Note: This is not a "presentation", per se.
It is a Keynote file with "notes" use in the discussions of dendrogramming
the Pipe at the Grenada meeting (May 2009) organized by J. Alves.

Dendro Pipe

Alyssa Goodman

+Joao Alves, Jens Kauffmann*, Jaime Pineda** & Erik Rosolowsky

*special thanks to Jens for his "mass-radius" & "AstroMed" work
**special thanks to Jaime for help with slides & all the CLUMPFIND work!

CLUMPFIND

Non-hiearchical

CMF easy

OK in “sparse” regions

BAD (unrealistic) in “crowded” regions

CLUMPFIND vs.

Non-hiearchical

CMF easy

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CLUMPFIND vs. DENDROGRAMS

Non-hiearchical

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OK in “sparse” regions

BAD (unrealistic) in “crowded” regions

Hierarchical

CMF hard
...to nonsensical(?)

OK in both sparse & crowded regions

CLUMPFIND vs. Dendrograms

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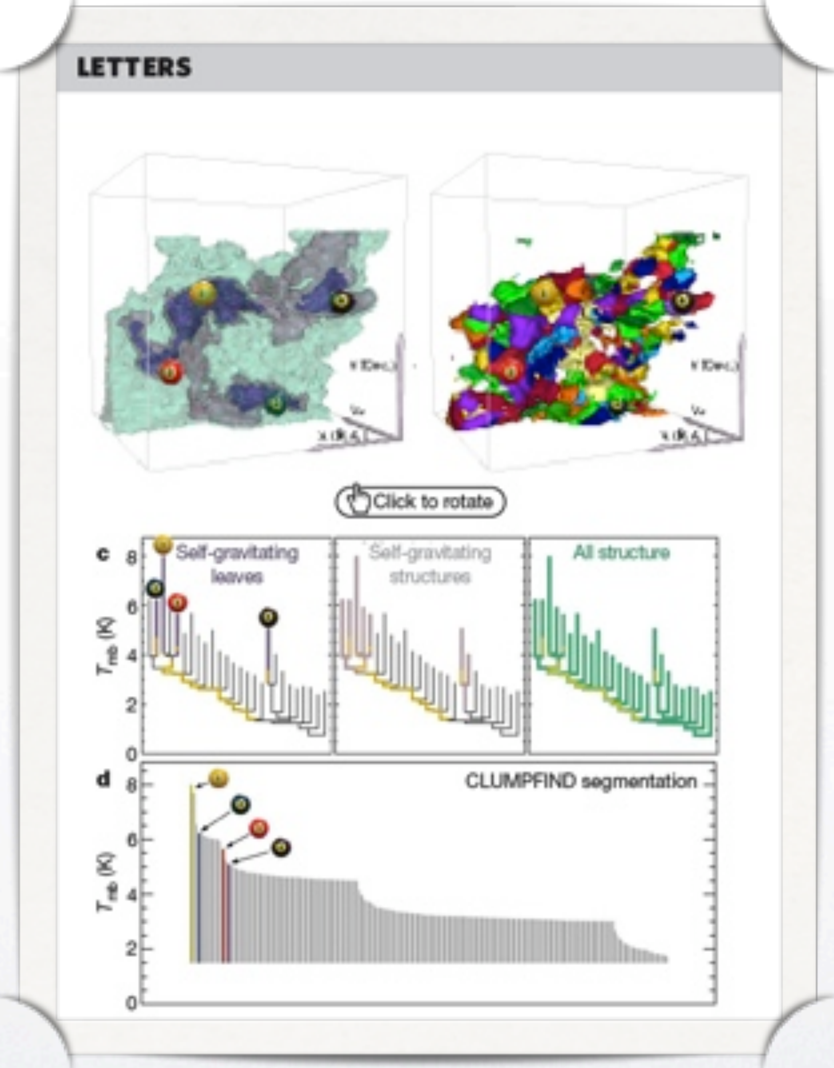

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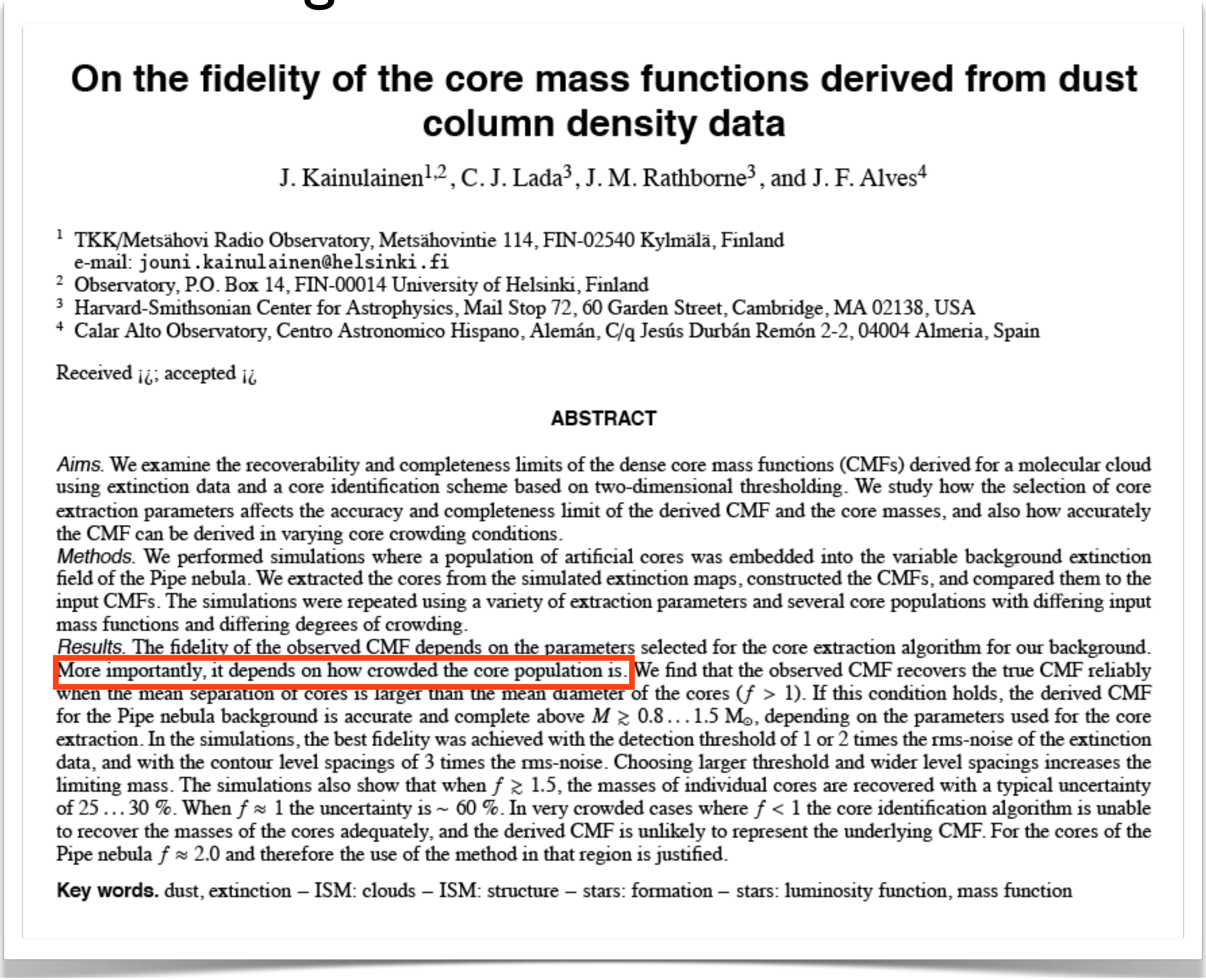
How good/bad is CLUMPFIND?



On the fidelity of the core mass functions derived from dust column density data

J. Kainulainen[1,2], C. J. Lada[3], J. M. Rathborne[3], and J. F. Alves[4]

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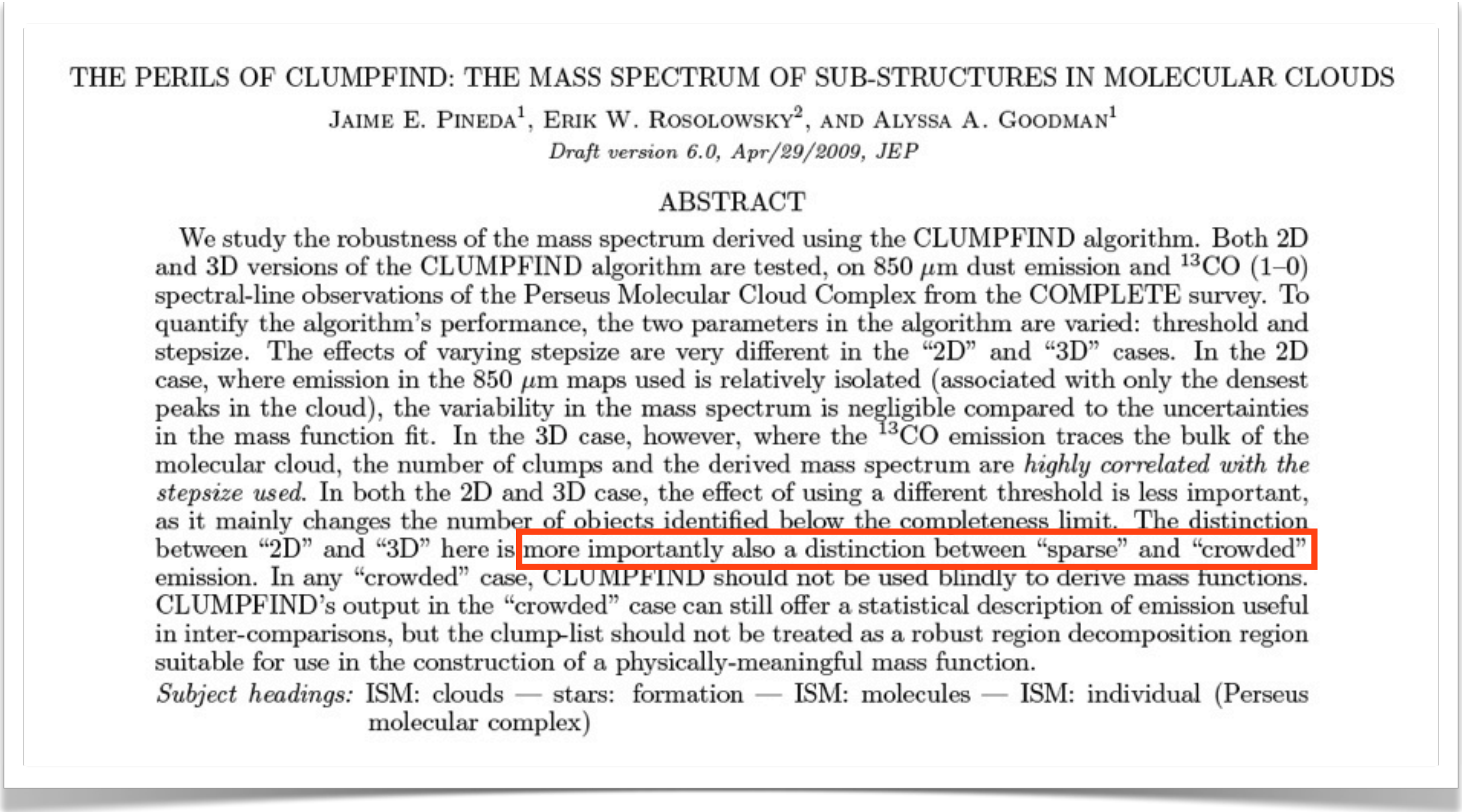
Received ¡¿; accepted ¡¿

ABSTRACT

Aims. We examine the recoverability and completeness limits of the dense core mass functions (CMFs) derived for a molecular cloud using extinction data and a core identification scheme based on two-dimensional thresholding. We study how the selection of core extraction parameters affects the accuracy and completeness limit of the derived CMF and the core masses, and also how accurately the CMF can be derived in varying core crowding conditions.
Methods. We performed simulations where a population of artificial cores was embedded into the variable background extinction field of the Pipe nebula. We extracted the cores from the simulated extinction maps, constructed the CMFs, and compared them to the input CMFs. The simulations were repeated using a variety of extraction parameters and several core populations with differing input mass functions and differing degrees of crowding.
Results. The fidelity of the observed CMF depends on the parameters selected for the core extraction algorithm for our background. More importantly, it depends on how crowded the core population is. We find that the observed CMF recovers the true CMF reliably when the mean separation of cores is larger than the mean diameter of the cores ($f > 1$). If this condition holds, the derived CMF for the Pipe nebula background is accurate and complete above $M \gtrsim 0.8 \ldots 1.5$ $M_\odot$, depending on the parameters used for the core extraction. In the simulations, the best fidelity was achieved with the detection threshold of 1 or 2 times the rms-noise of the extinction data, and with the contour level spacings of 3 times the rms-noise. Choosing larger threshold and wider level spacings increases the limiting mass. The simulations also show that when $f \gtrsim 1.5$, the masses of individual cores are recovered with a typical uncertainty of 25 … 30 %. When $f \approx 1$ the uncertainty is ~ 60 %. In very crowded cases where $f < 1$ the core identification algorithm is unable to recover the masses of the cores adequately, and the derived CMF is unlikely to represent the underlying CMF. For the cores of the Pipe nebula $f \approx 2.0$ and therefore the use of the method in that region is justified.

Key words. dust, extinction – ISM: clouds – ISM: structure – stars: formation – stars: luminosity function, mass function

How good/bad is CLUMPFIND?



THE PERILS OF CLUMPFIND: THE MASS SPECTRUM OF SUB-STRUCTURES IN MOLECULAR CLOUDS

JAIME E. PINEDA[1], ERIK W. ROSOLOWSKY[2], AND ALYSSA A. GOODMAN[1]

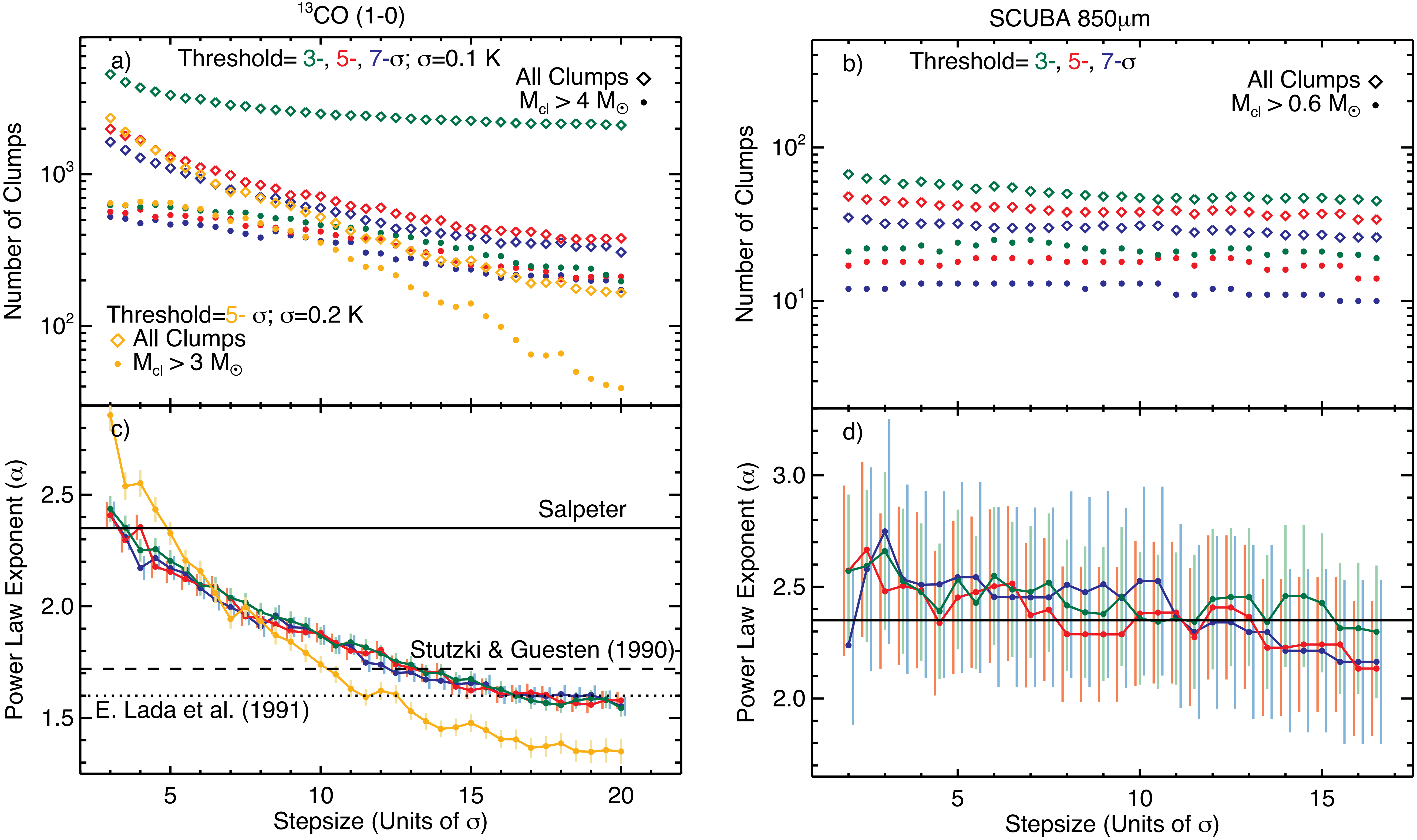
Draft version 6.0, Apr/29/2009, JEP

ABSTRACT

We study the robustness of the mass spectrum derived using the CLUMPFIND algorithm. Both 2D and 3D versions of the CLUMPFIND algorithm are tested, on 850 μm dust emission and ^{13}CO (1–0) spectral-line observations of the Perseus Molecular Cloud Complex from the COMPLETE survey. To quantify the algorithm's performance, the two parameters in the algorithm are varied: threshold and stepsize. The effects of varying stepsize are very different in the "2D" and "3D" cases. In the 2D case, where emission in the 850 μm maps used is relatively isolated (associated with only the densest peaks in the cloud), the variability in the mass spectrum is negligible compared to the uncertainties in the mass function fit. In the 3D case, however, where the ^{13}CO emission traces the bulk of the molecular cloud, the number of clumps and the derived mass spectrum are *highly correlated with the stepsize used*. In both the 2D and 3D case, the effect of using a different threshold is less important, as it mainly changes the number of objects identified below the completeness limit. The distinction between "2D" and "3D" here is more importantly also a distinction between "sparse" and "crowded" emission. In any "crowded" case, CLUMPFIND should not be used blindly to derive mass functions. CLUMPFIND's output in the "crowded" case can still offer a statistical description of emission useful in inter-comparisons, but the clump-list should not be treated as a robust region decomposition region suitable for use in the construction of a physically-meaningful mass function.

Subject headings: ISM: clouds — stars: formation — ISM: molecules — ISM: individual (Perseus molecular complex)

How good/bad is CLUMPFIND?



Pineda, Rosolowsky & Goodman 2009

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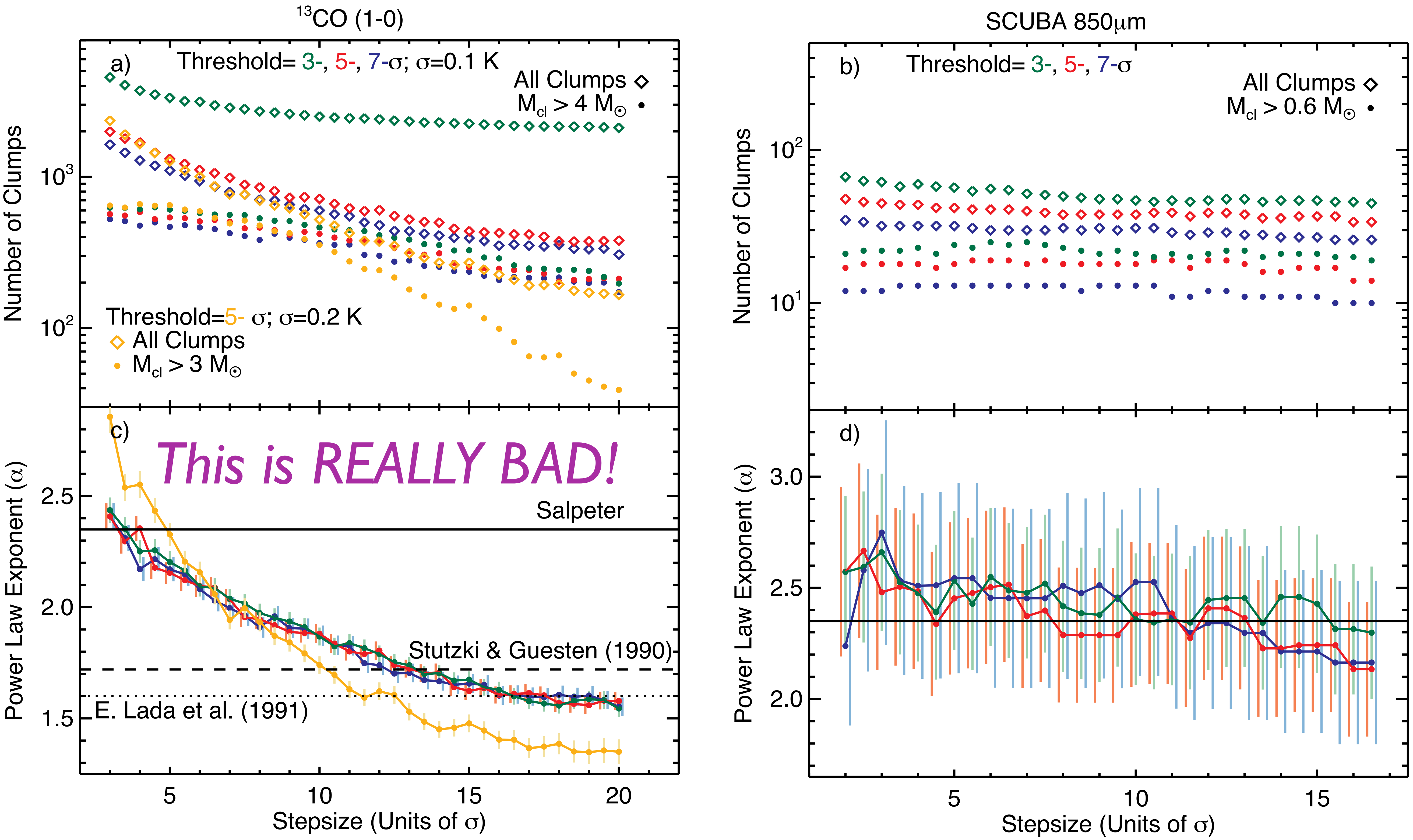

This is REALLY BAD!

Pineda, Rosolowsky & Goodman 2009

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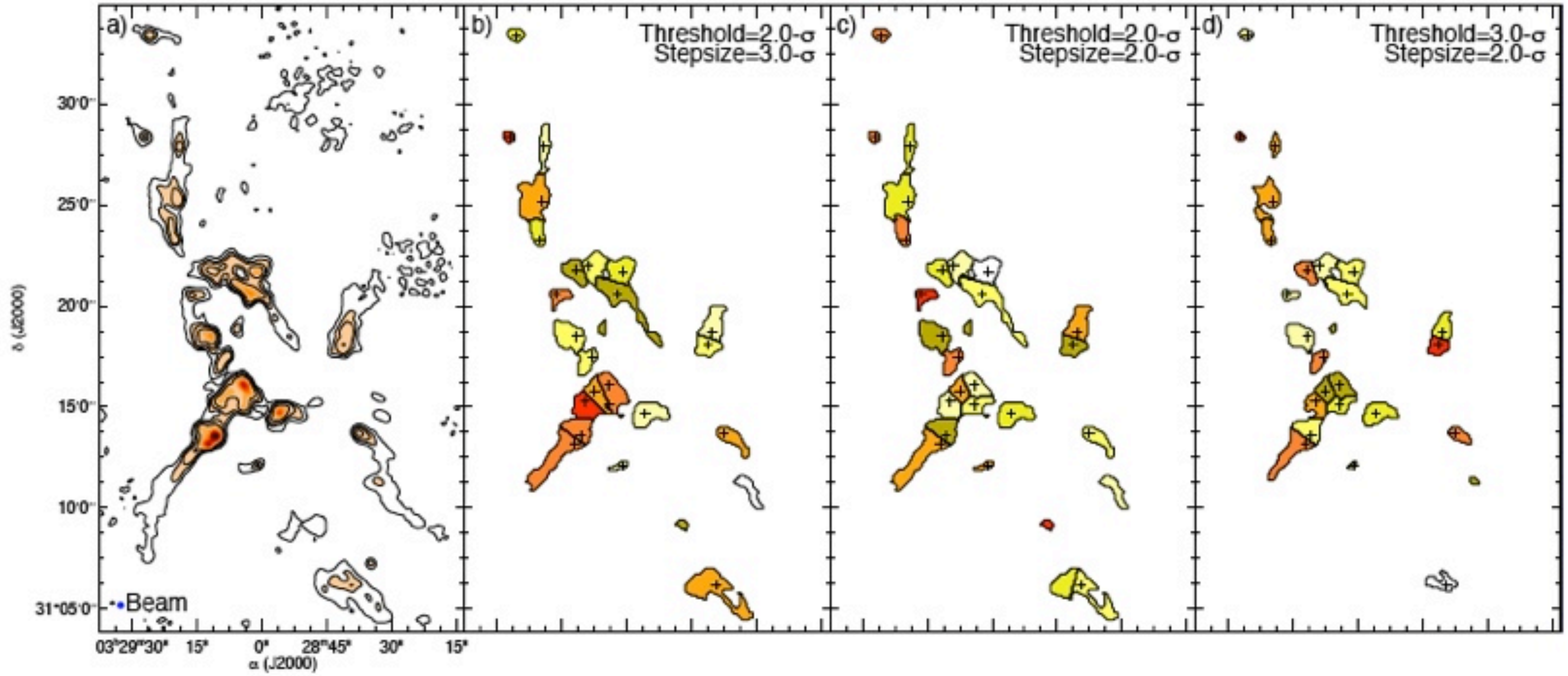


FIG. 3.— Comparison of different CLUMPFIND runs on the NGC1333 region. Panels **b**, **c** and **d** show clumps found in three different CLUMPFIND runs, and crosses mark the position of cores found by Kirk et al. (2006). Panel **a** shows the dust emission map in the NGC1333 region, with the overlaid contours at 1–, 3–, 5–, and 10–σ level; in addition the beam size (19.9″) is shown in bottom left corner. Small changes in the parameters used generate small (but important) changes the catalogue obtained.

