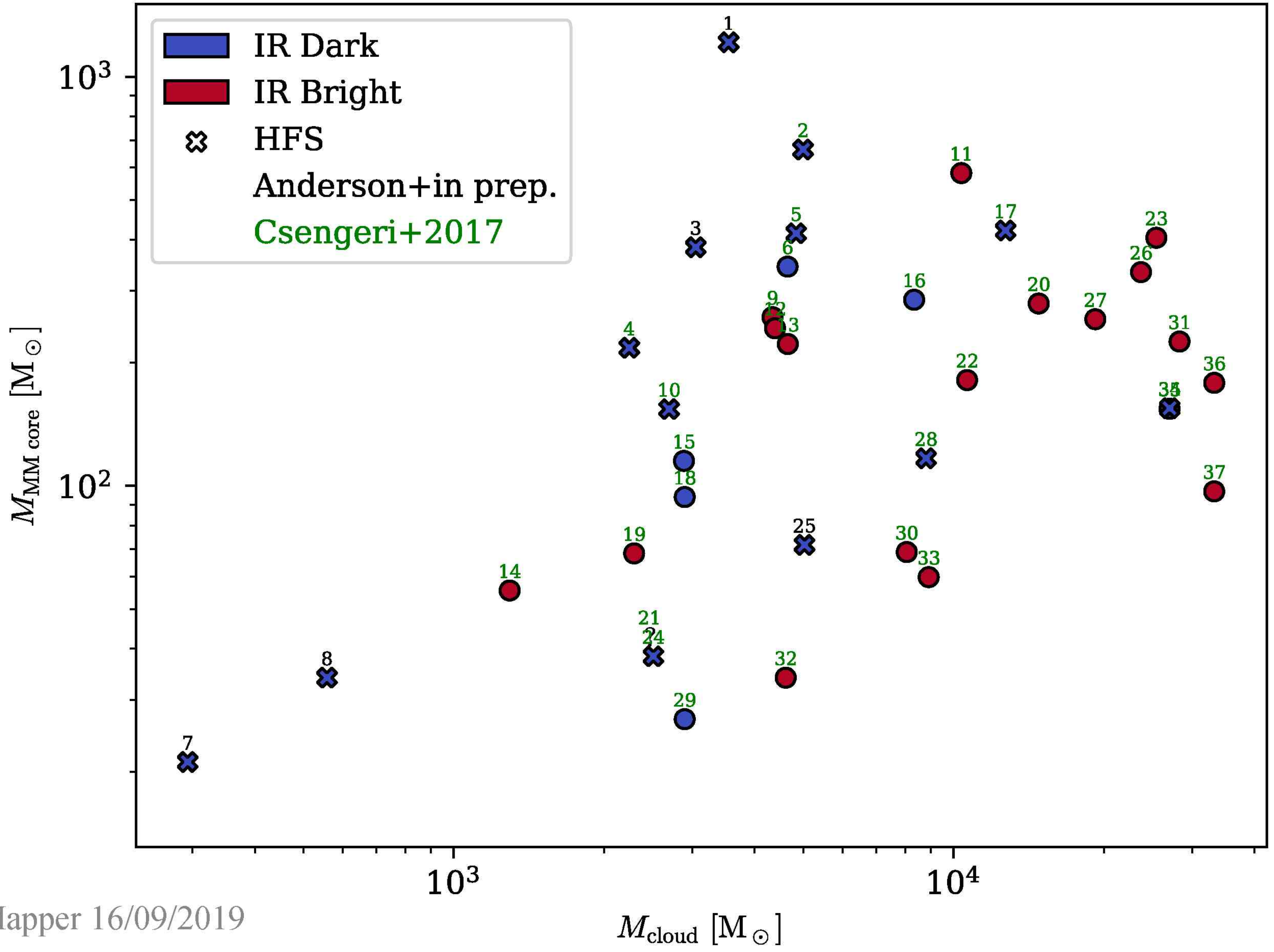
Csengeri et al (2017)

Final sample and cloud classification

- Cloud masses derived from *Herschel* column density maps from Peretto et al (2016)
- Cloud "boundary" defined to be at the $N_{H2} = 10^{22}cm^{-2}$
- Joined sample contains **152 cores** in **37 clouds**