Pineda, Rosolowsky & Goodman 2009

Dendro Pipe: What do we want to know?

1. Is pre-wavelet CLUMPFIND useful?
    1. No. The structures identified do not correspond well to those seen by-eye, or to dense core positions.
2. Is post-wavelet CLUMPFIND useful? (Yes, João says so!)
    - 2.1. Are the clumps cores? (e.g. is NH_3 detected?)...answer from this A.M.!?
    - 2.2. Are the clumps physically possible? (Mostly, see Charlie's discussion...)
3. What can dendrograms tell us that CLUMPFIND cannot?
    - 3.1. Nested-ness (hierarchy) of structure
    - 3.2. Realistic "boundedness" of structures using spectral-line maps
4. How do CLUMPFIND "clumps" correspond to structures one can find with dendrograms?
    - 4.1. Relationship to "real" dense cores...
      (What does "real" really mean?.. Is NH_3 enough? ... sub-mm peaks?)

Pre-Wavelet CLUMPFIND

Thanks to Jaime Pineda for this figure...

Pre-Wavelet CLUMPFIND

Definition of hugly

hugly ⭐

adjective

1. extremely ugly. An contraction of "hella ugly."

That girl is hugly!

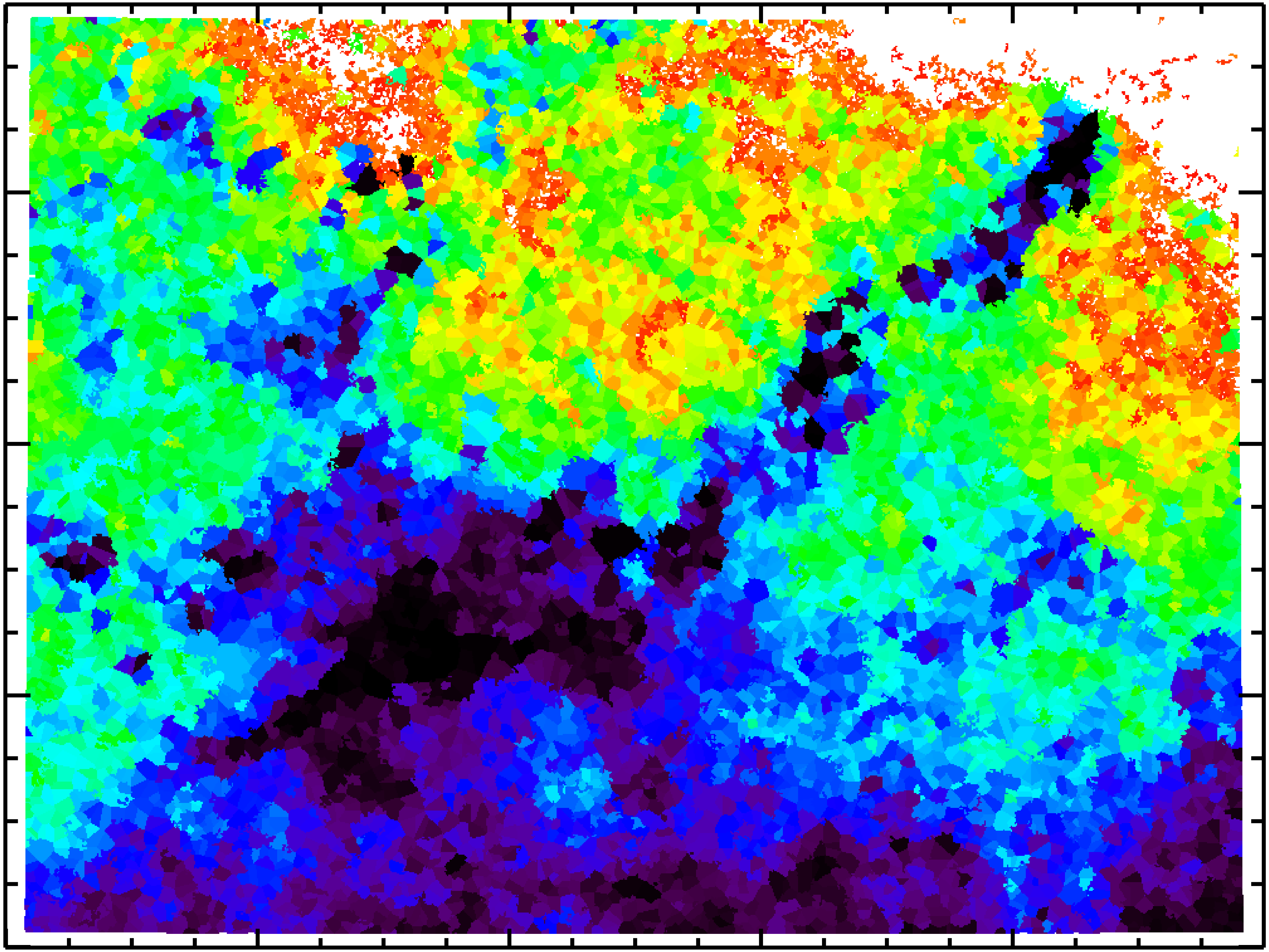
Submitted by Rob E. W., DE, USA, Dec 31 2002.

Discover slang words with the same meaning:

- unattractive, ugly

Thanks to Jaime Pineda for this figure...

Pre-Wavelet CLUMPFIND



Thanks to Jaime Pineda for this figure...

Post-wavelet CLUMPFIND+unseeded dendro

L18 J. Alves et al.: The mass function of dense molecular cores and the origin of the IMF

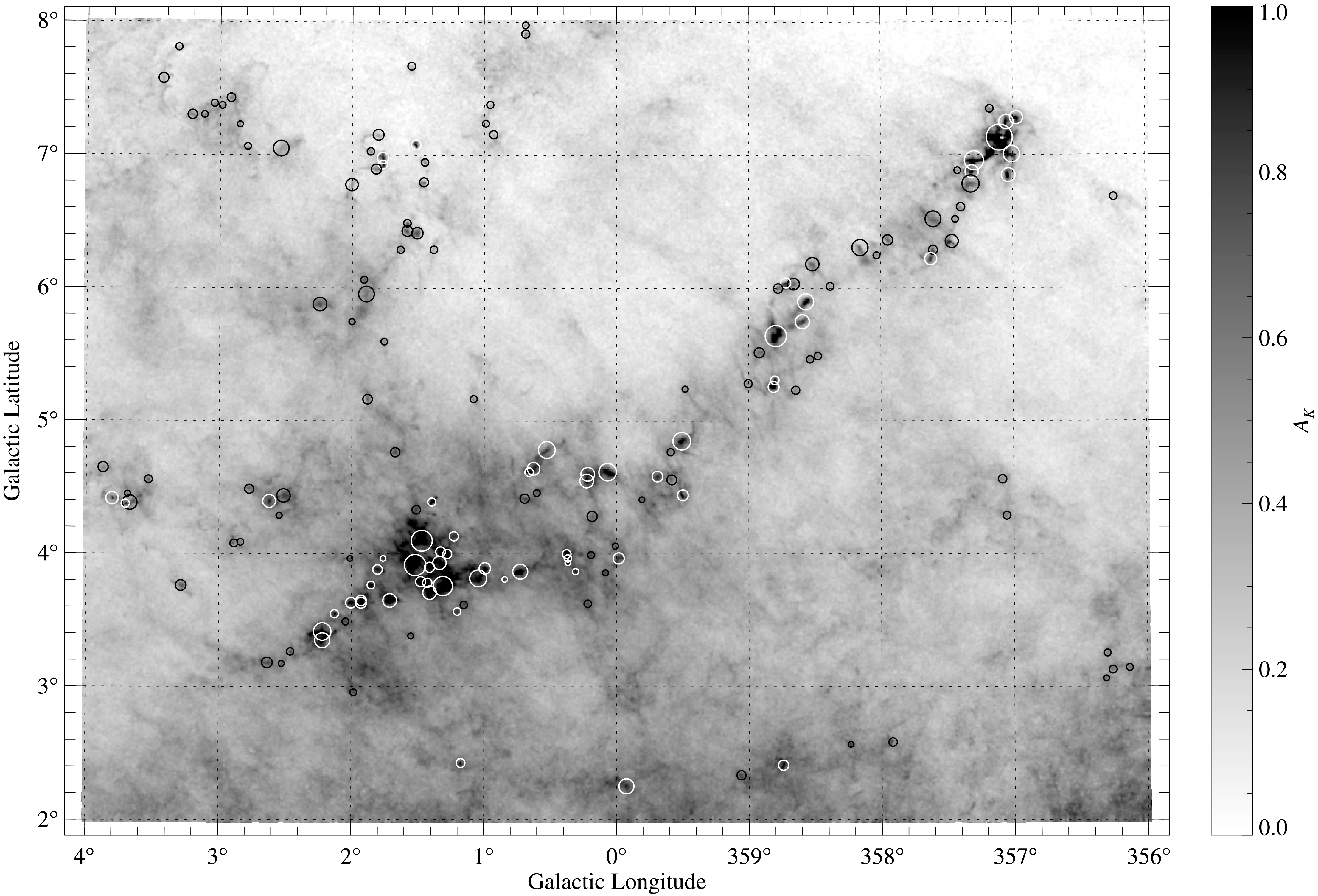


Fig. 1. Dust extinction map of the Pipe nebula molecular complex from Lombardi et al. (2006). This map was constructed from near-infrared observations of about 4 million stars in the background of the complex. Approximately 160 individual cores are identified within the cloud and are marked by an open circle proportional to the core radius. Most of these cores appear as distinct, well separated entities.

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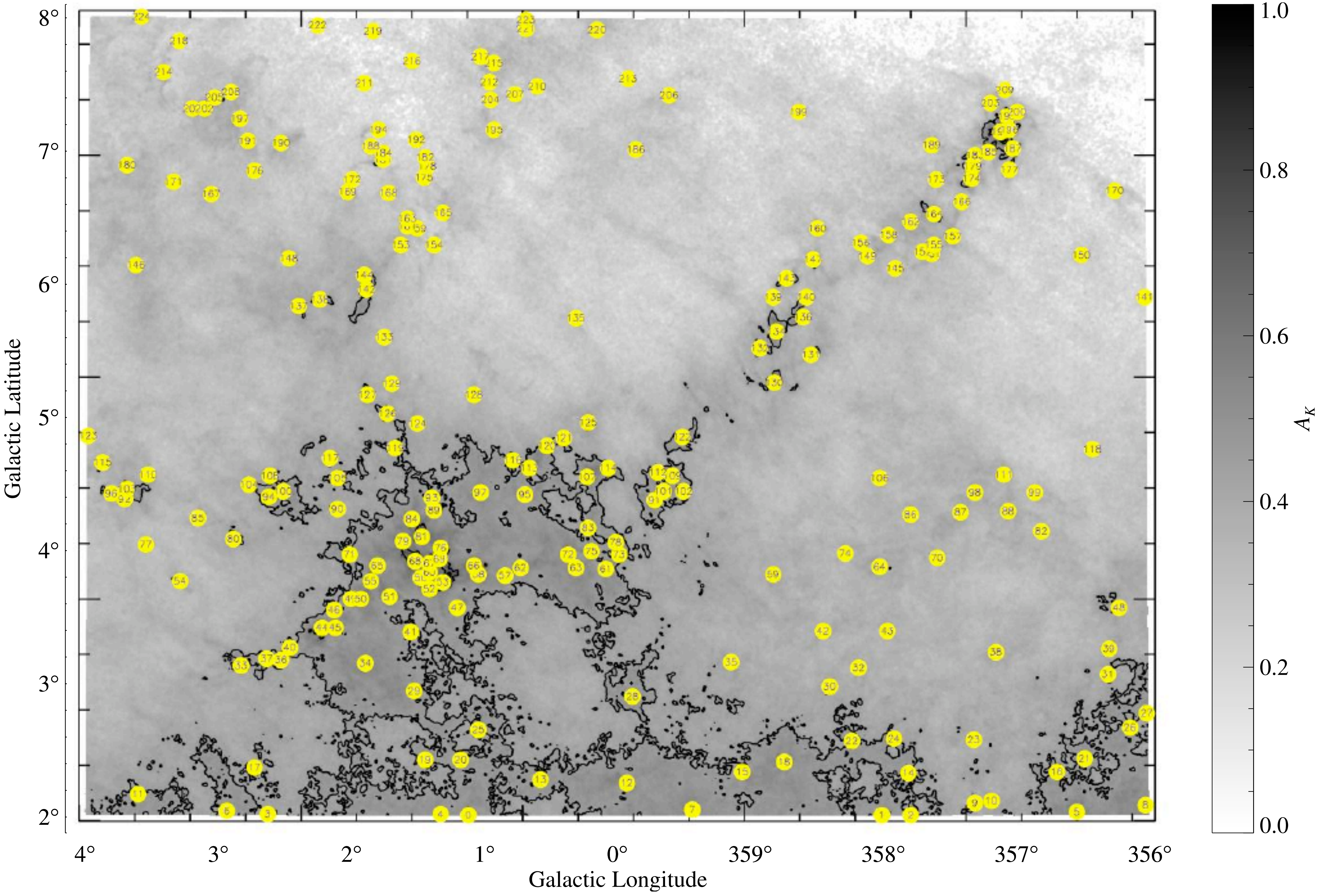

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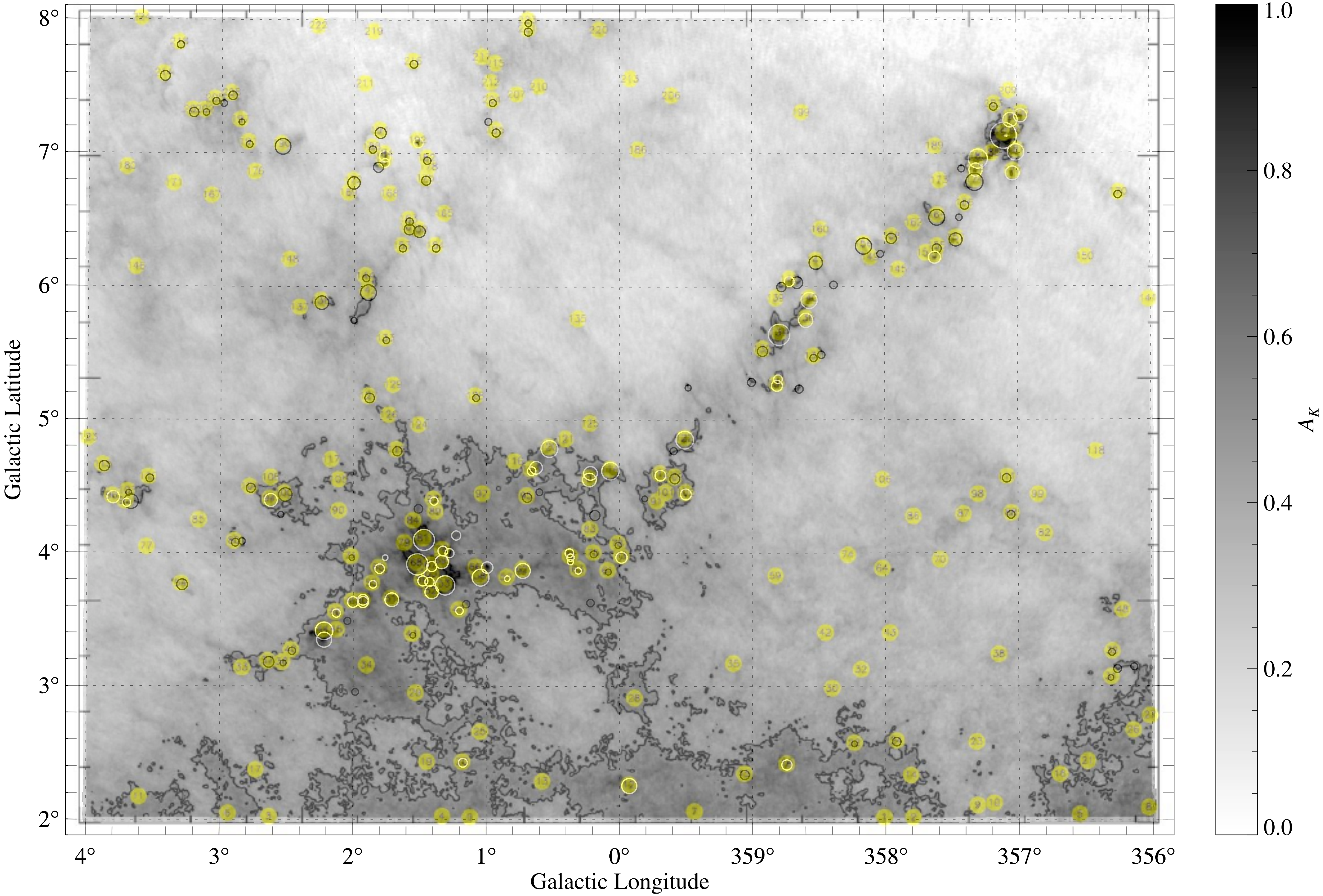

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Post-wavelet CLUMPFIND+seeded Dendro

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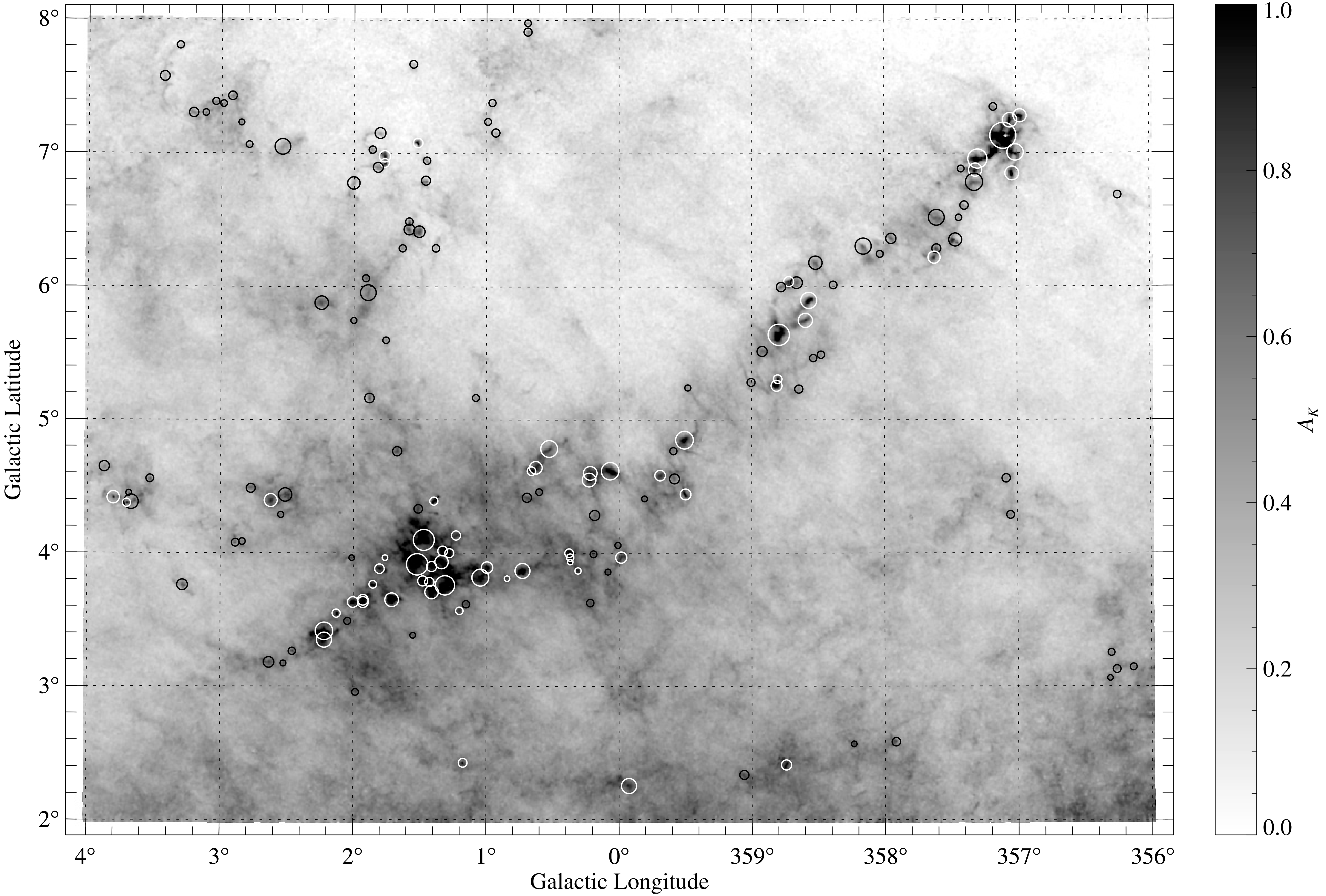

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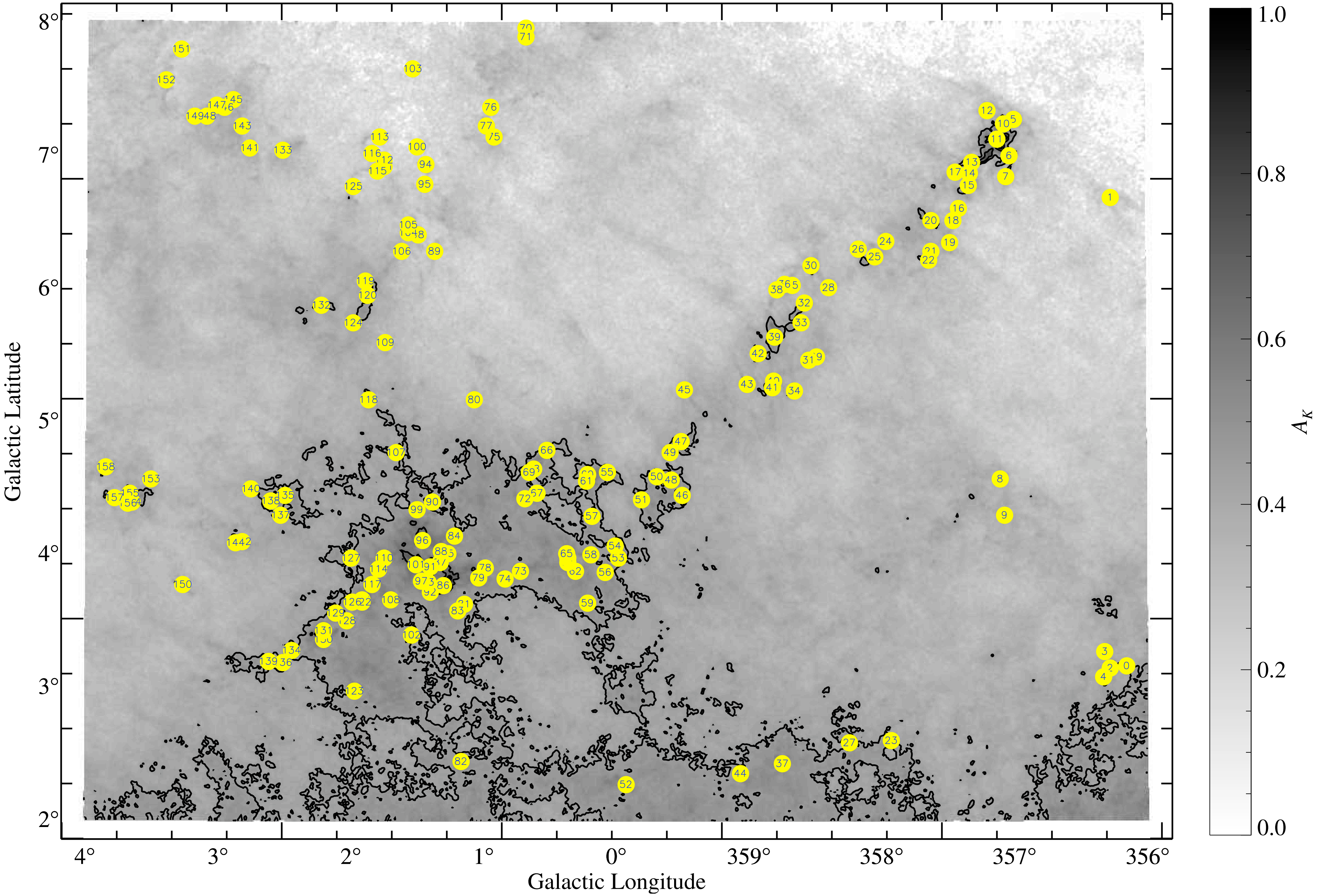

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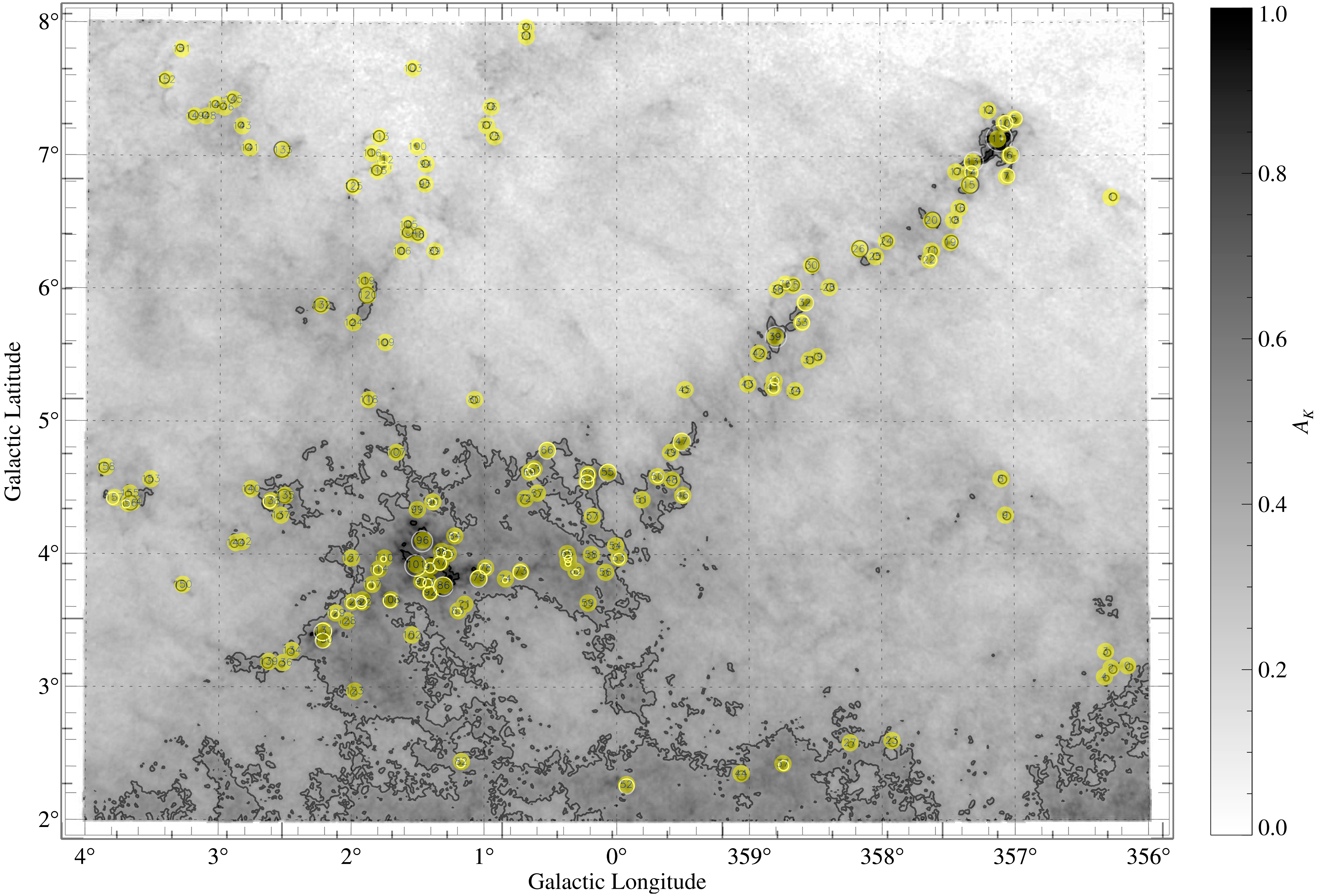

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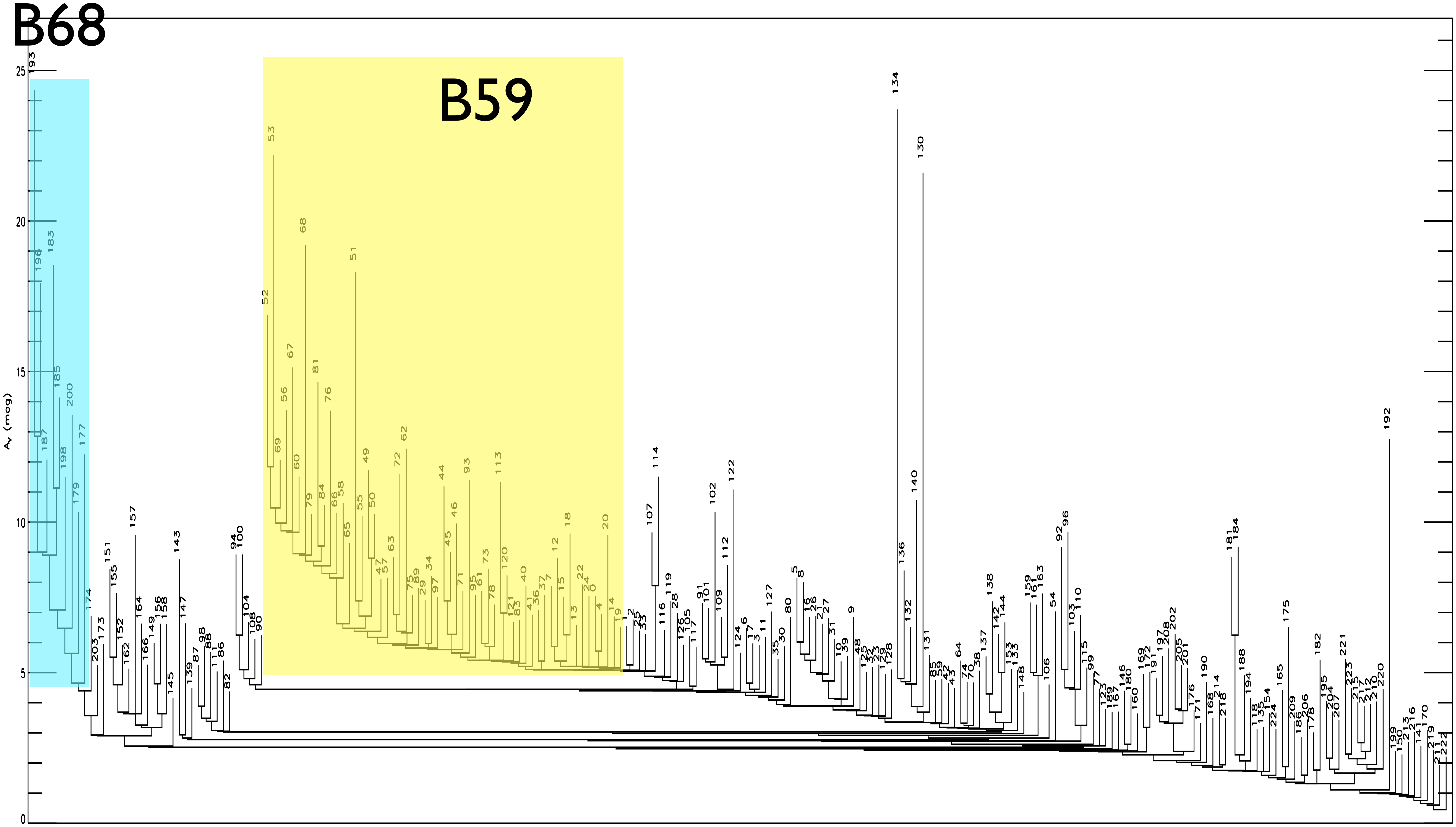
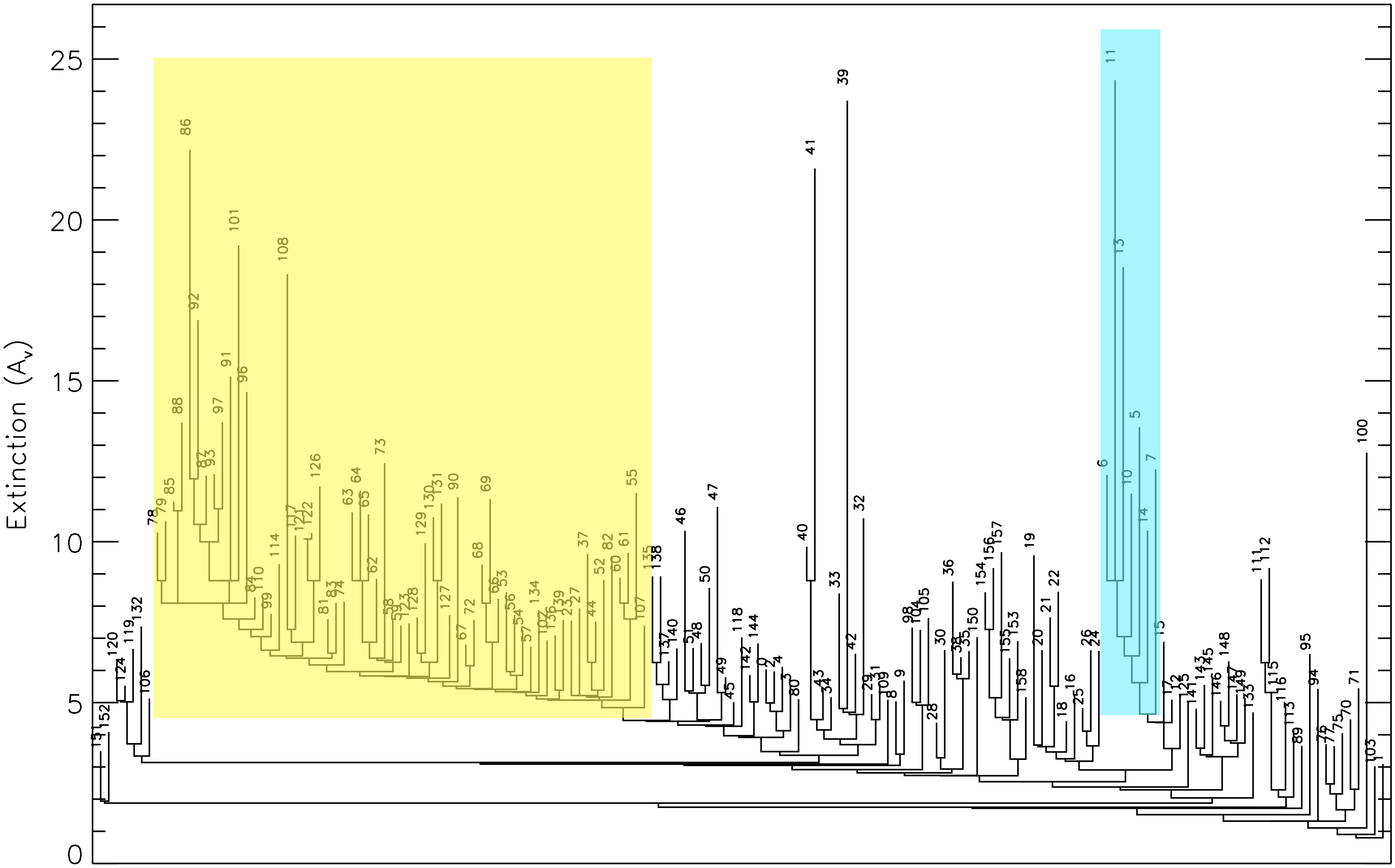
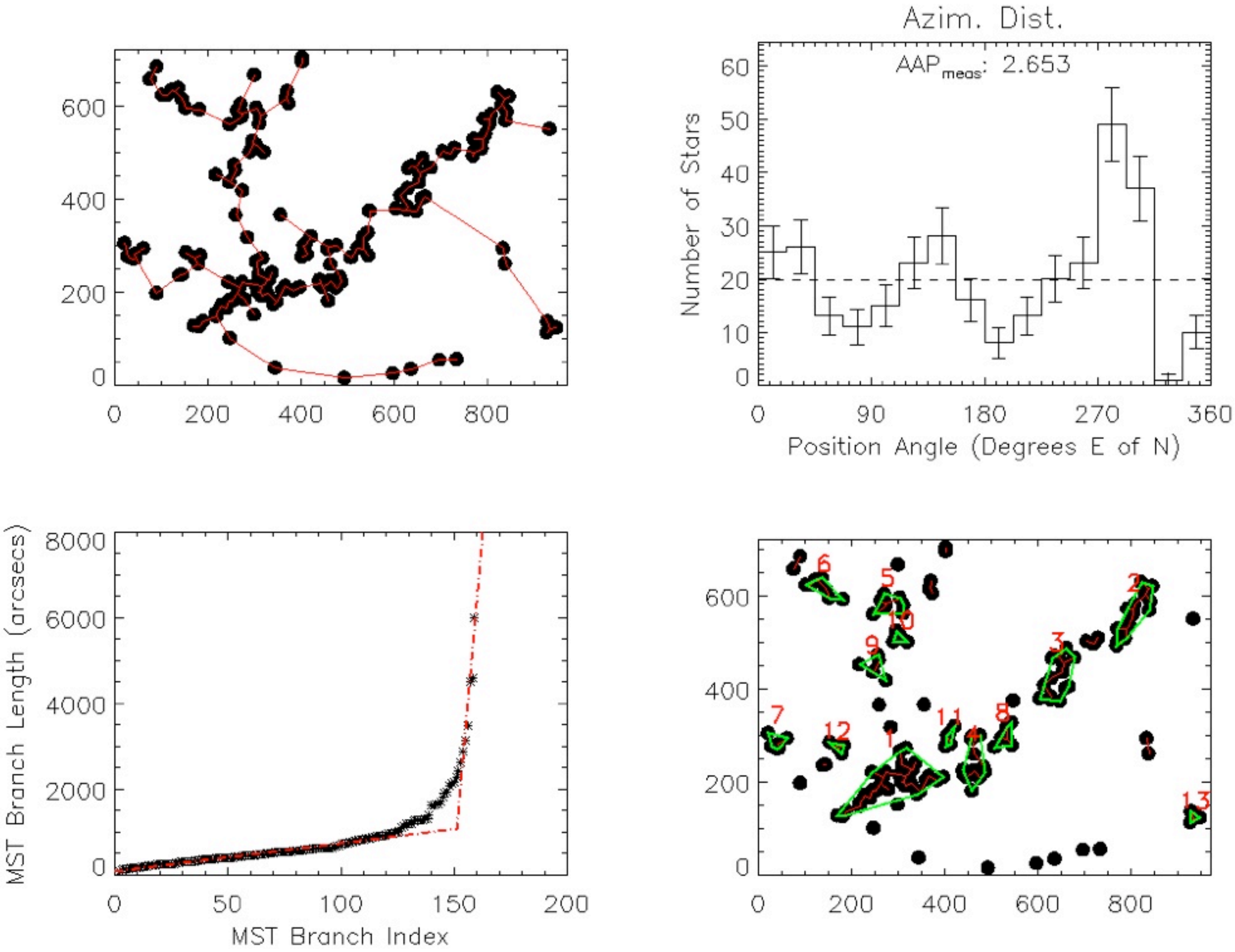
Full Original Pipe Dendrogram (Erik)

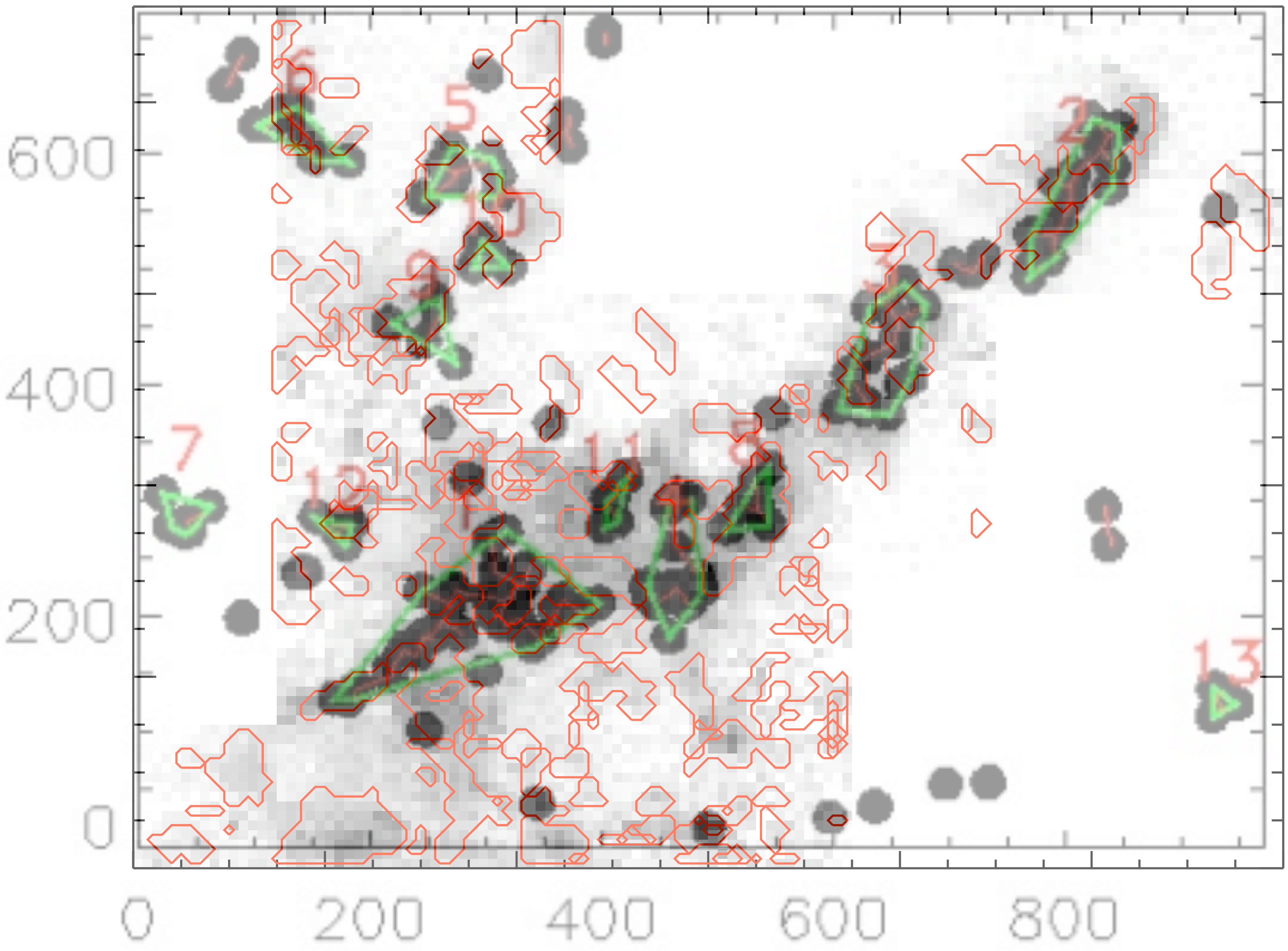


Seeded Dendrogram on Pre-Wavelet Data (Erik)



Gutermuth et al. “Minimum Spanning Tree”

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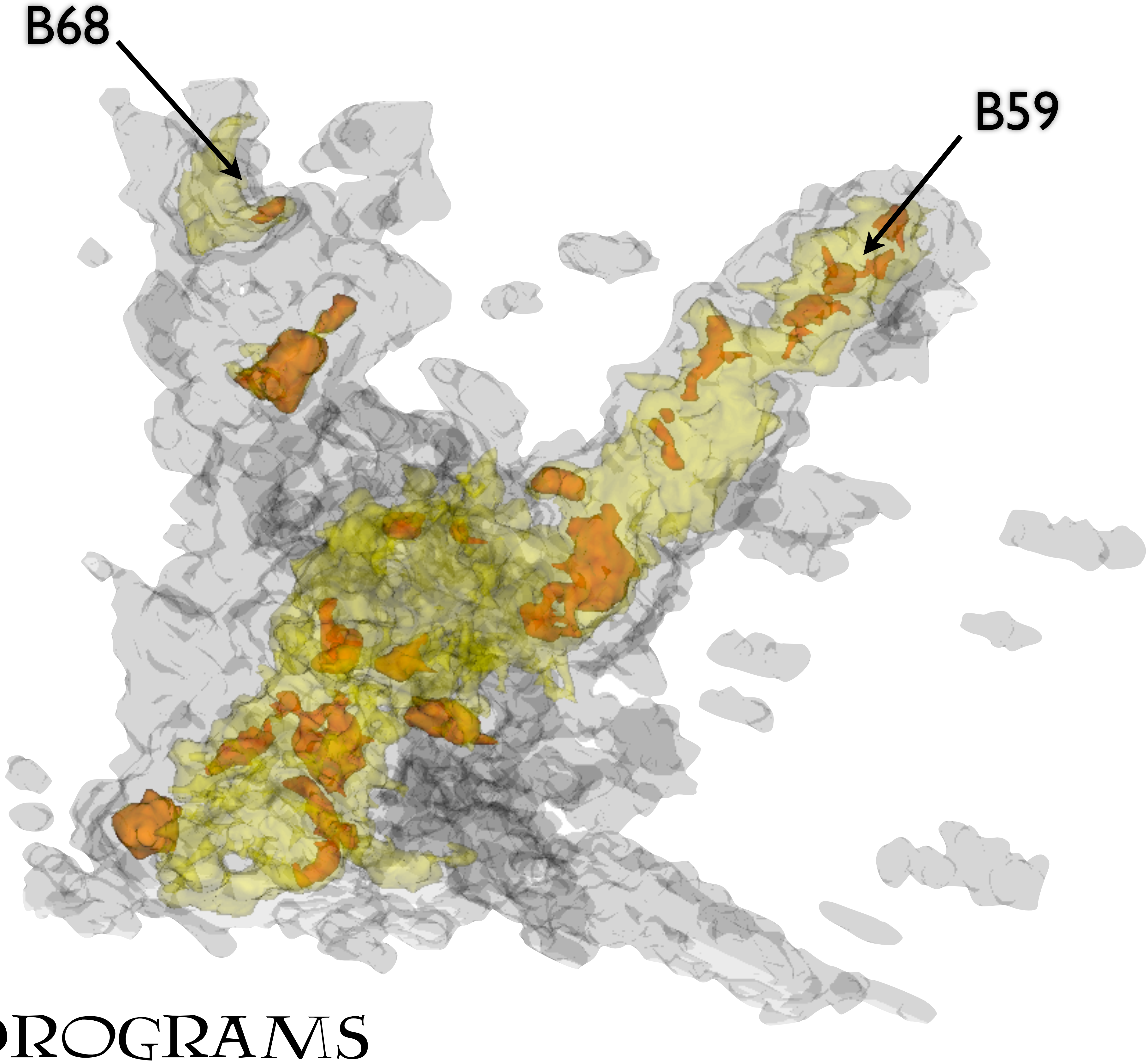
3D (Onishi) data

^{12}CO



DENDROGRAMS

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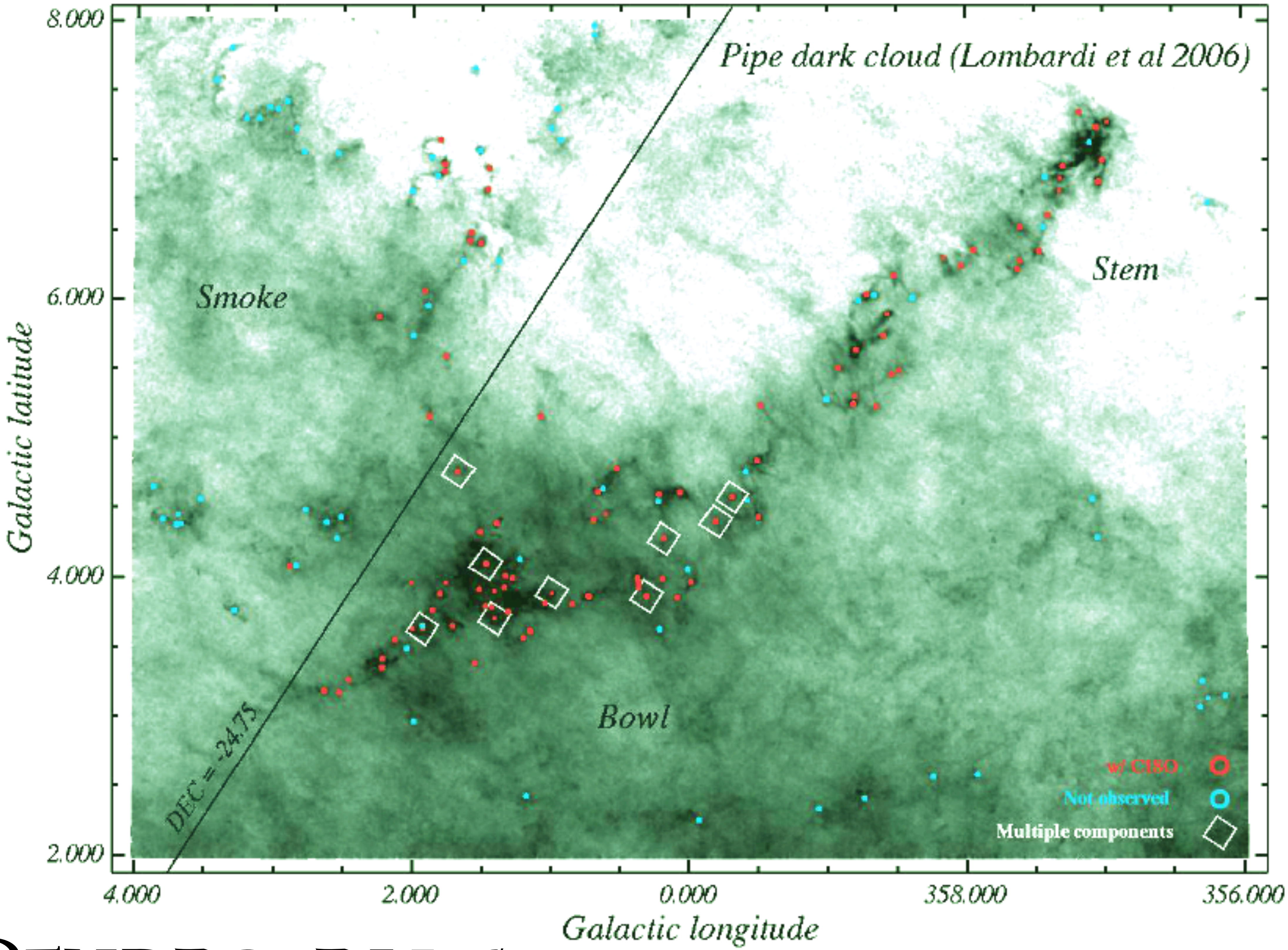