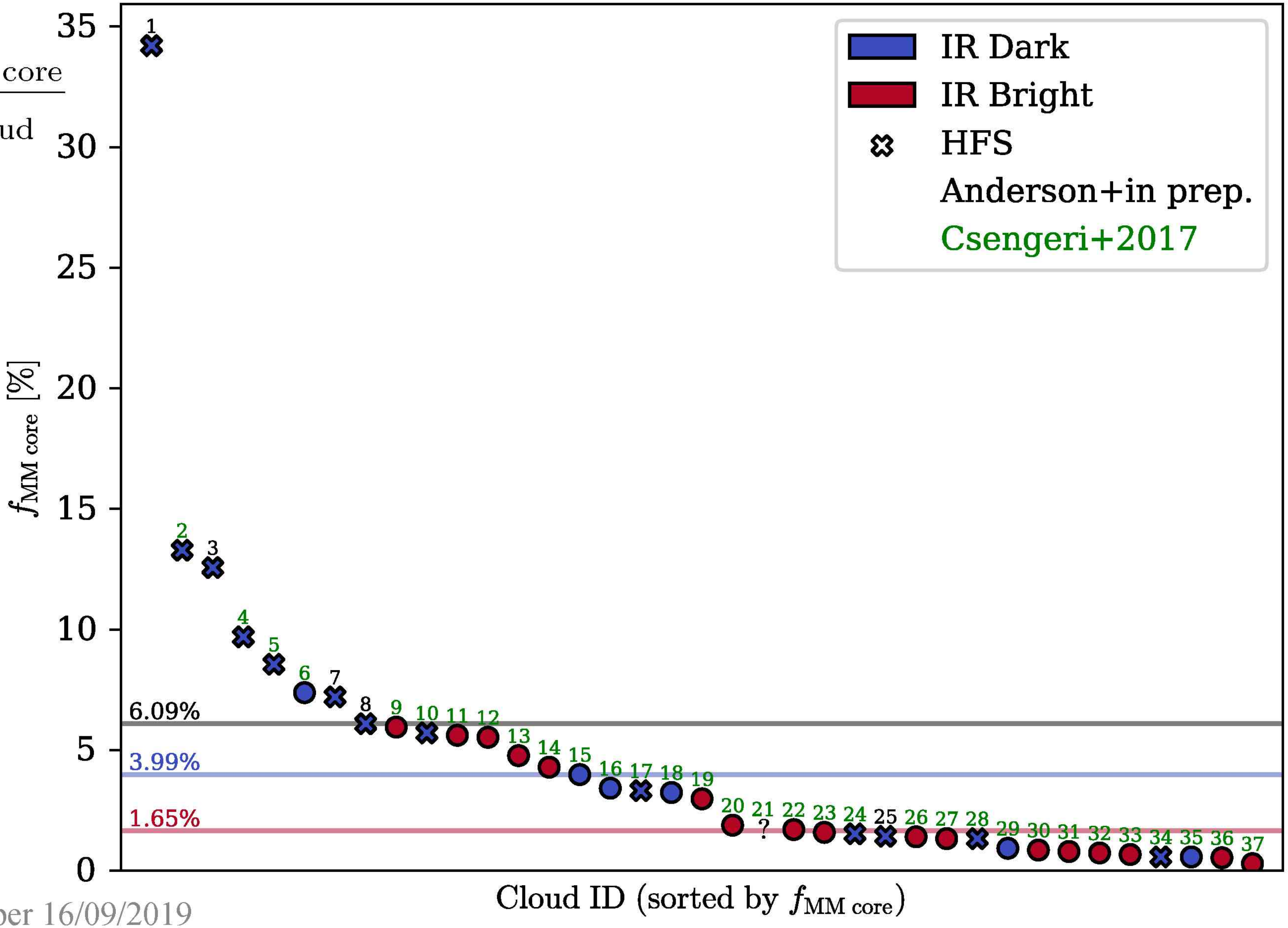


Cloud mass against mass of most-massive core



Mass concentration onto the most-massive cores