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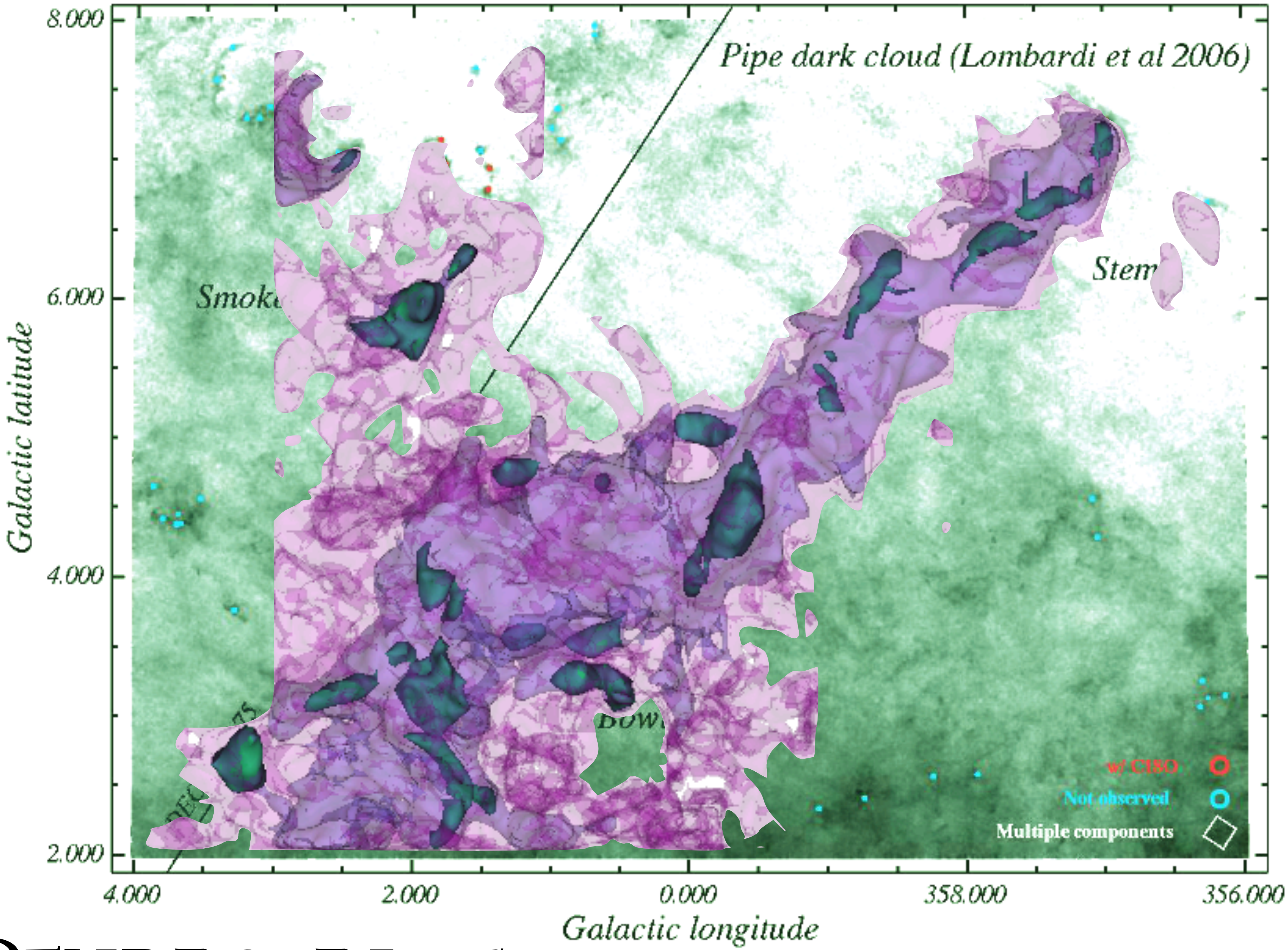
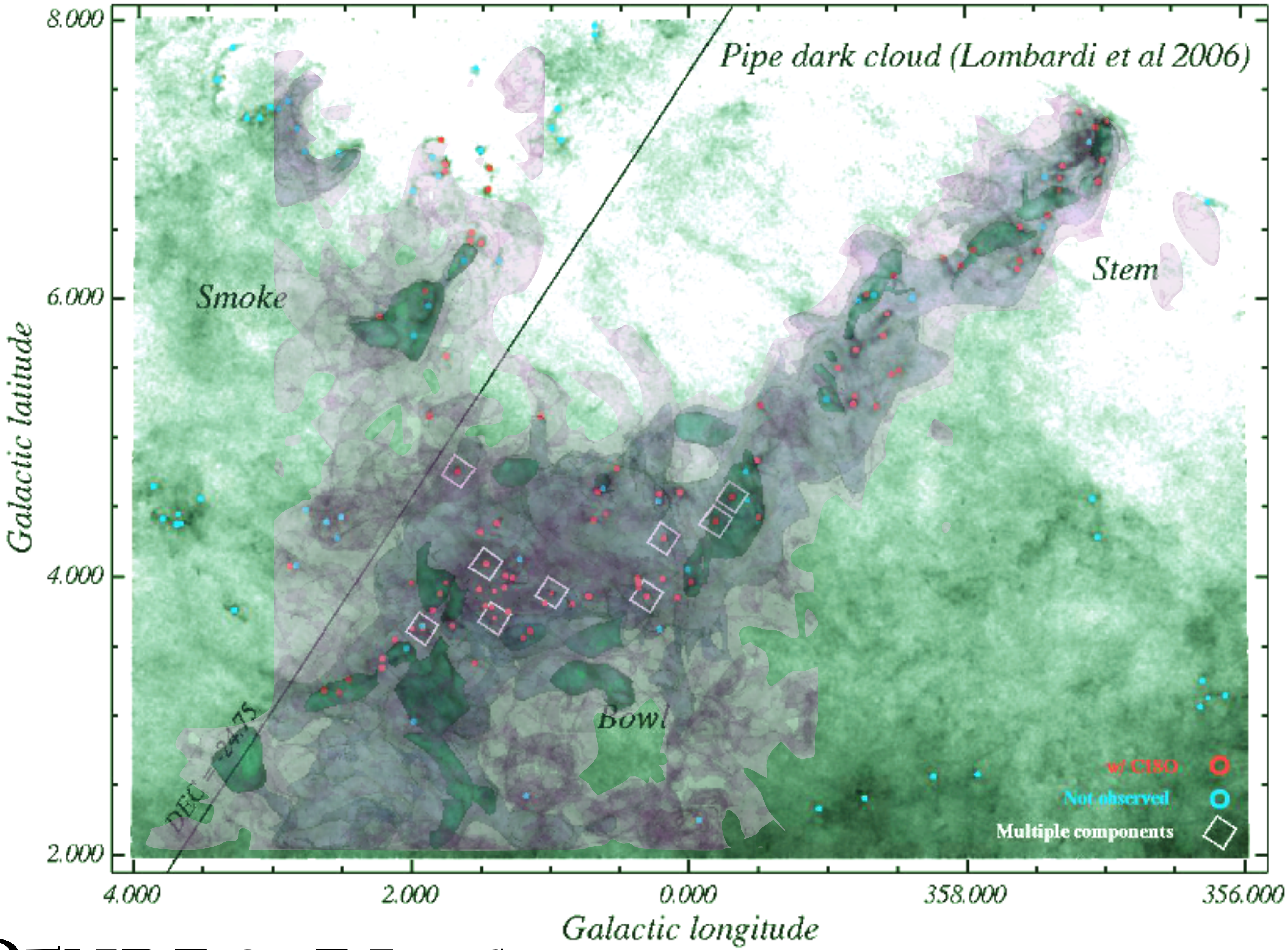


Dendrograms

^{12}CO



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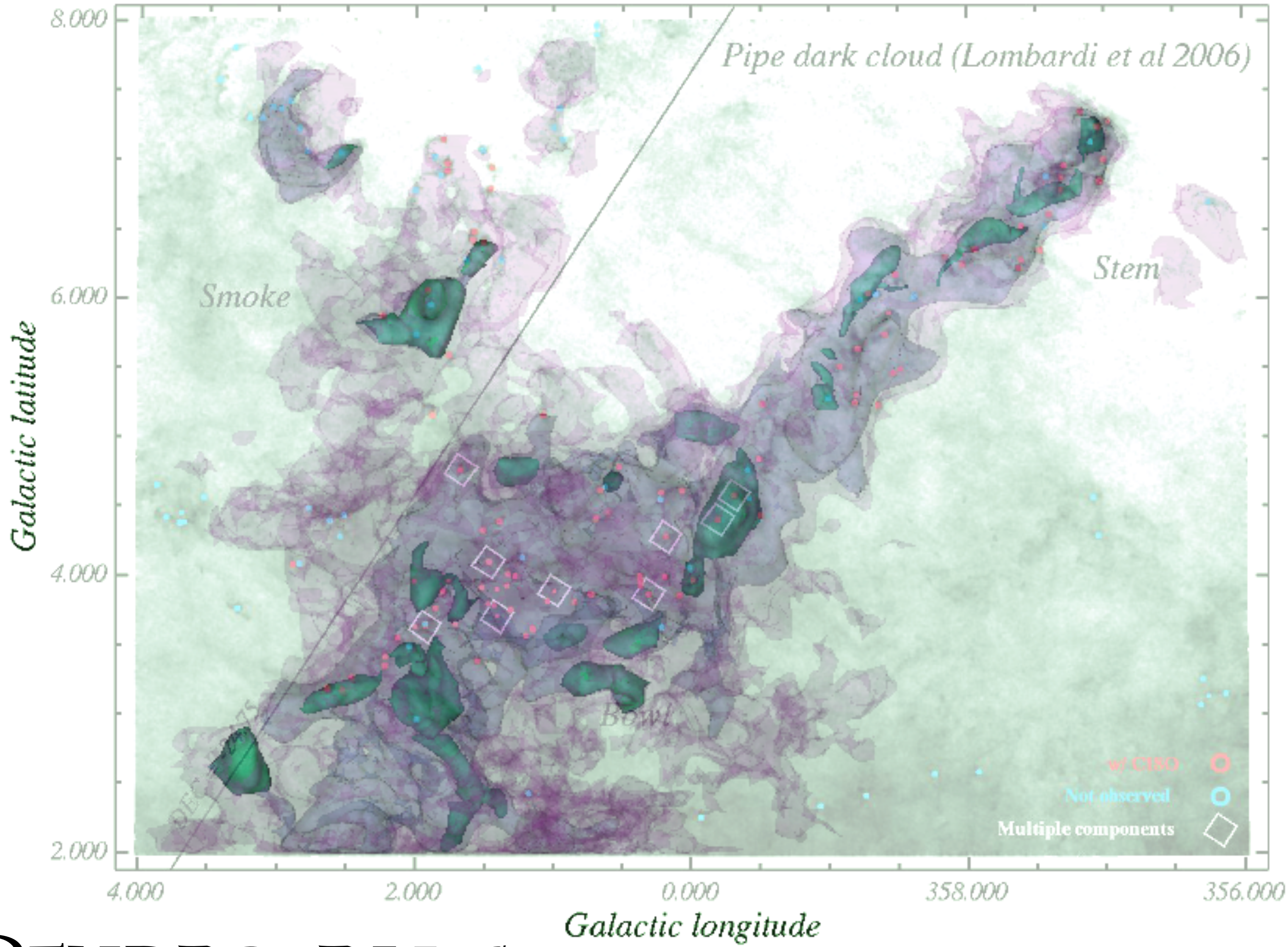

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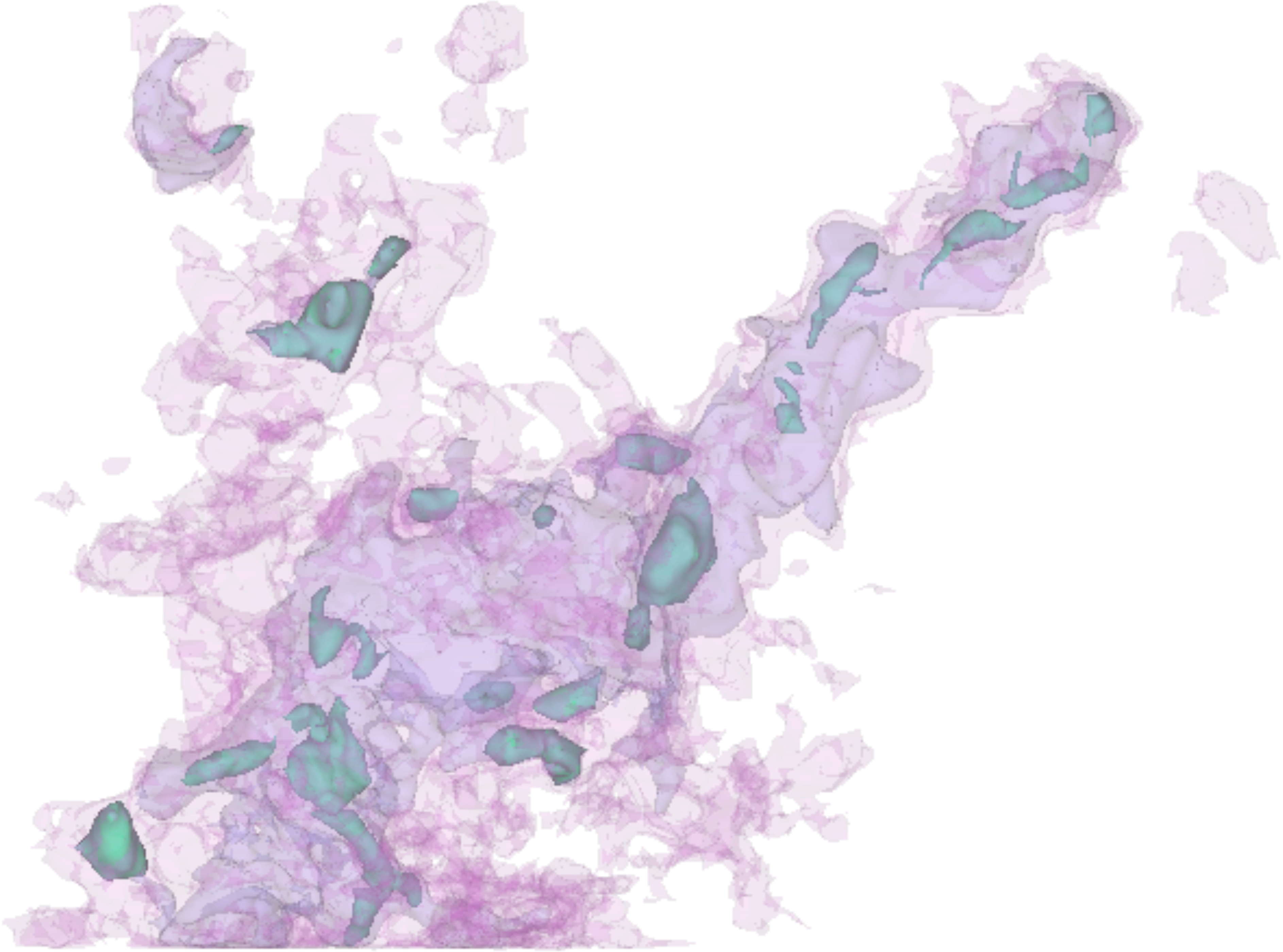

DENDROGRAMS

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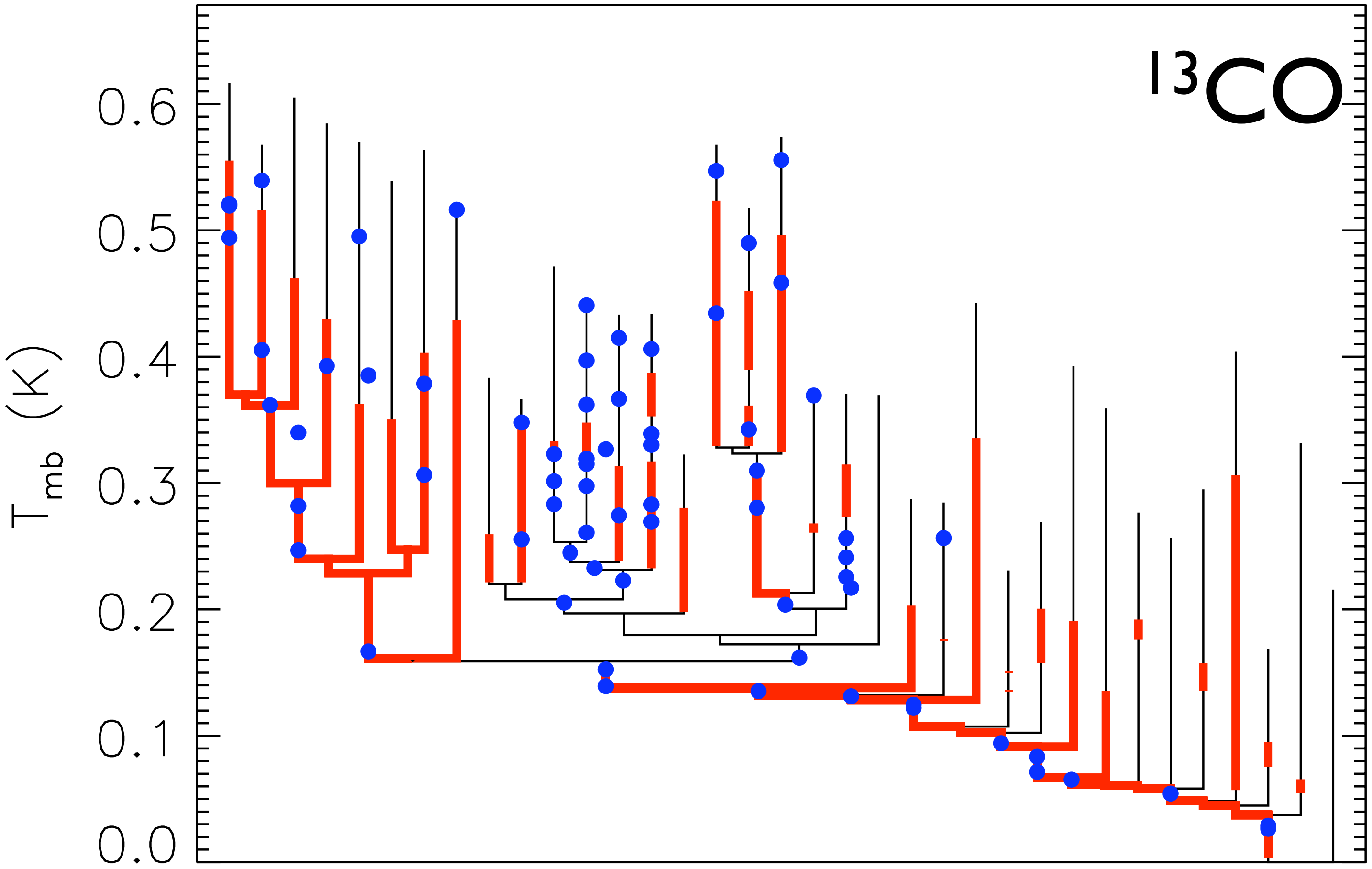
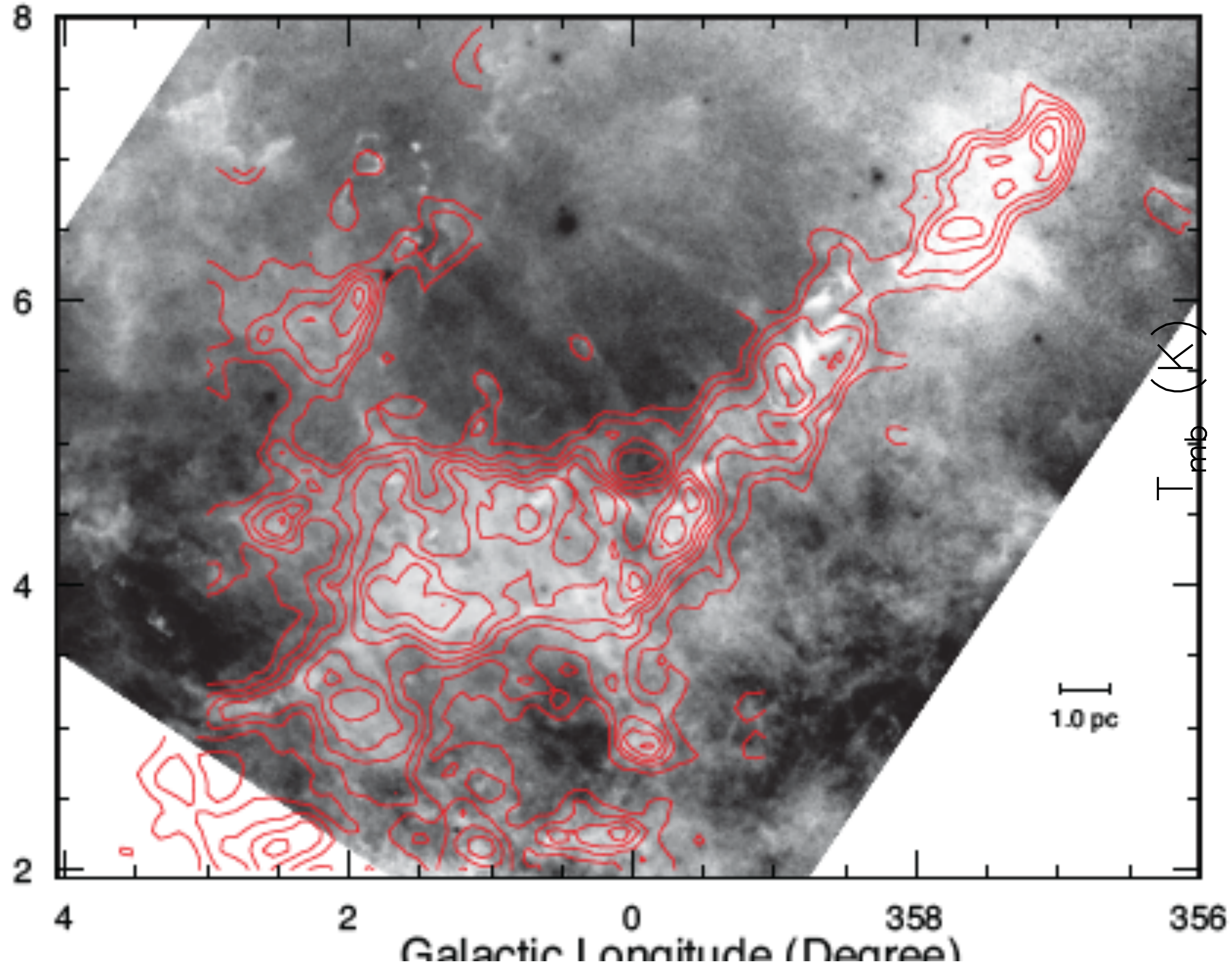
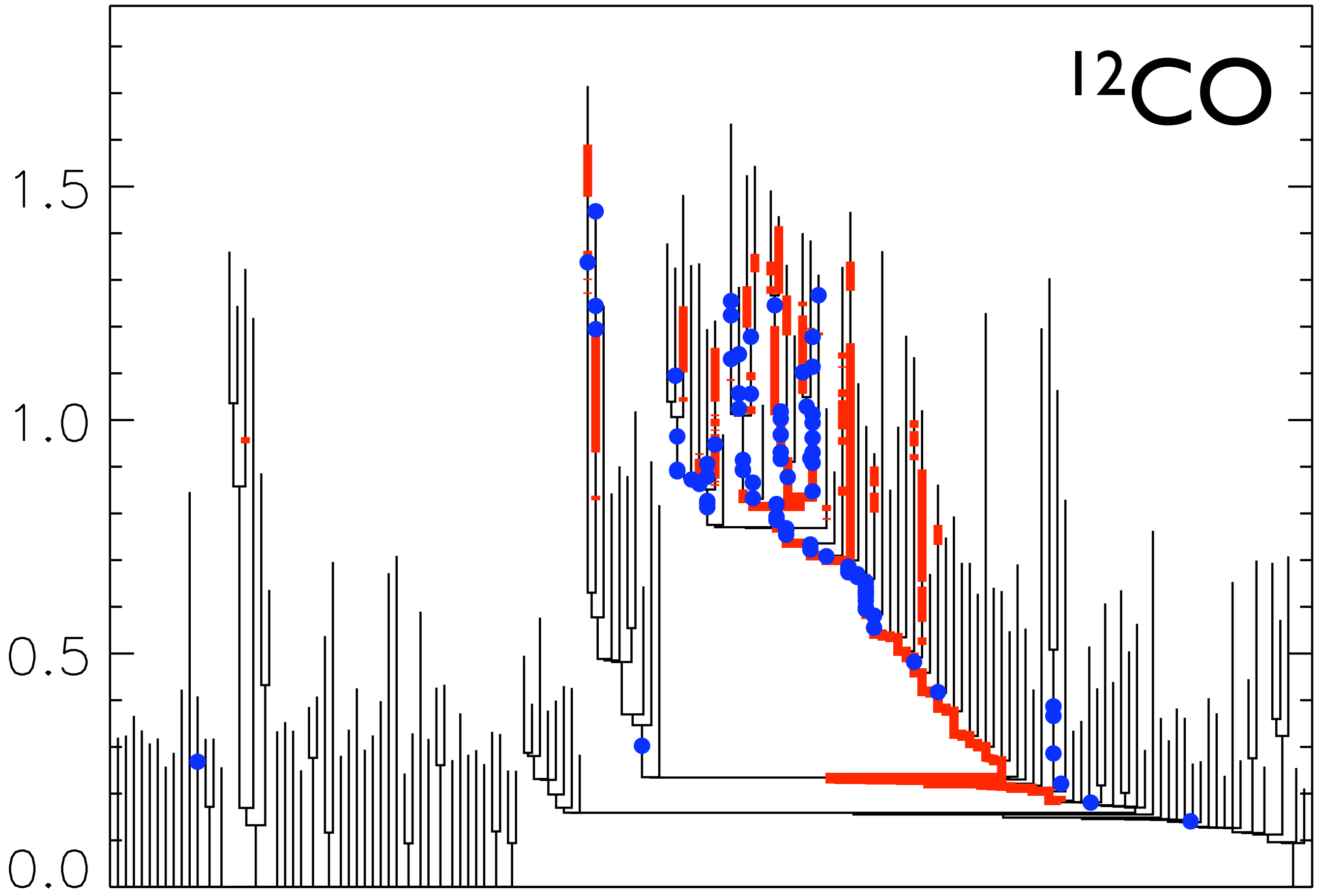
Kinematic Analysis (Erik)

- 🟥 "self-gravitating"
- ● "cores" observed in $C^{18}O$ *(Muench)*







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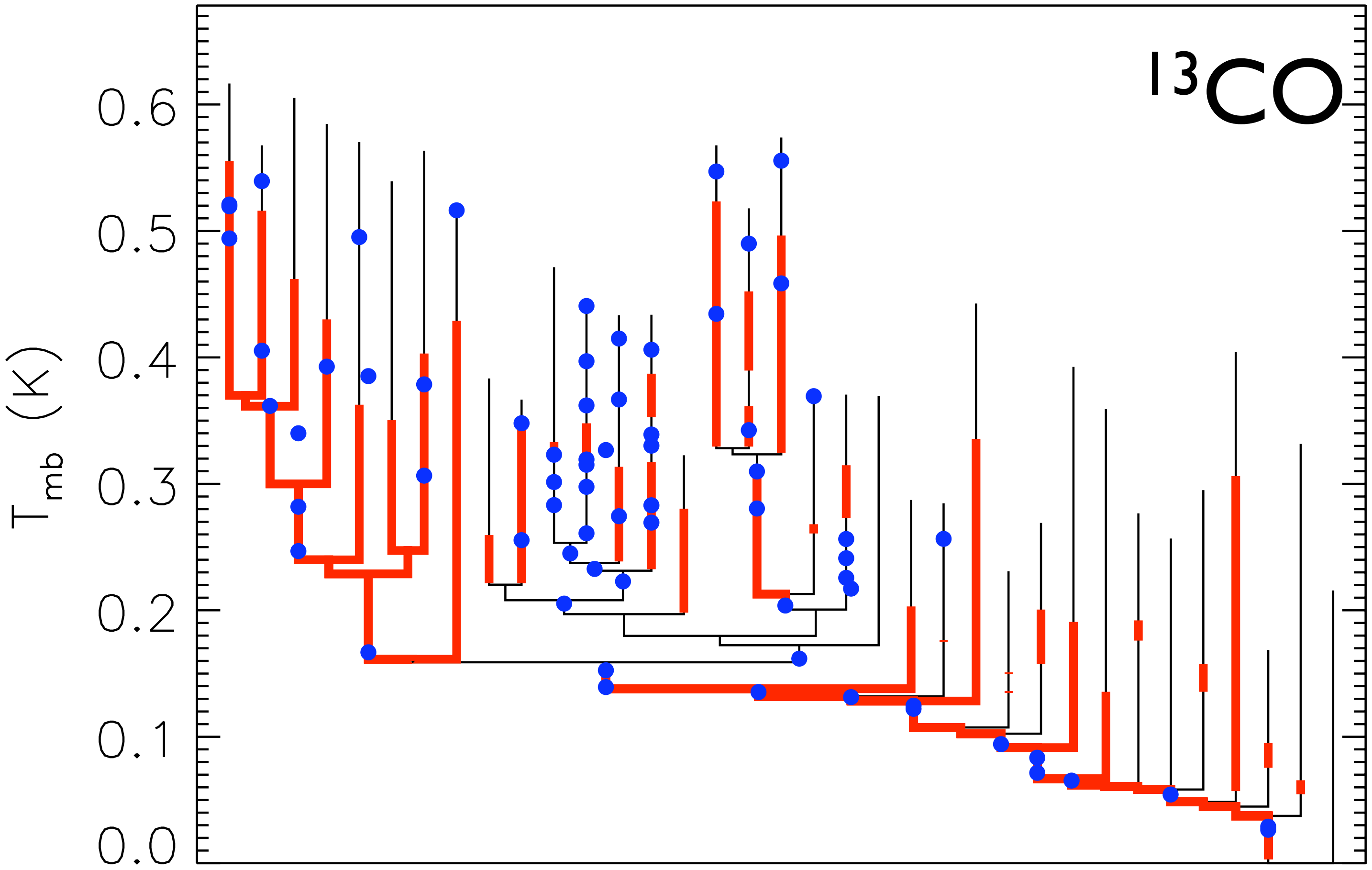

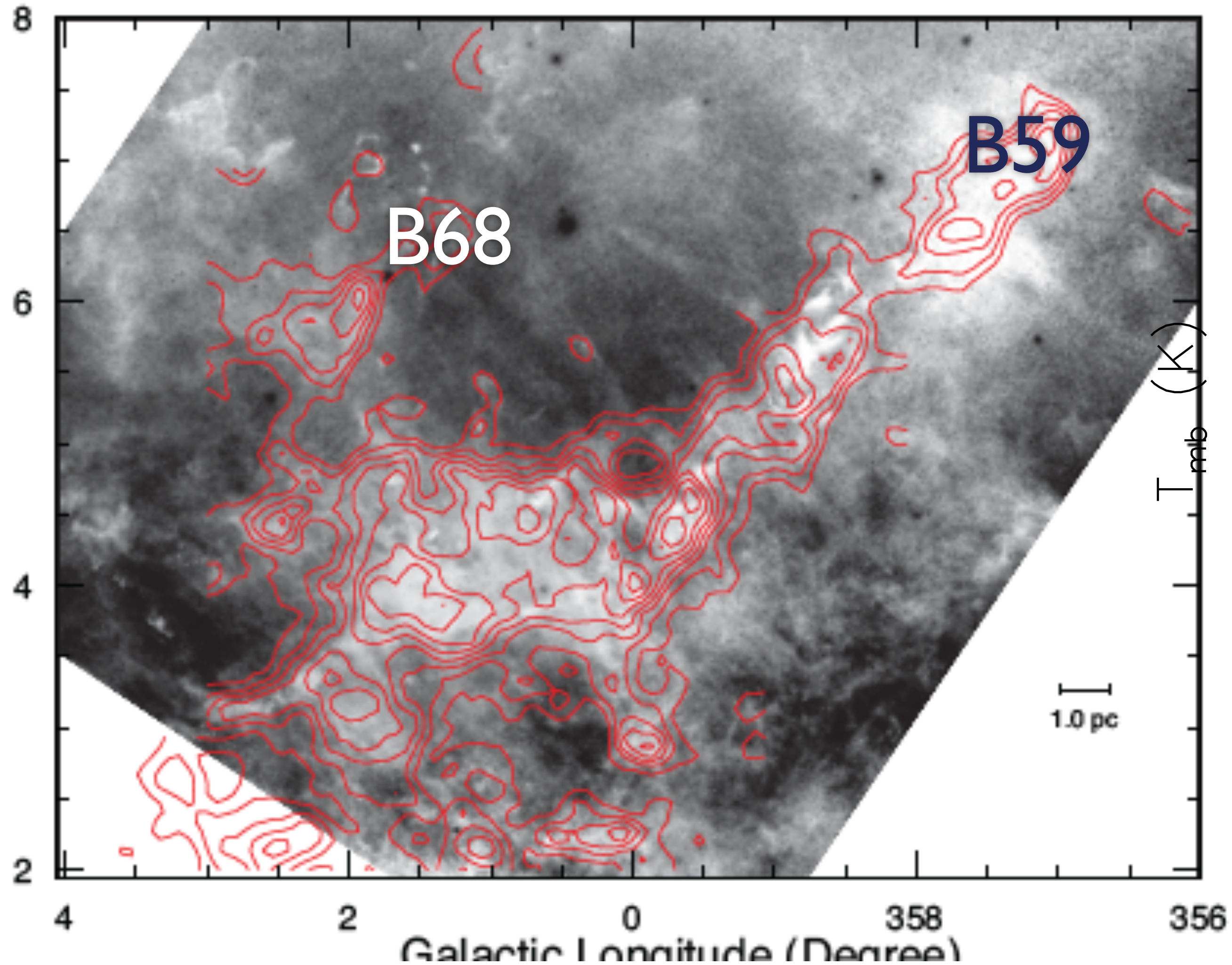

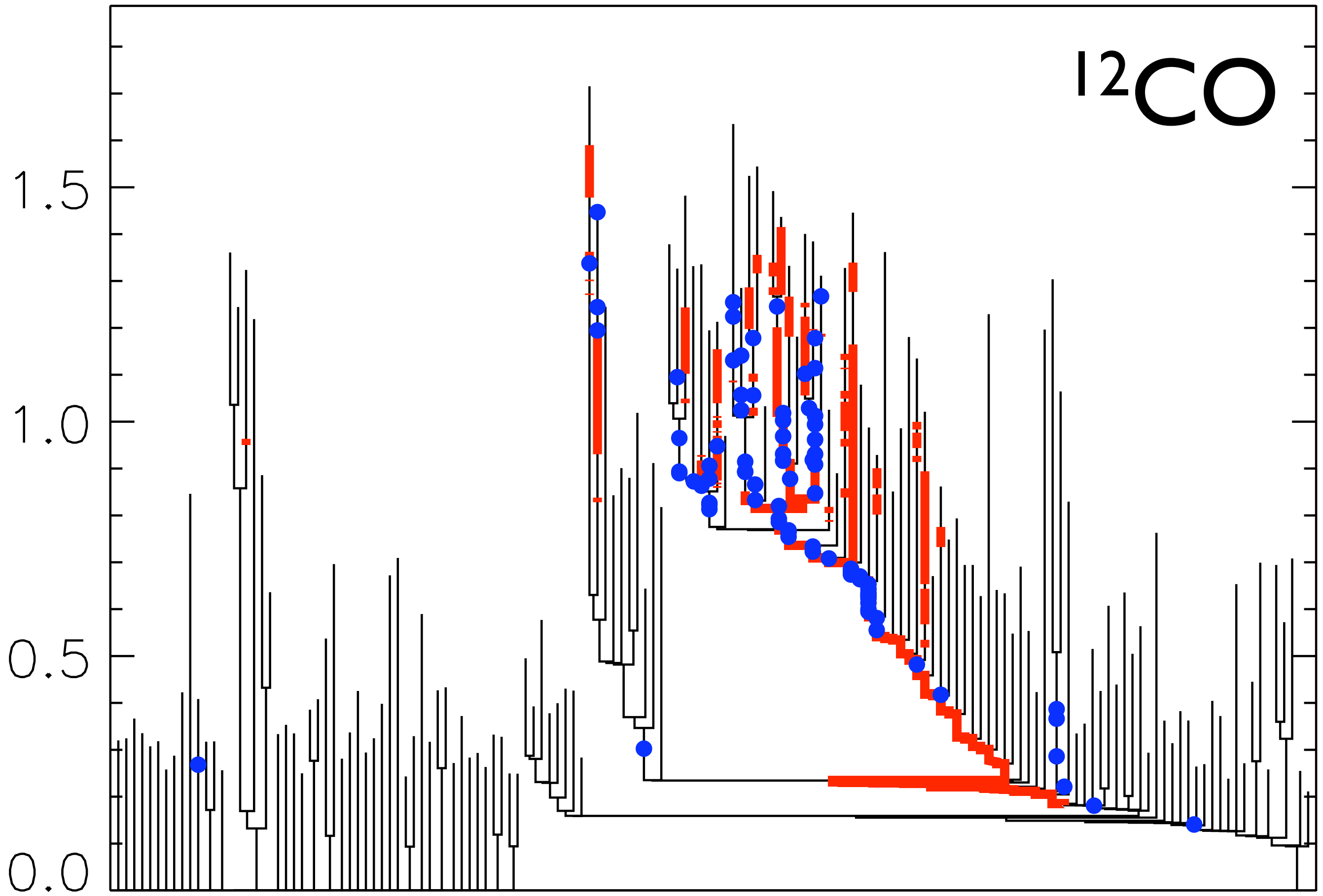

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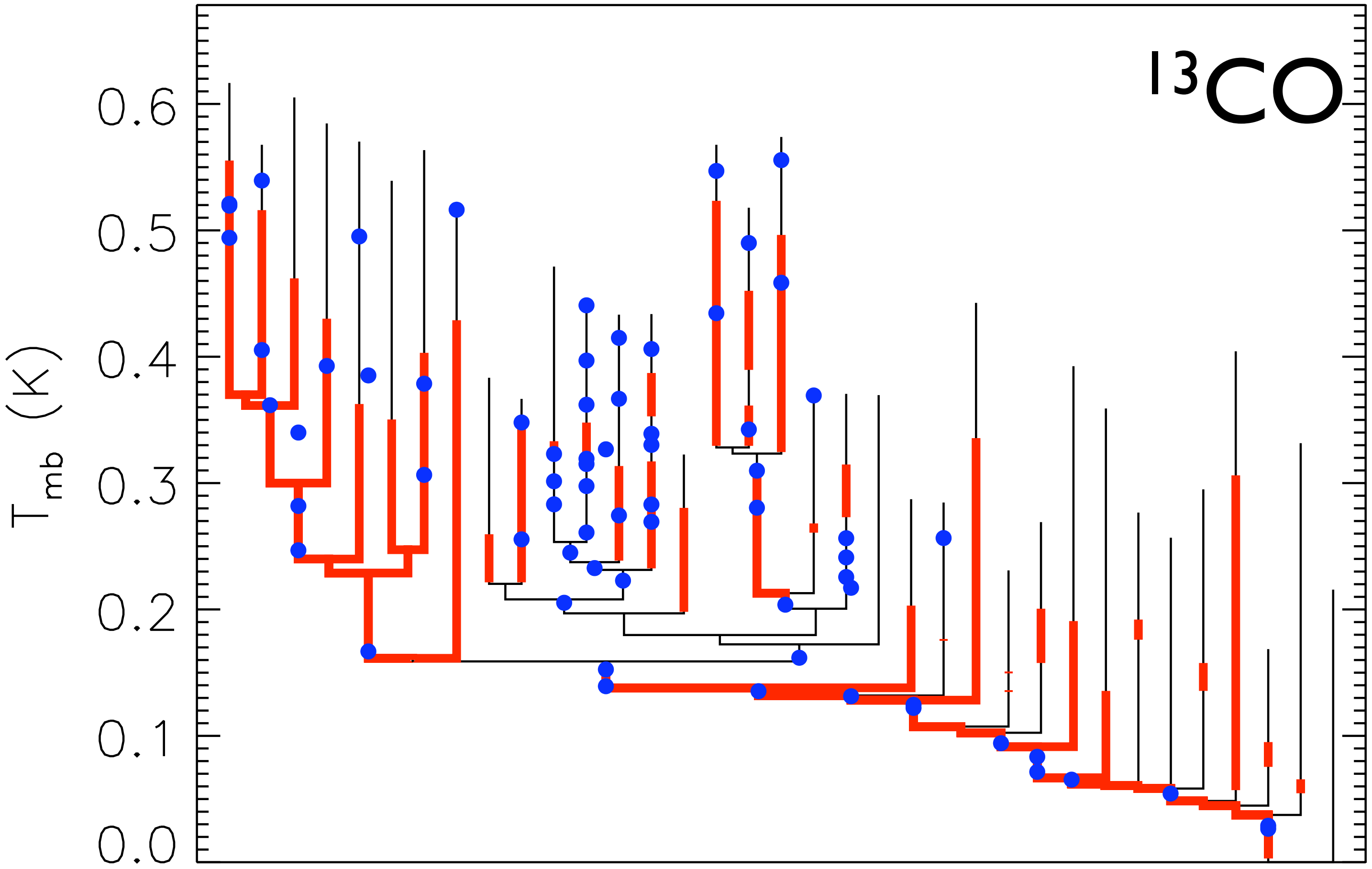

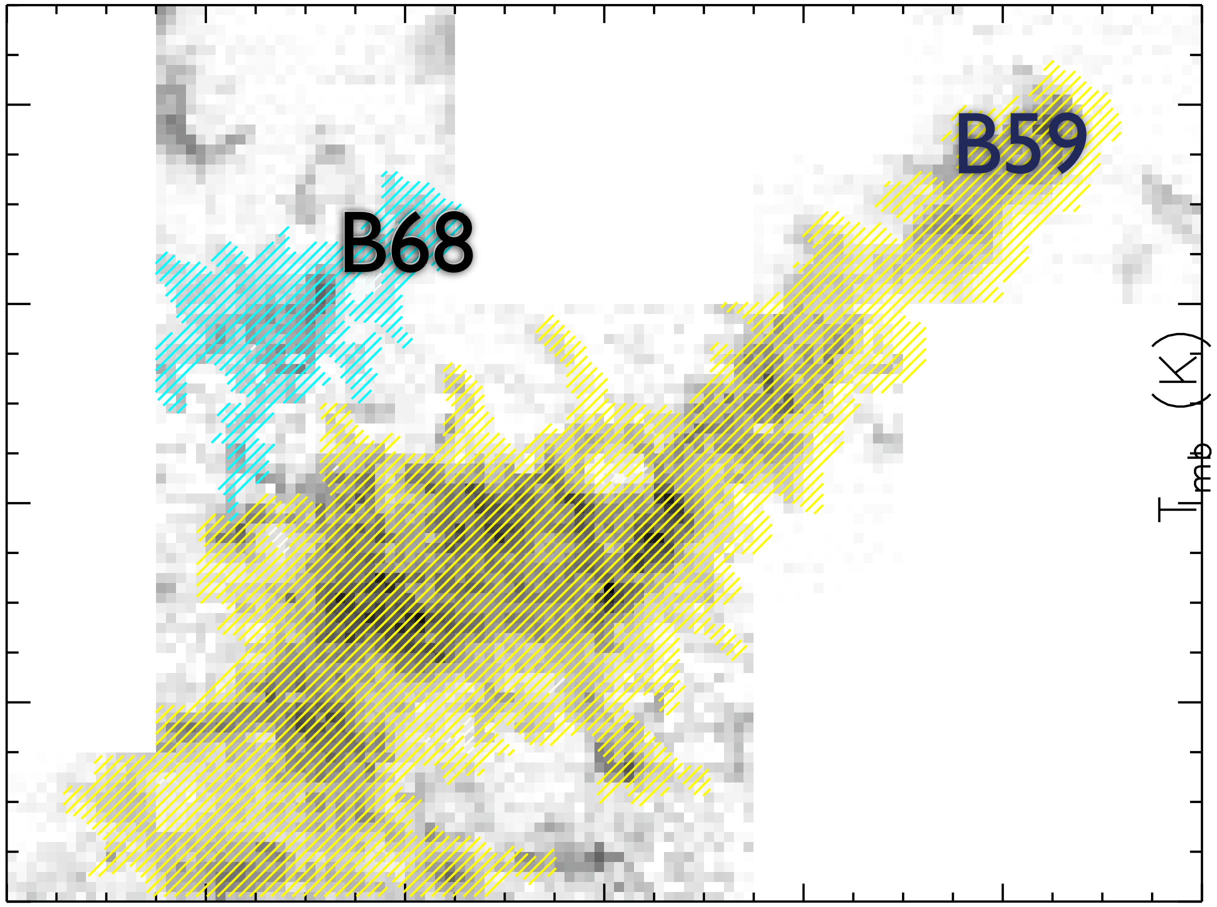

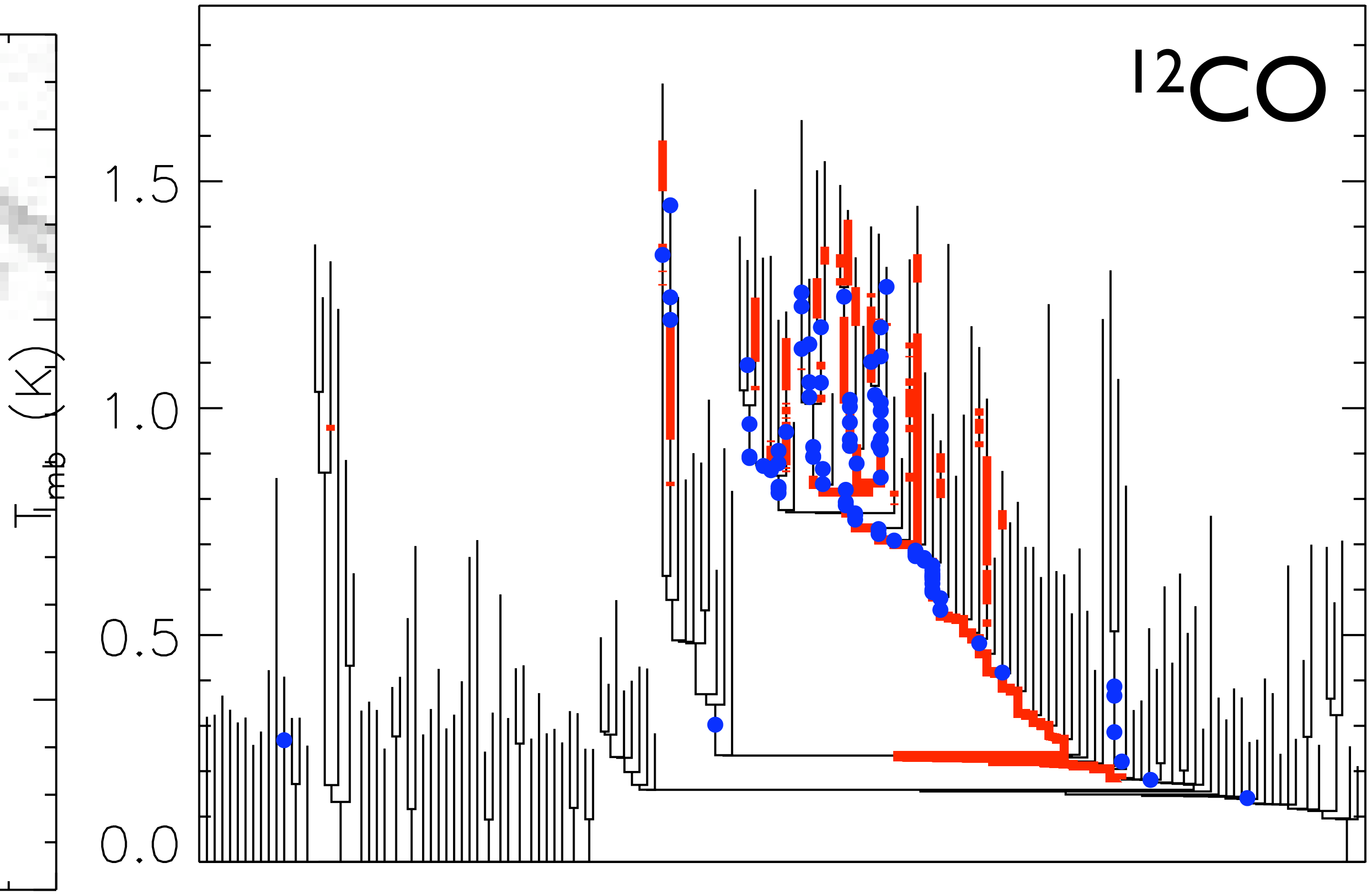

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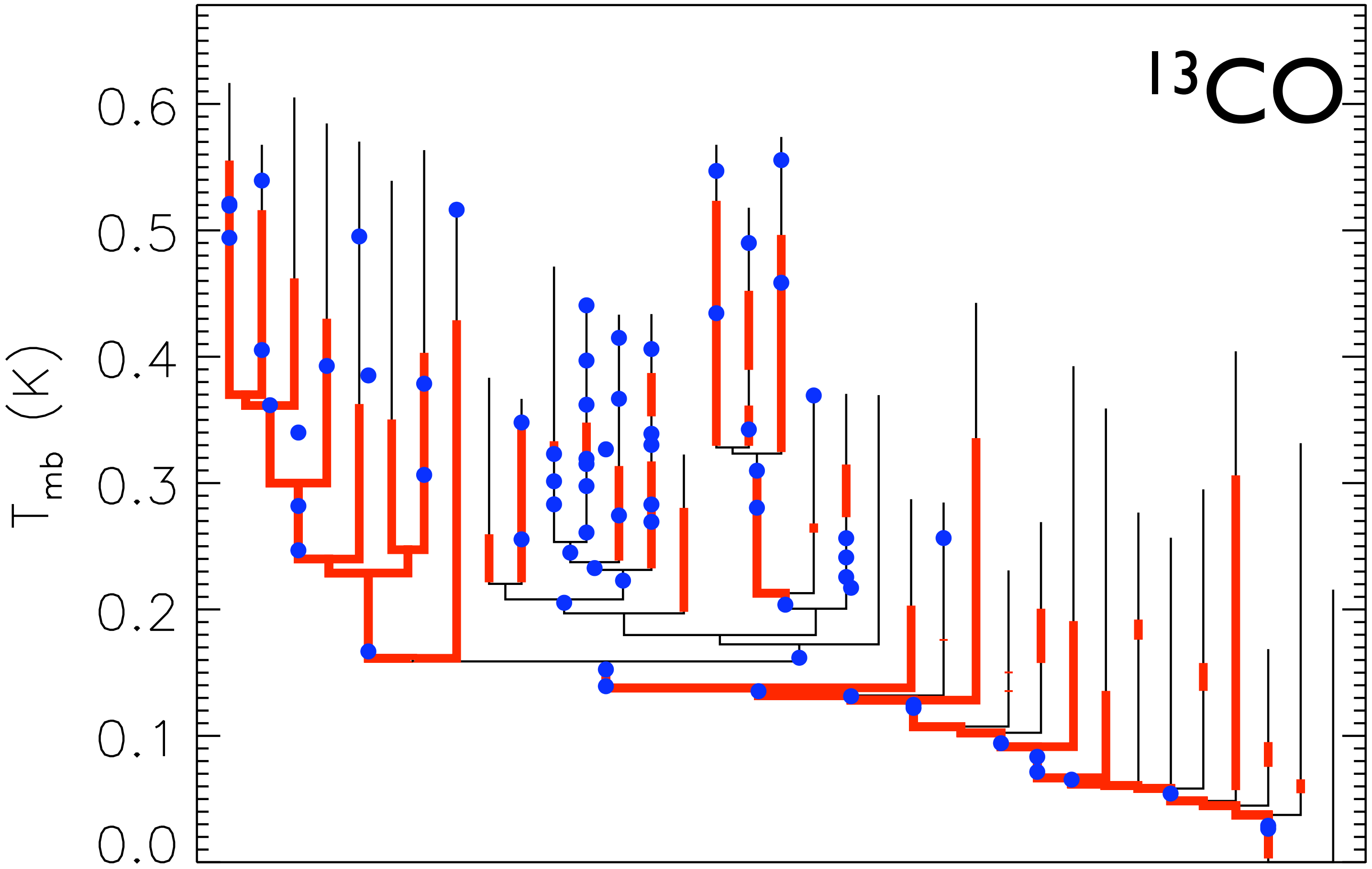