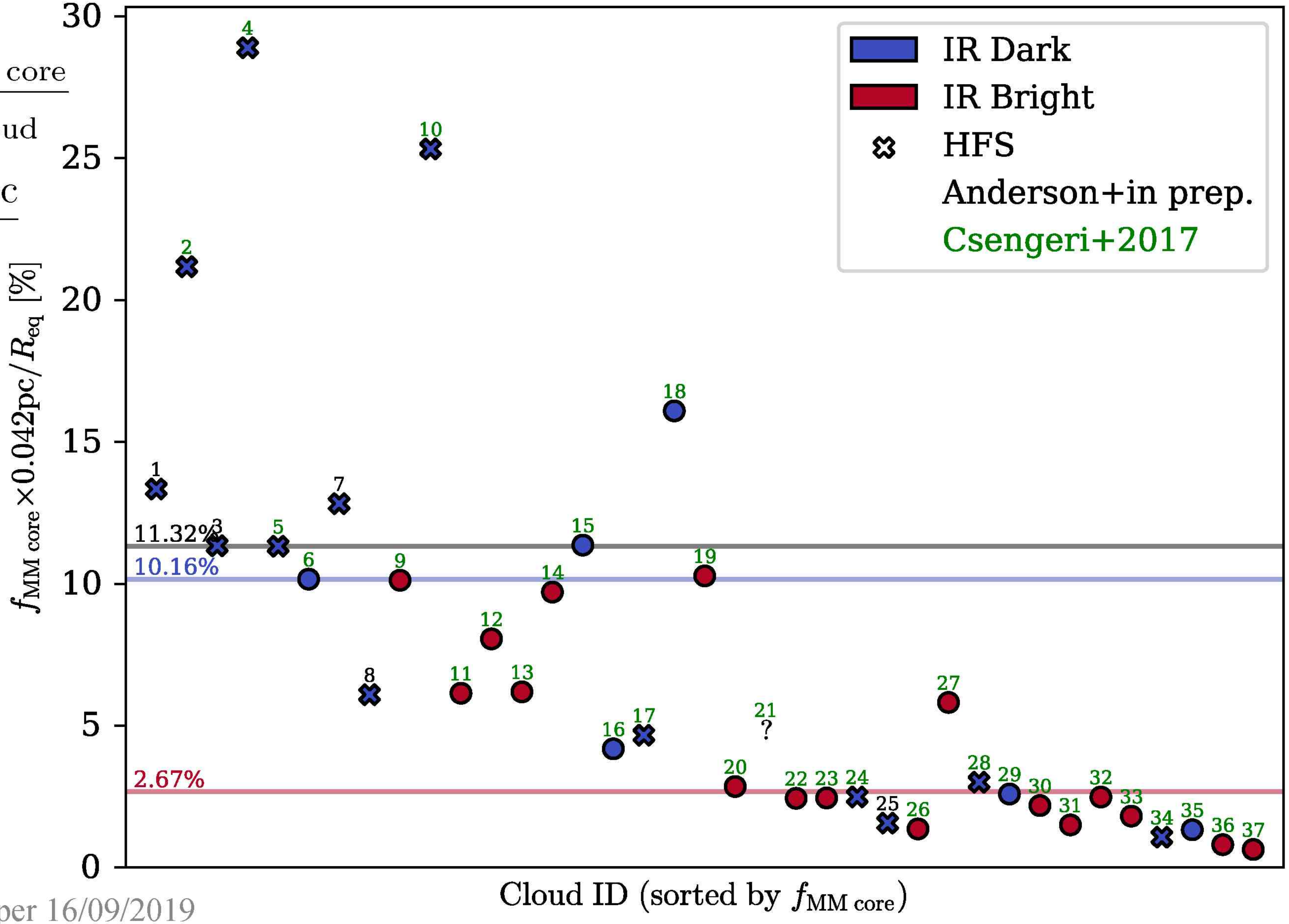
$$f_{\mathrm{MM\ core}} = \frac{M_{\mathrm{MM\ core}}}{M_{\mathrm{cloud}}}$$