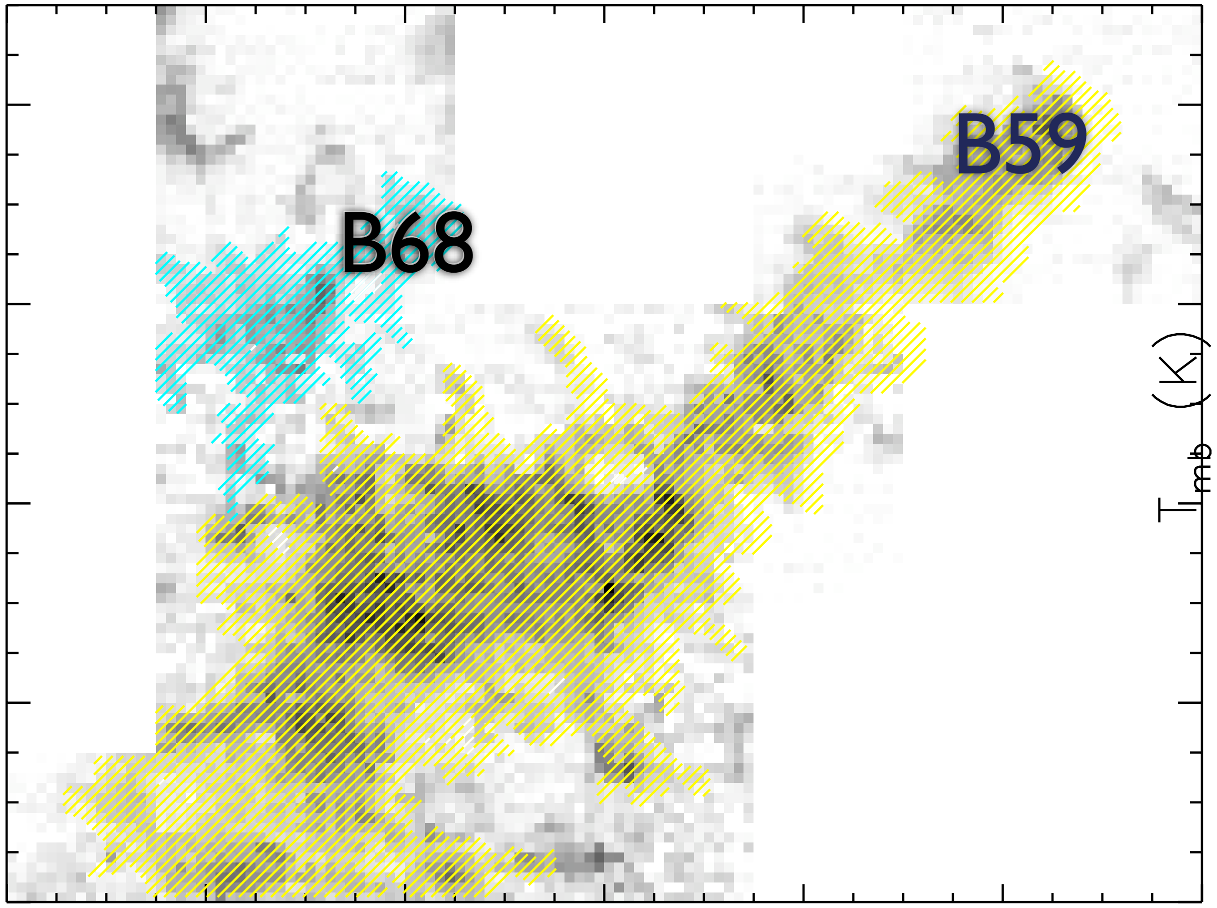

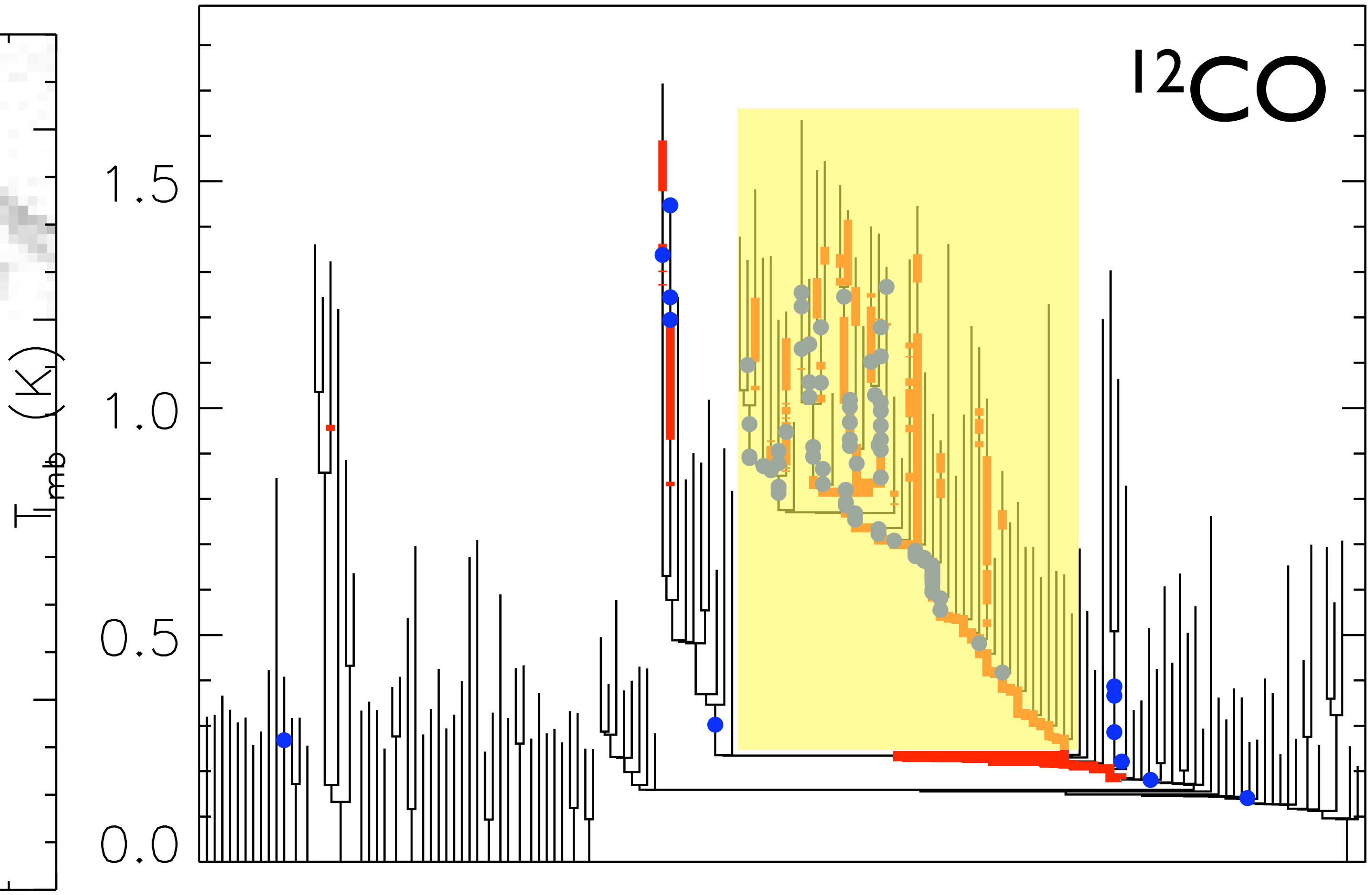

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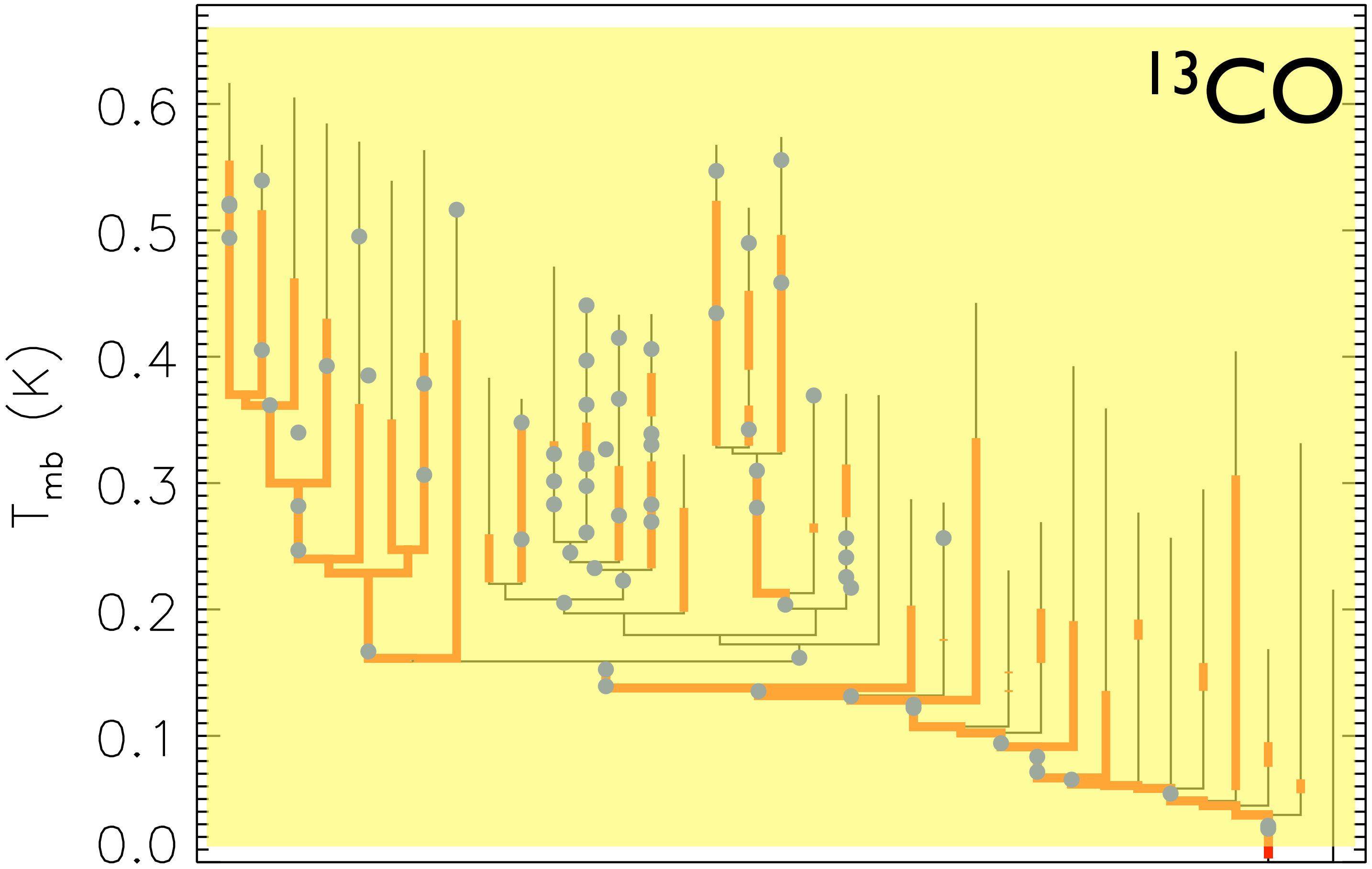

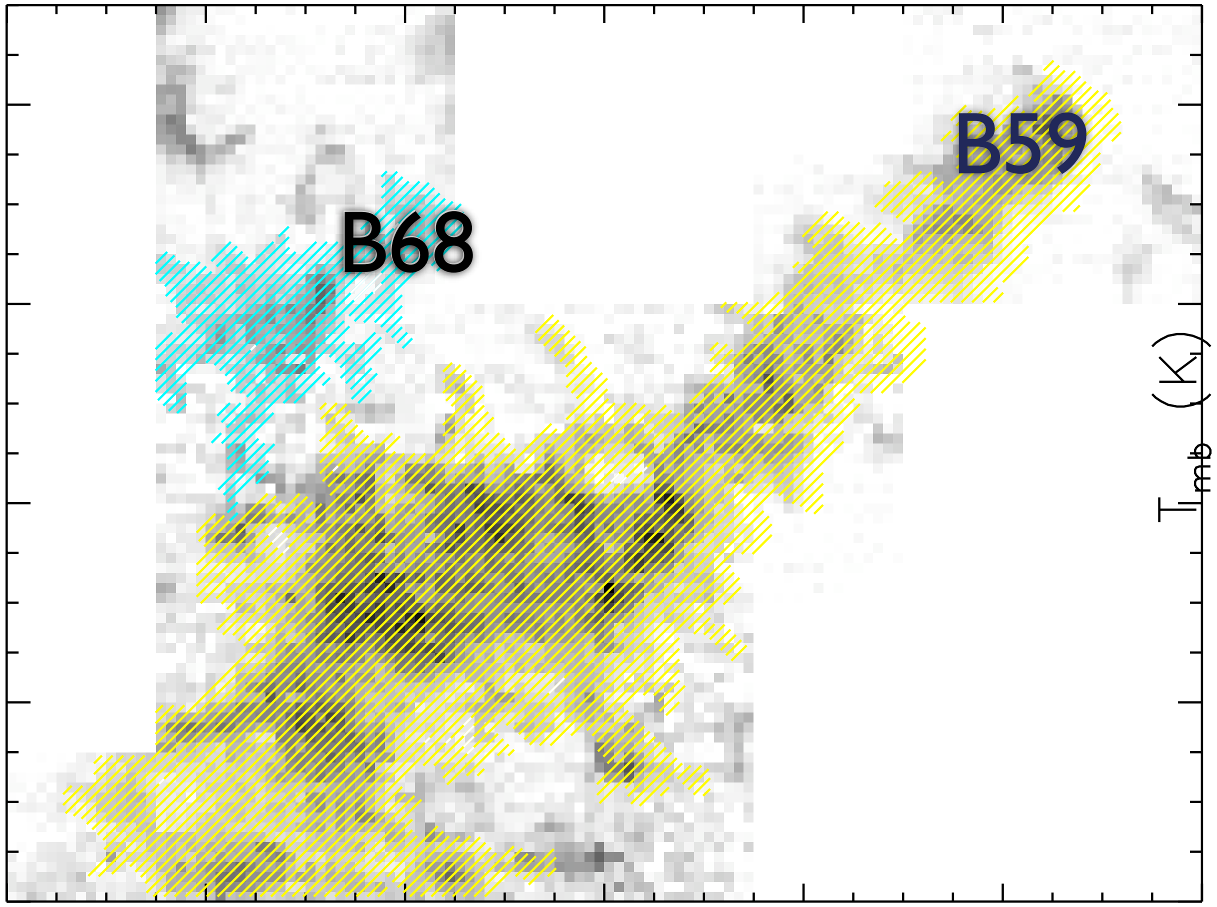

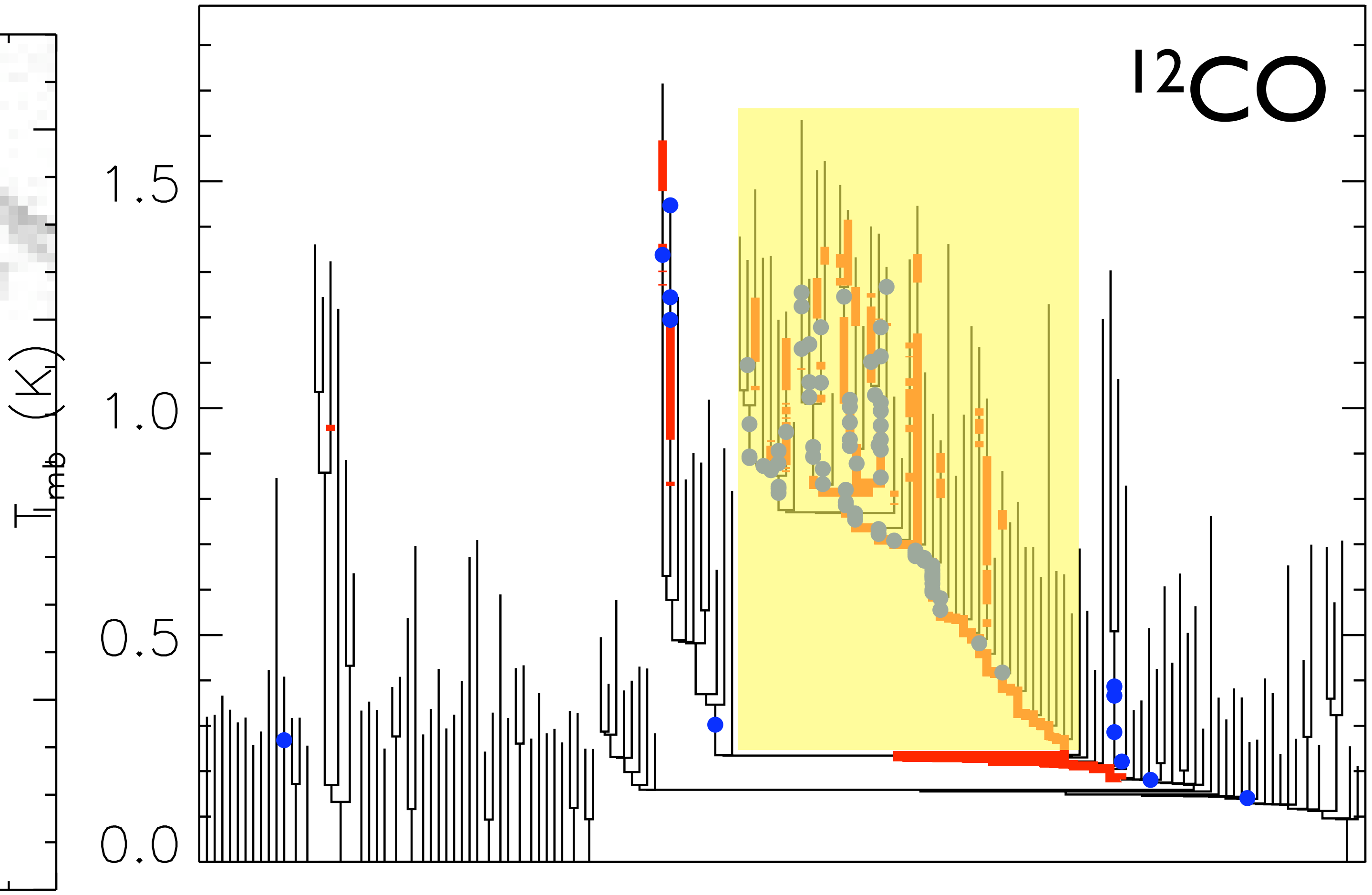

Dendrograms

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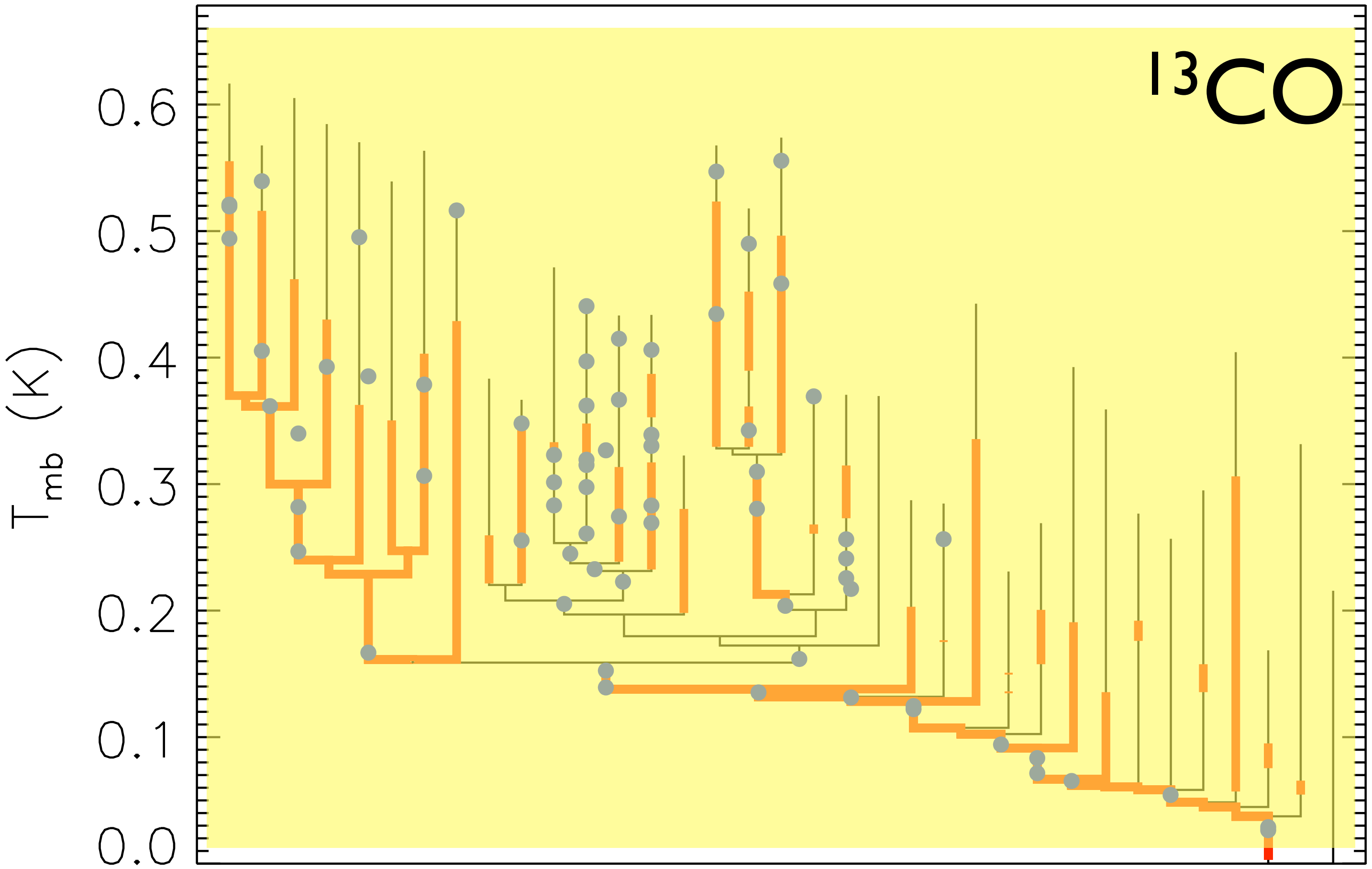

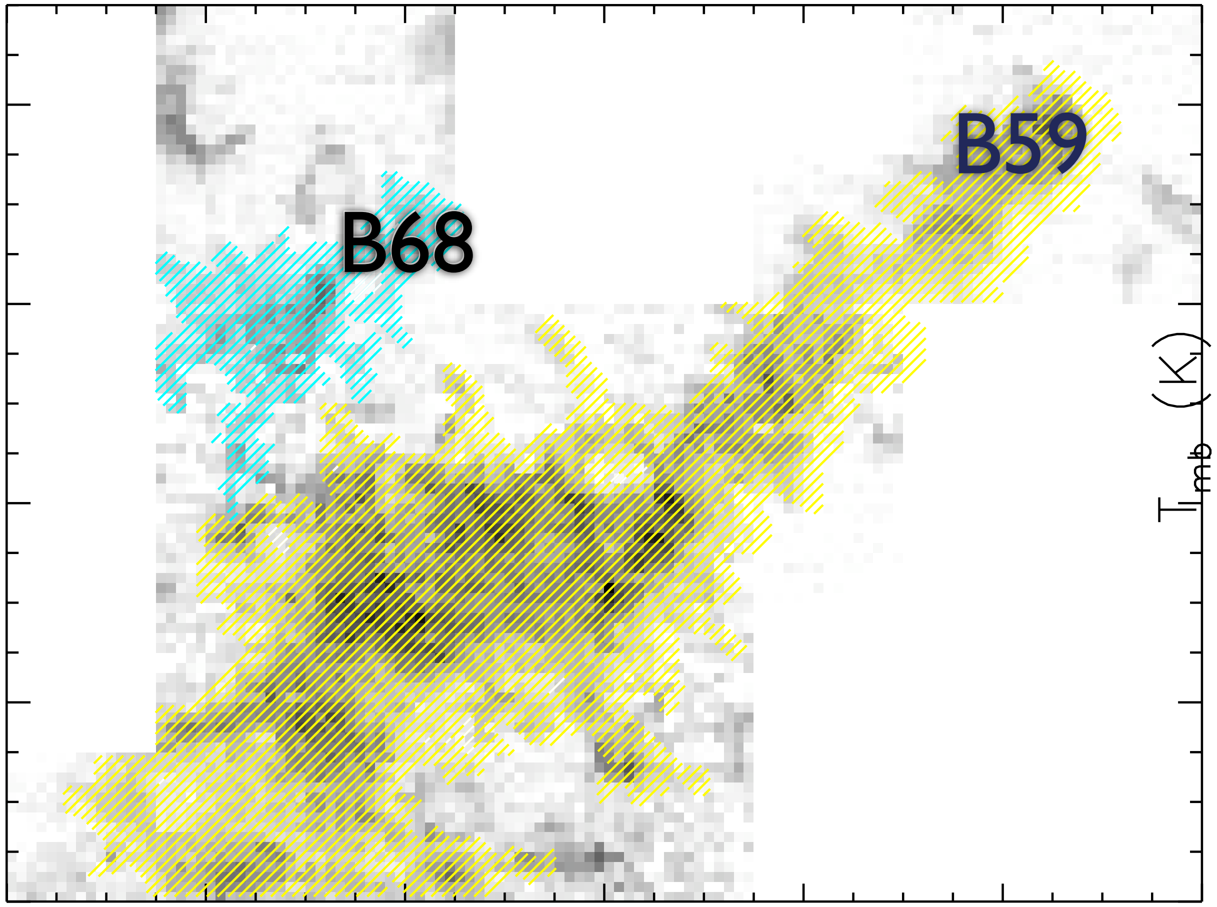

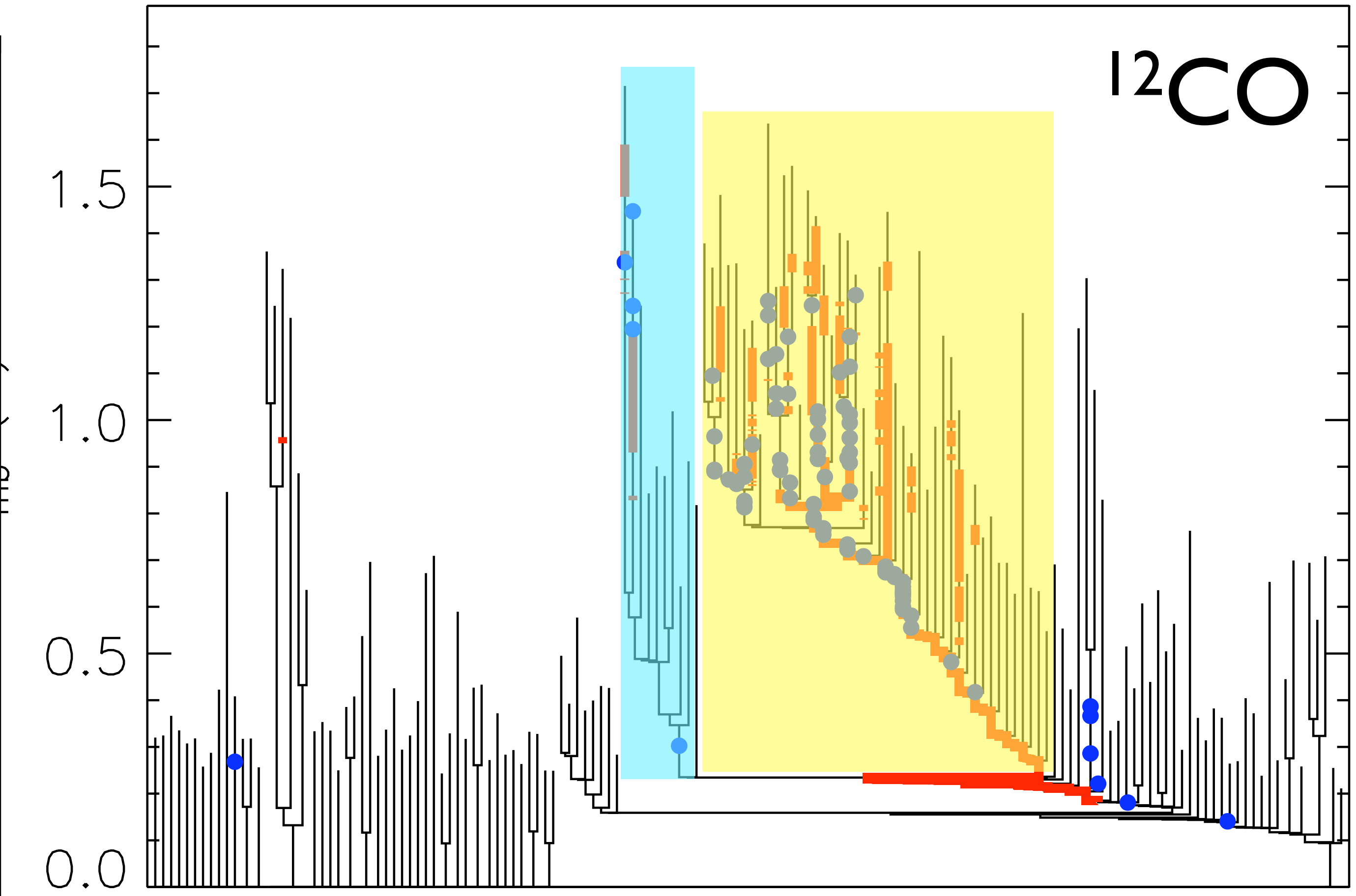

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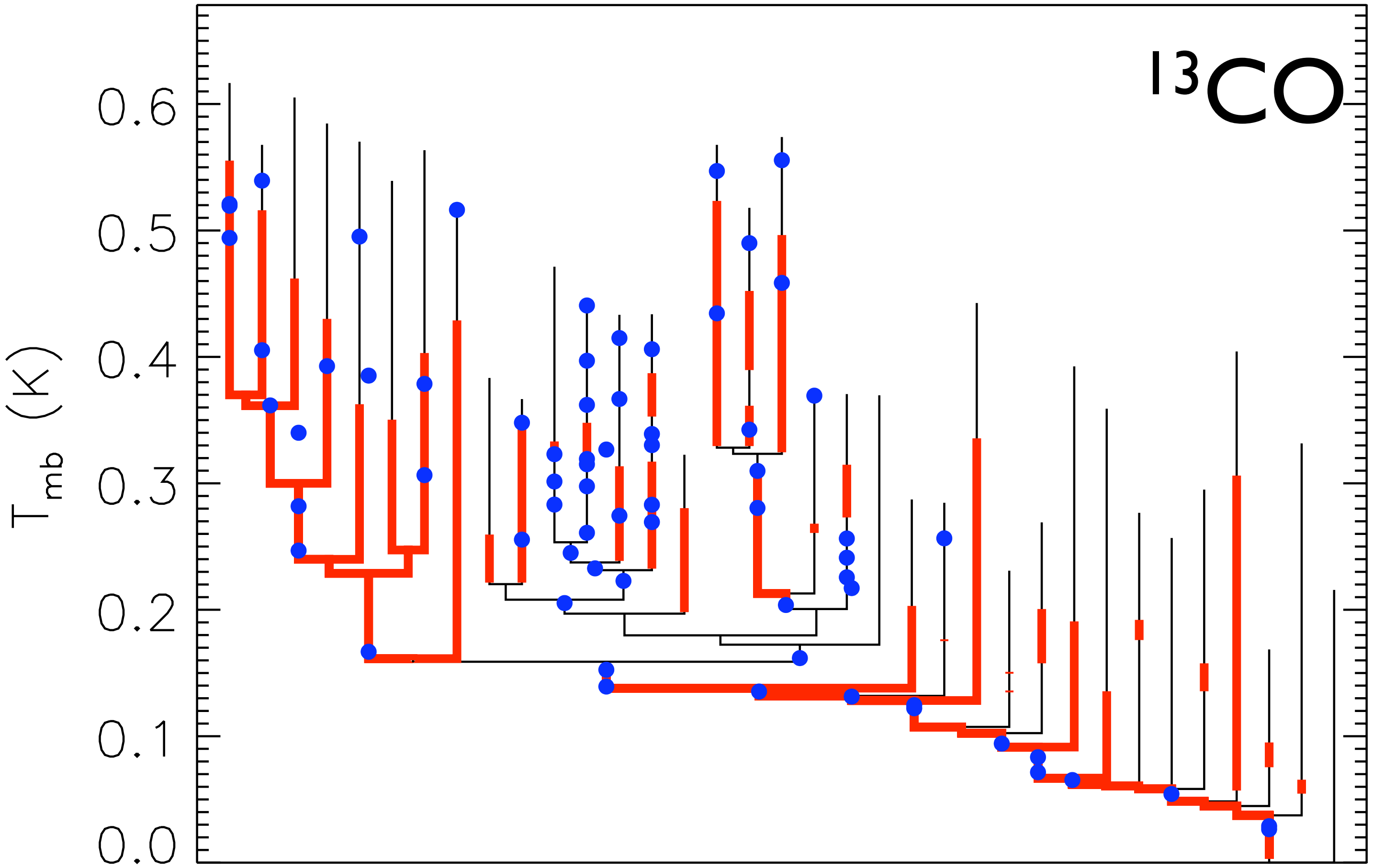
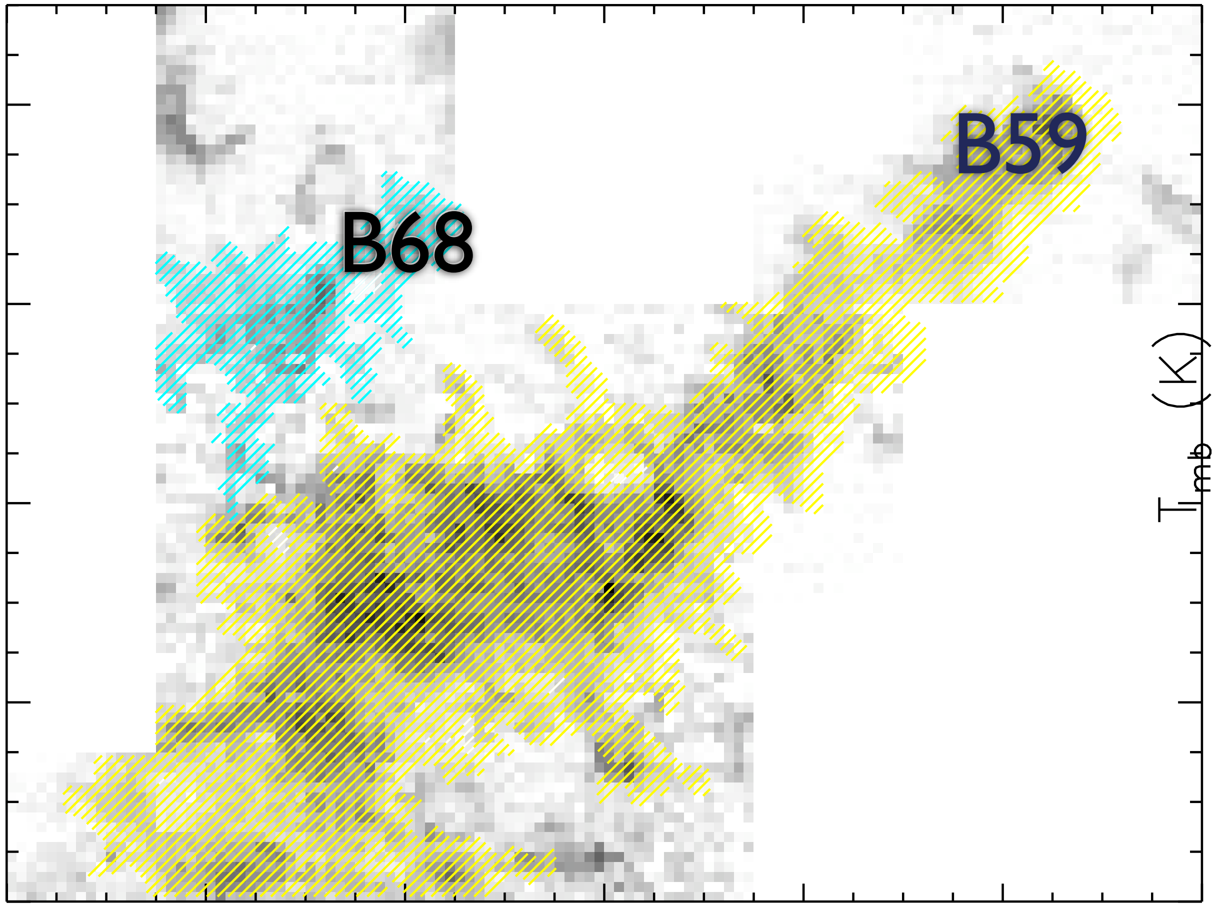
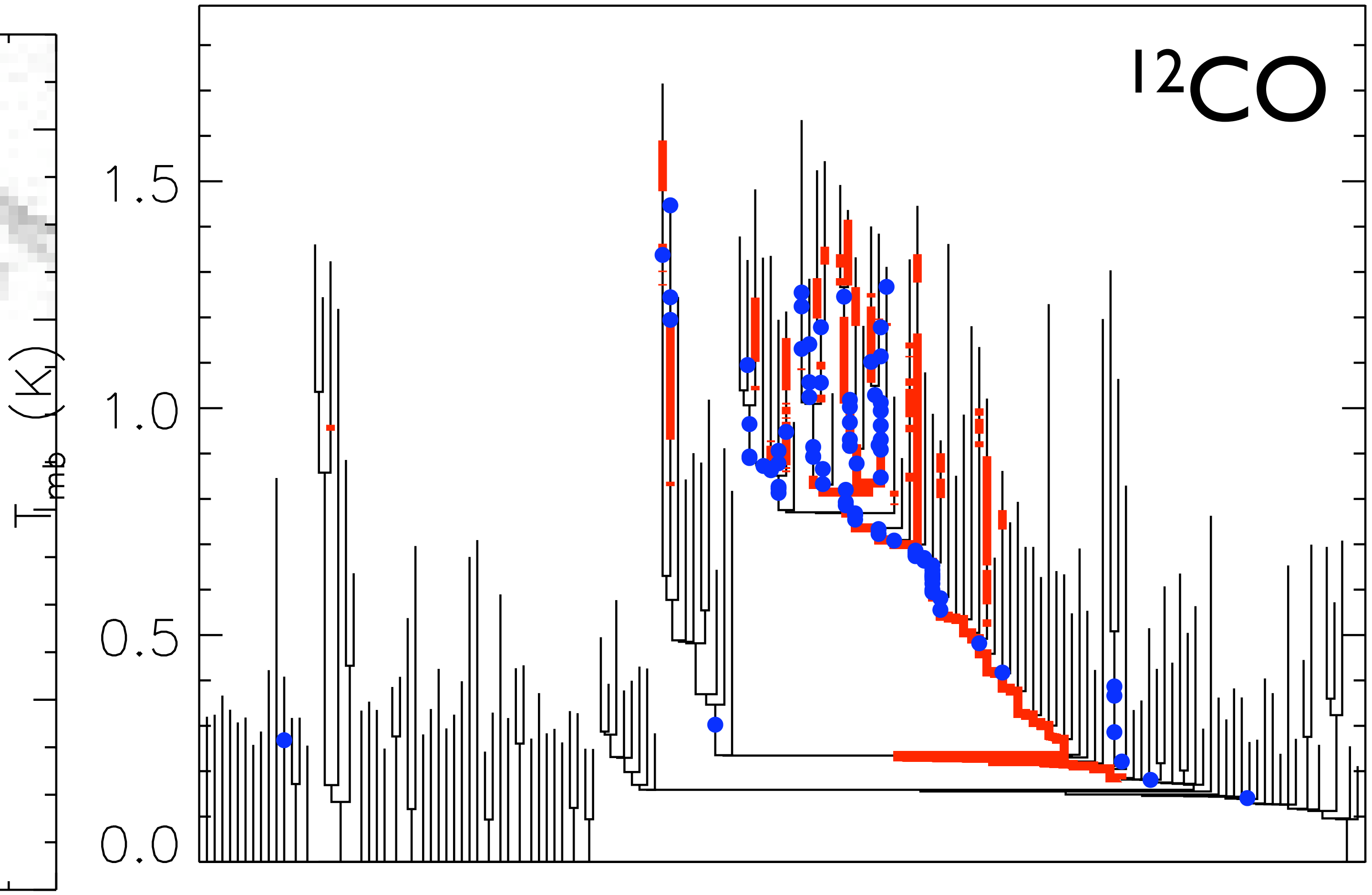
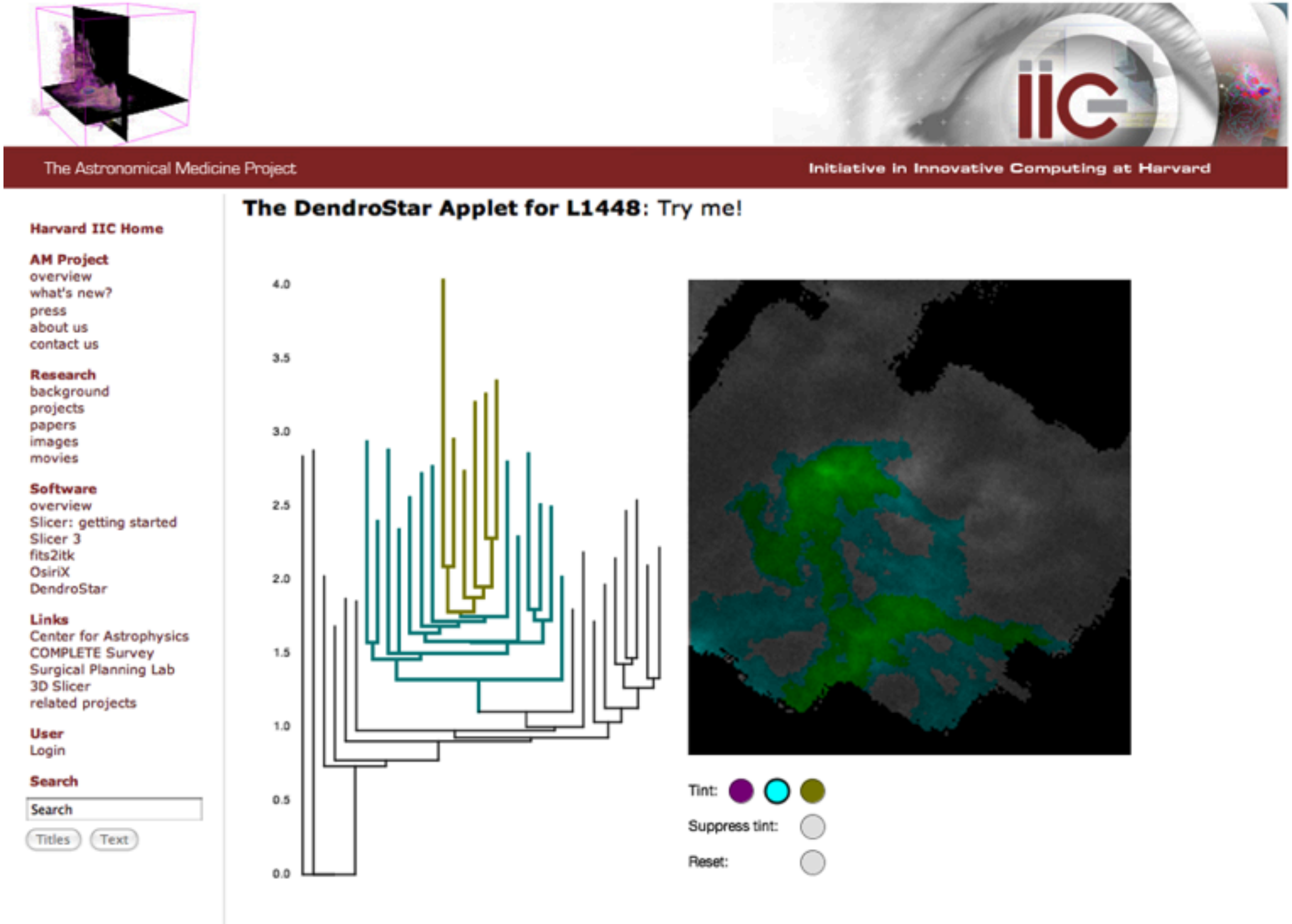




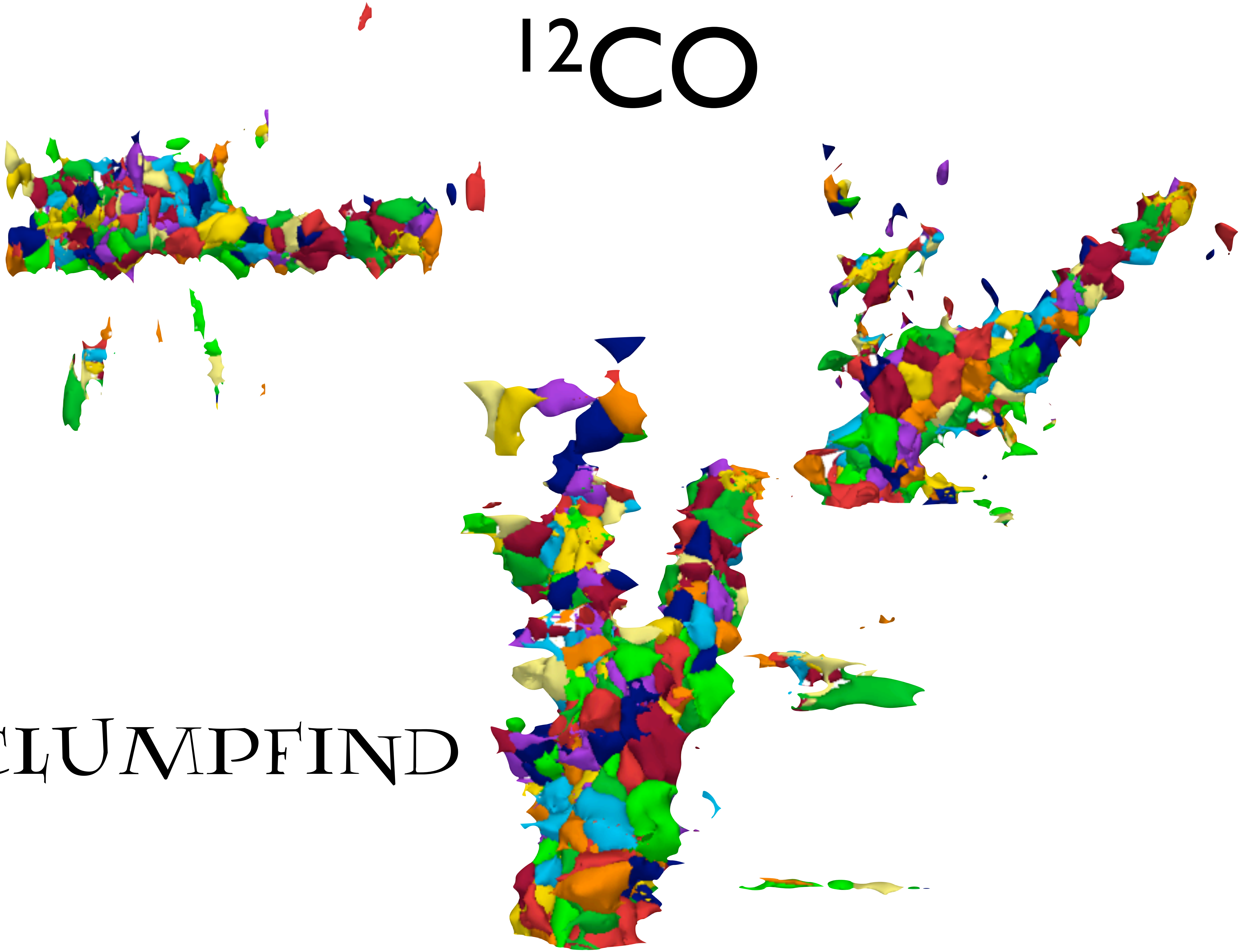


Which is which?