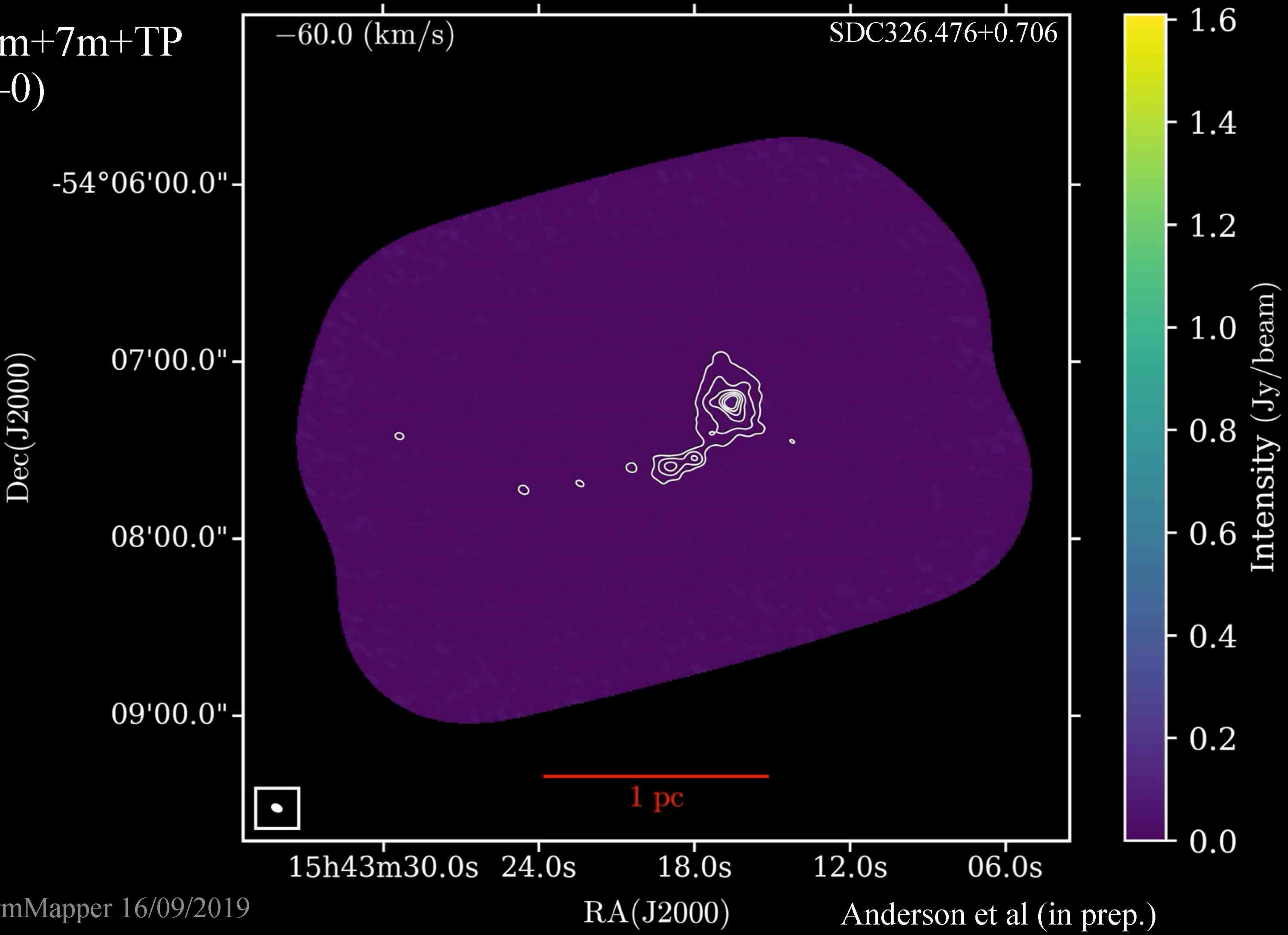
Mass concentration rescaled by median core radius

$$f_{\mathrm{MM\ core}} = \frac{M_{\mathrm{MM\ core}}}{M_{\mathrm{cloud}}}$$

$$\text{rescaled by } \frac{0.042\mathrm{pc}}{R_{\mathrm{eq}}}$$



ALMA 12m+7m+TP
N_2H^+(J=1–0)



Anderson et al (in prep.)

Conclusions

- We obtain properties for 152 cores across 37 clouds
- No correlation between mass of MM core and cloud mass
- IRDC (even more so HFS) more efficient at concentrating onto high-mass cores
- Perhaps there is an evolutionary sequence from HFS→IRDC→IRBC
- N_2H^+ emission corresponds well with *Spitzer* 8µm extinction features
- Now working on kinematics and also quantifying the convergence to help understand the growth of high-mass cores

Thank you for listening!

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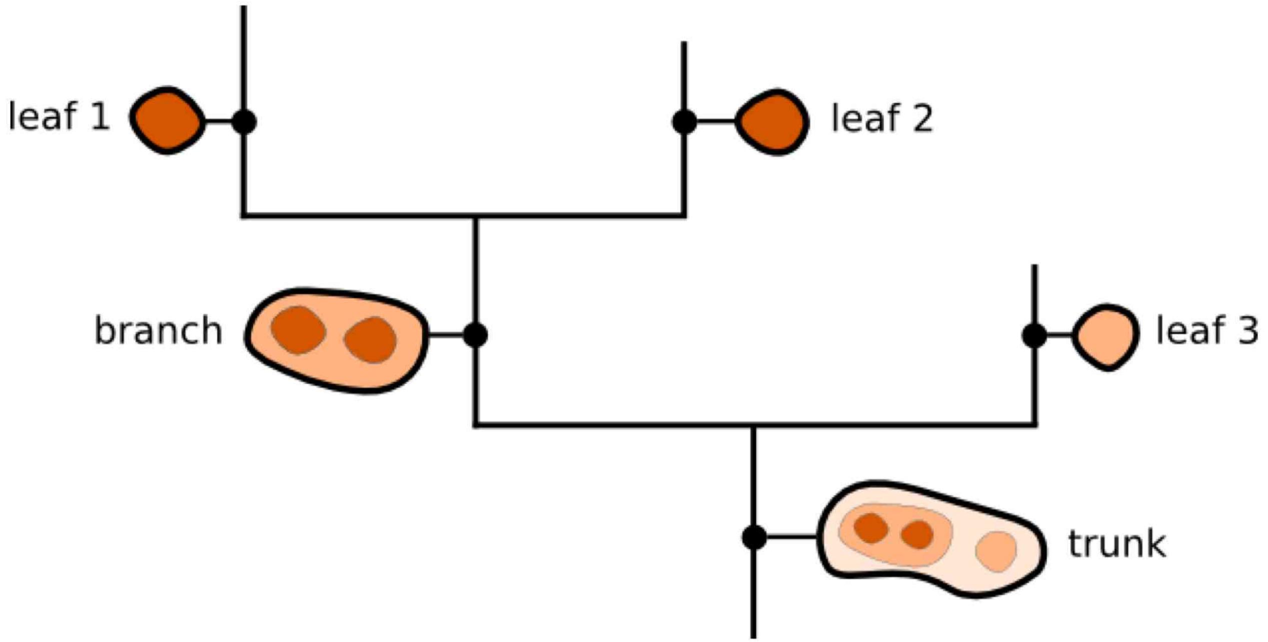
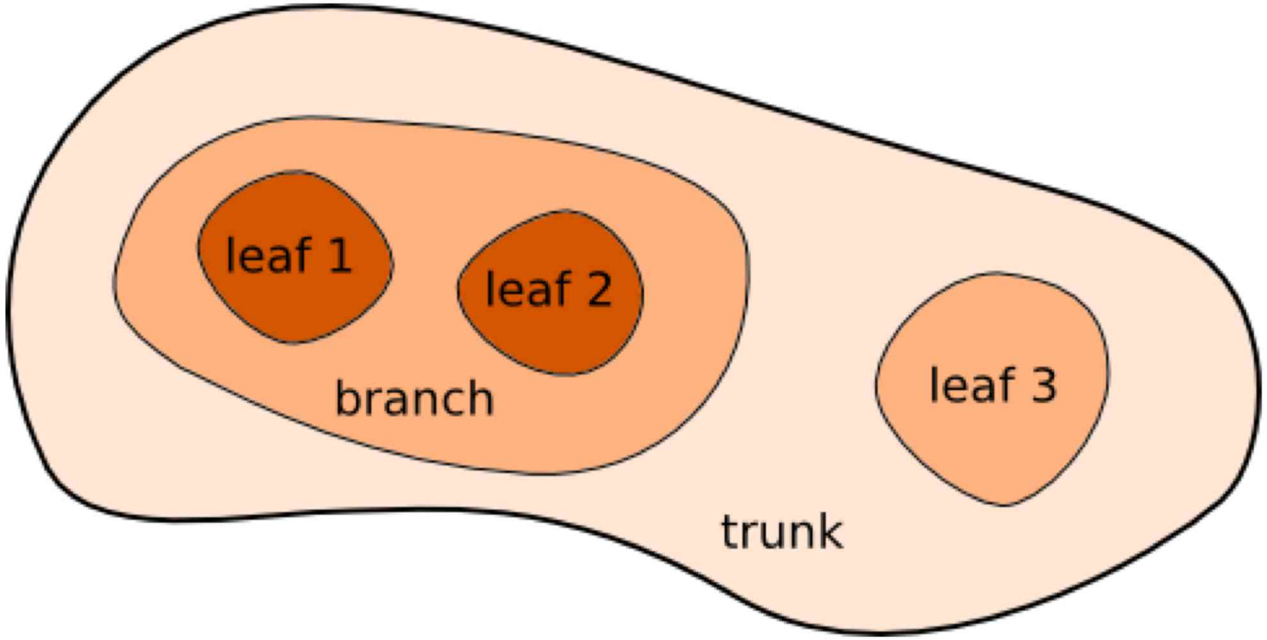
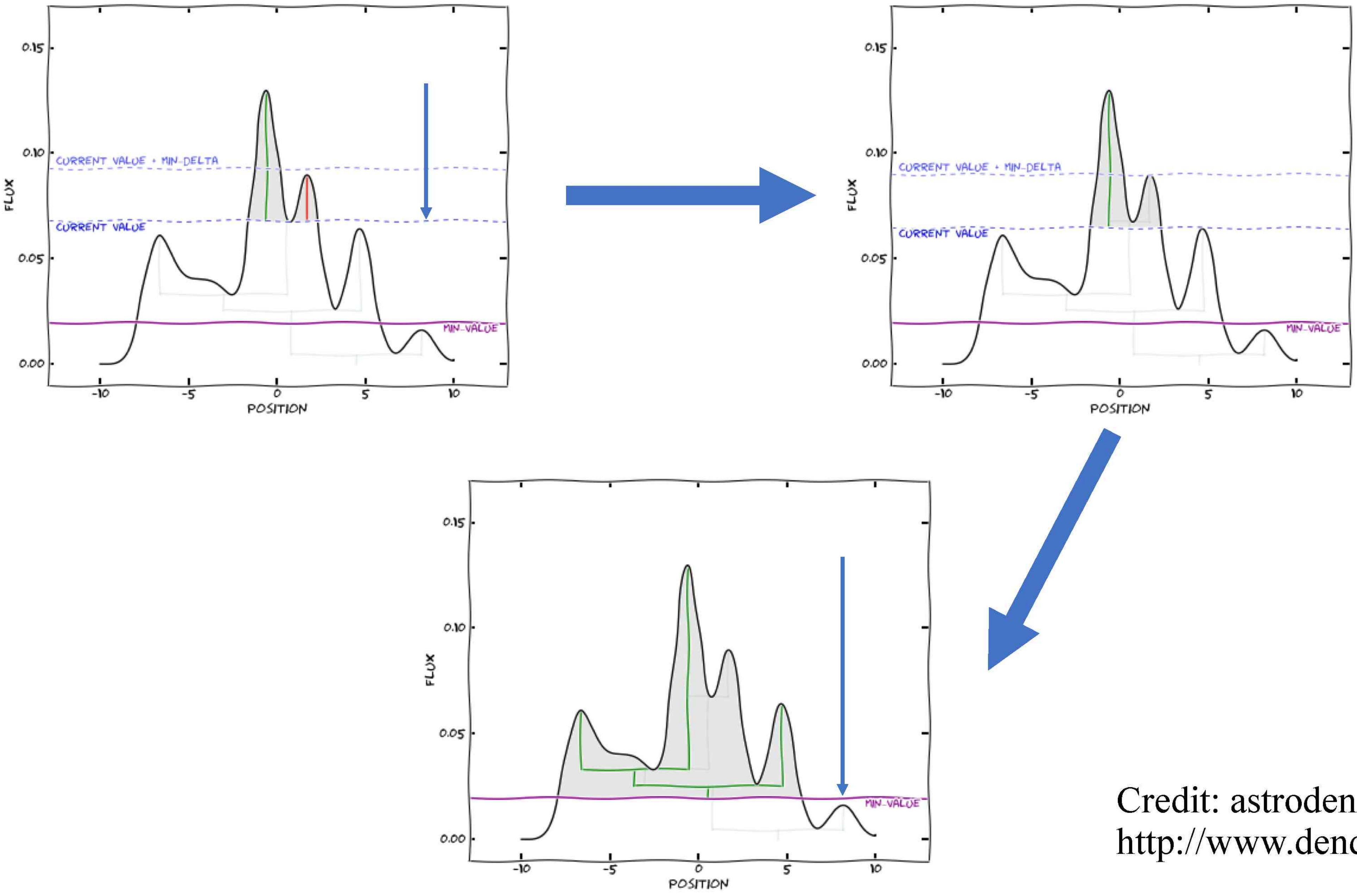




Credit: astrodendro
http://www.dendrograms.org/



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