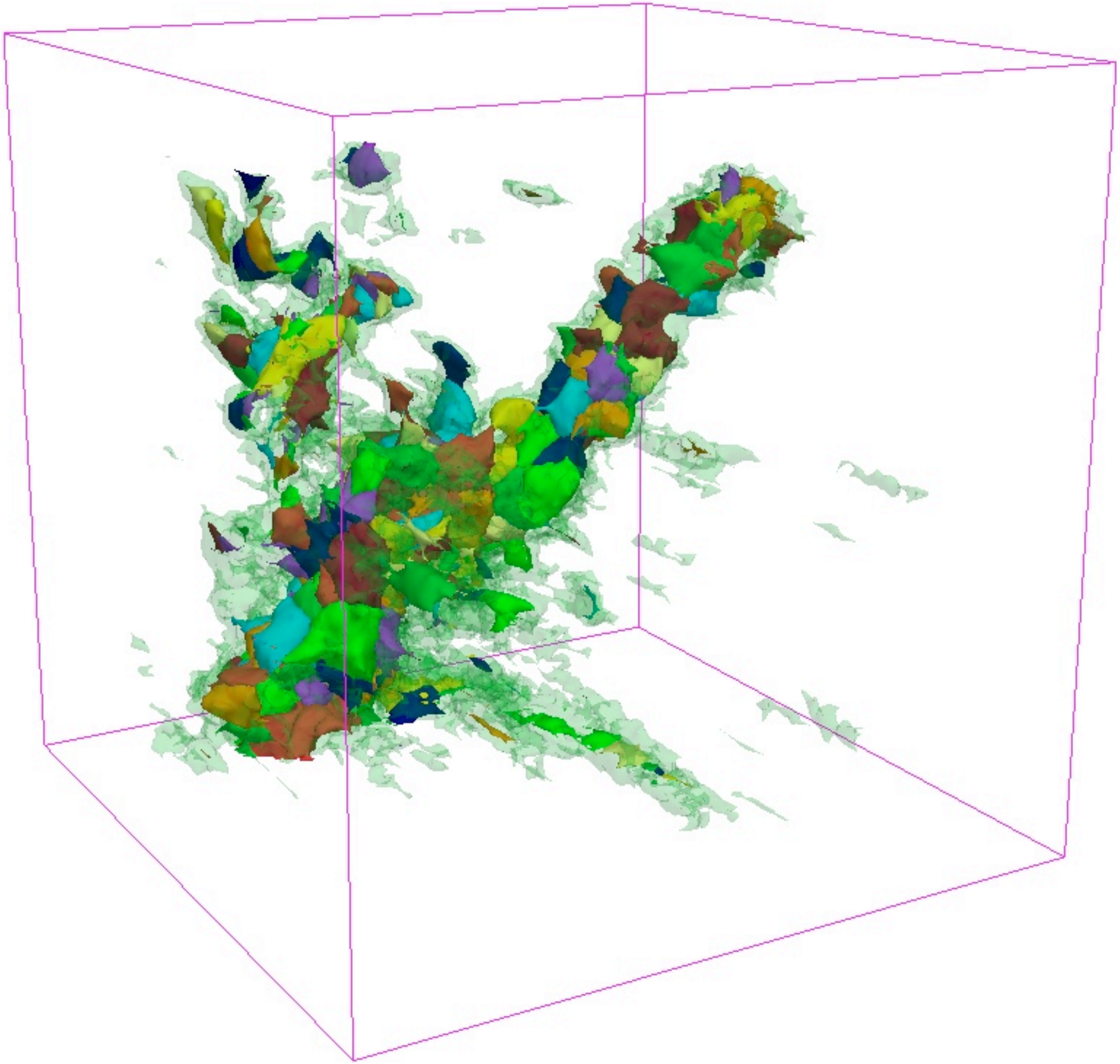
The DendroStar Applet for L1448: Try me!

^{12}CO

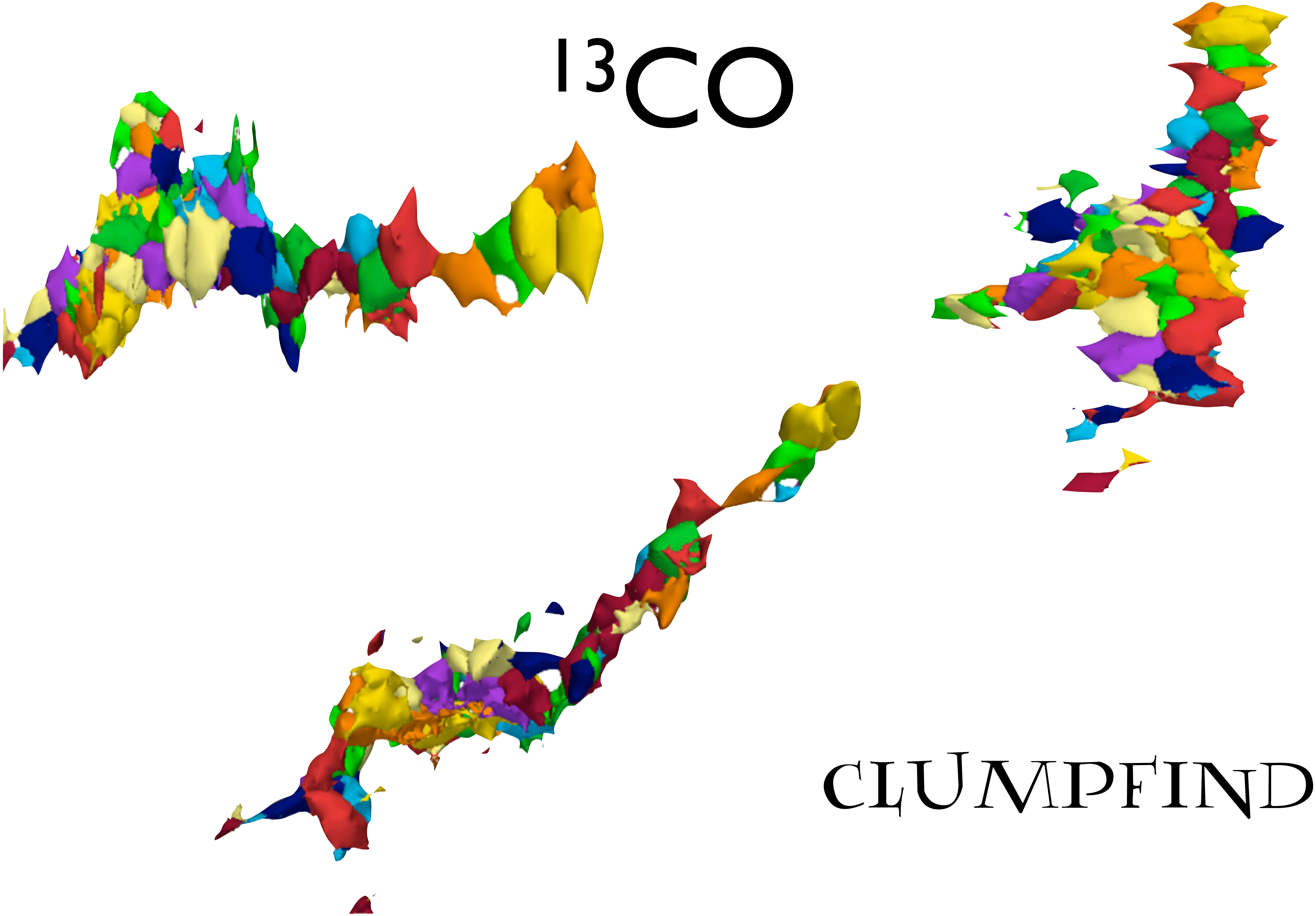


CLUMPFIND

Clumpfind+Dendro ^{12}CO

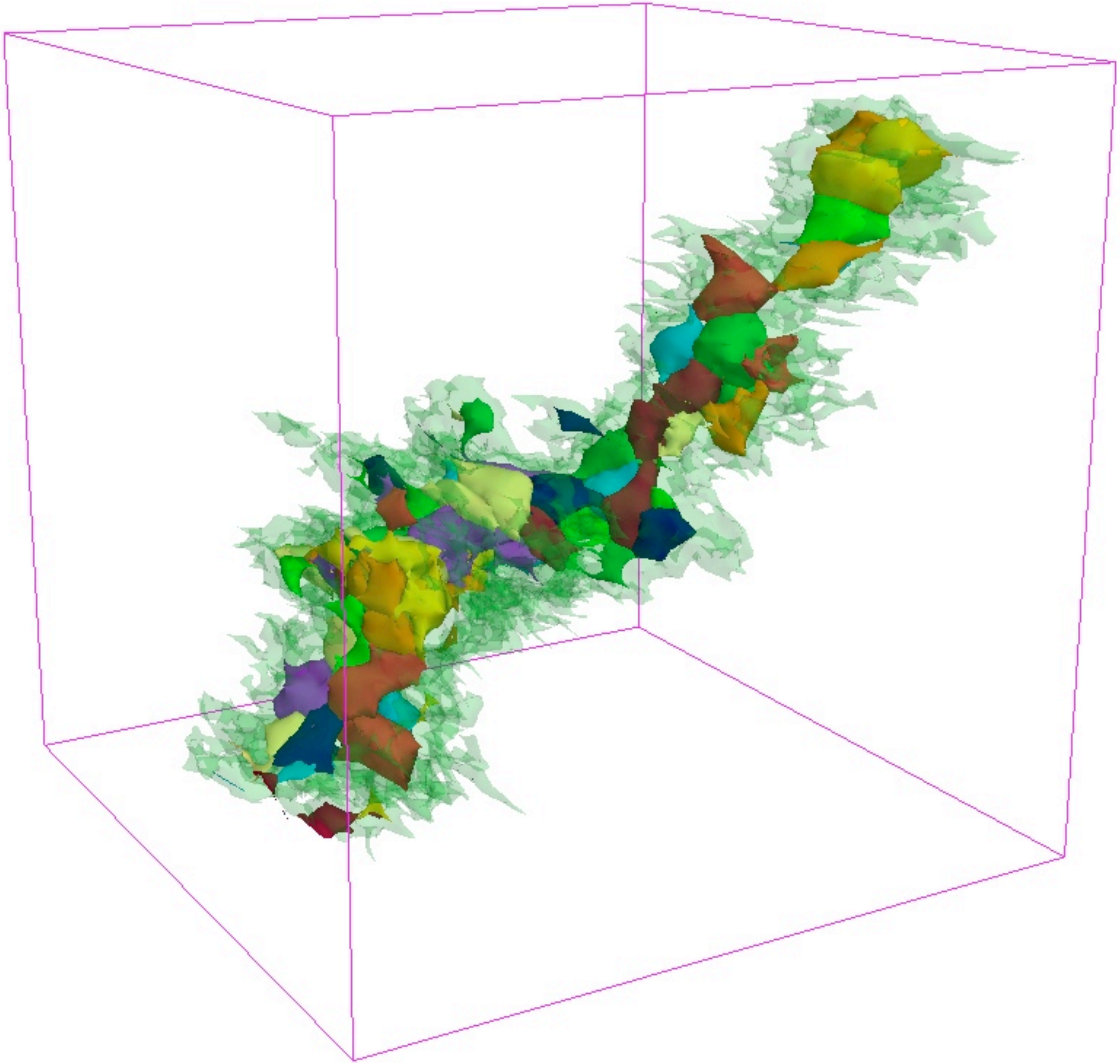


^{13}CO

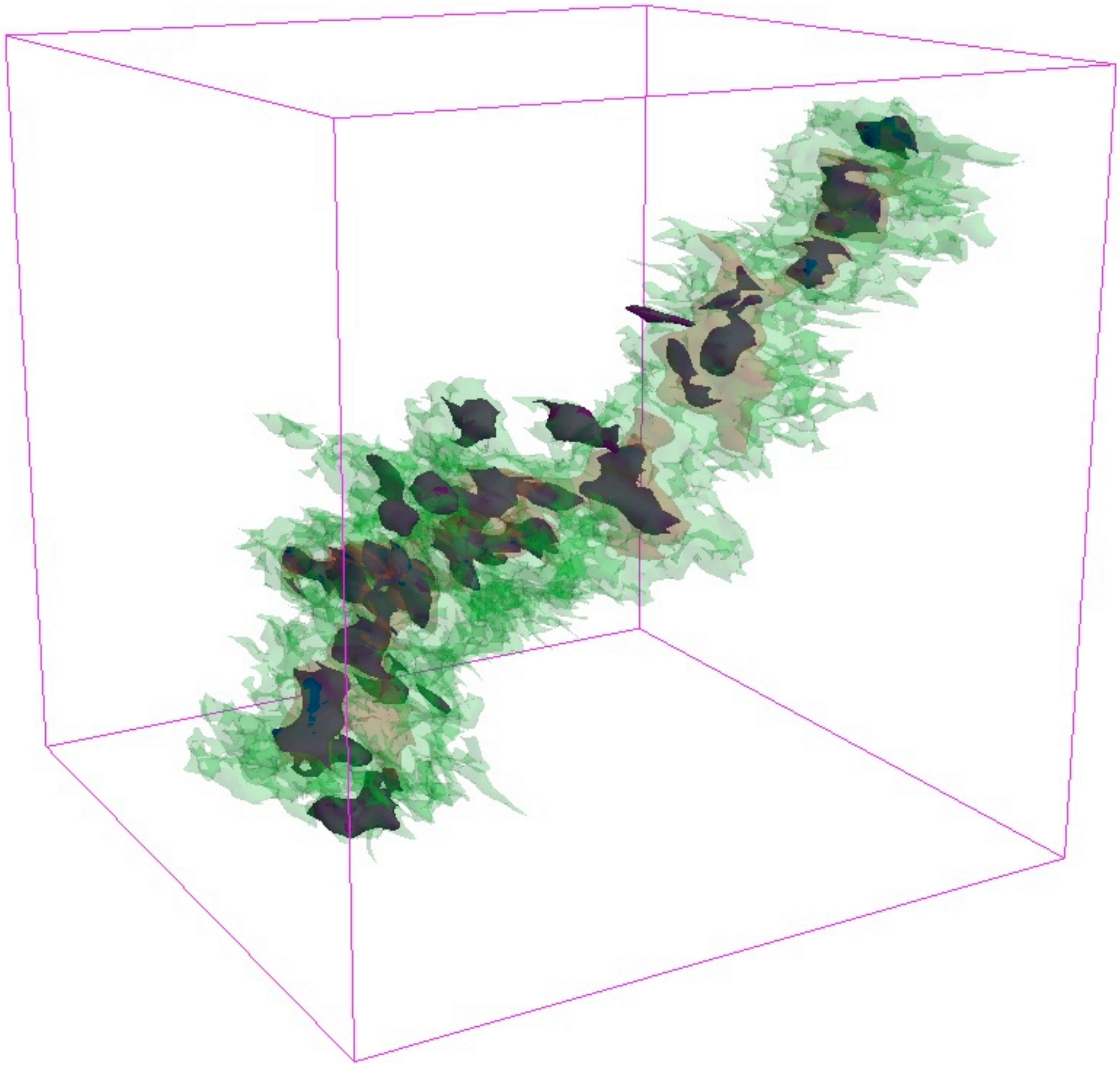


CLUMPFIND

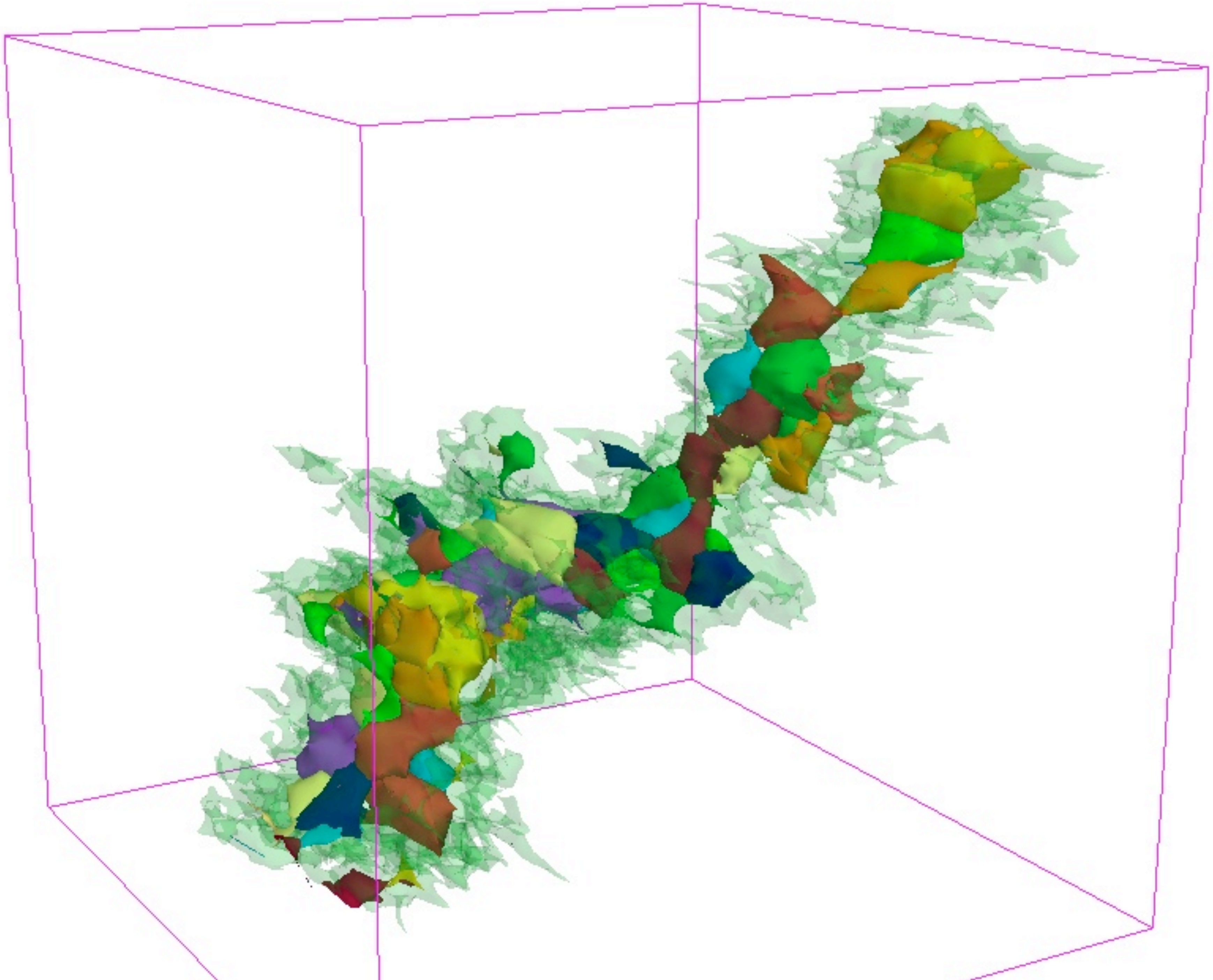
Clumpfind+Dendro ^{13}CO



Clumpfind+Dendro ^{13}CO

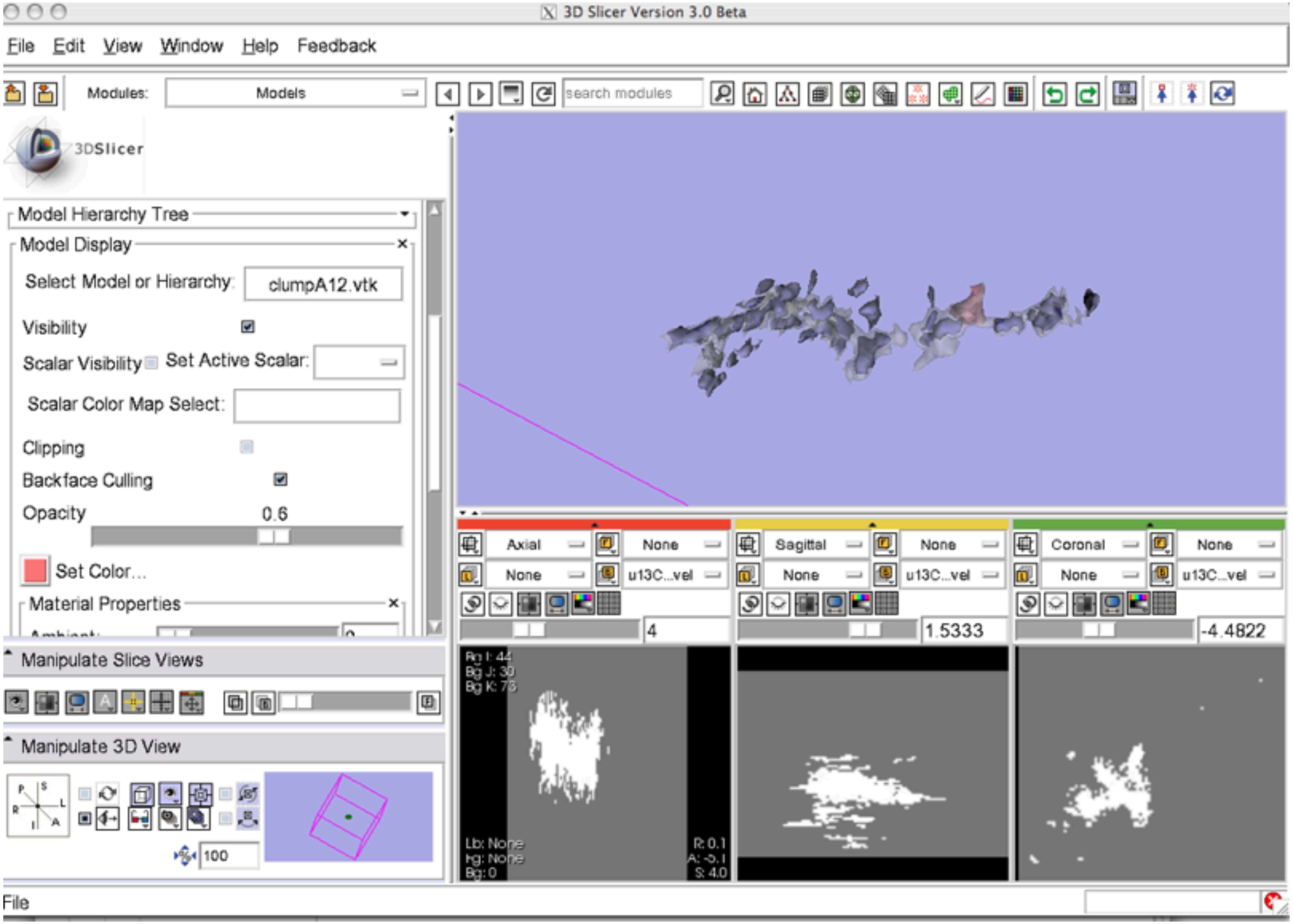


Clumpfind+Dendro ^{13}CO



Slicer demo...

^{13}CO



Select Model or Hierarchy: clumpA12.vtk

Visibility ☑

Scalar Visibility ☐ Set Active Scalar:

Scalar Color Map Select:

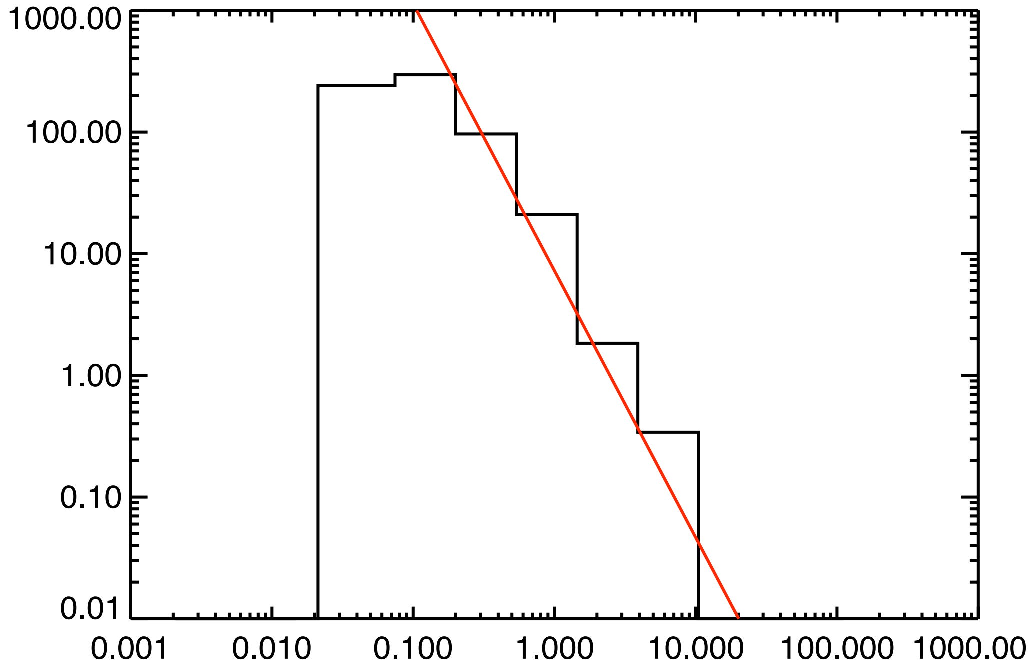
Clipping ☐

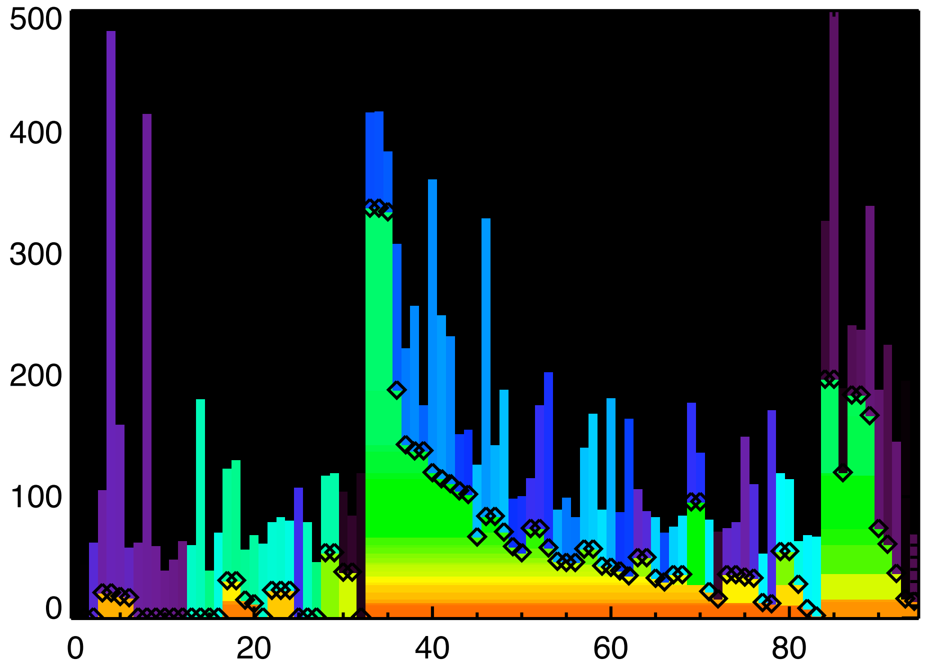
Backface Culling ☑

Opacity 0.6

DENDROGRAMS

What about the Pipe CMF...from extinction data leaves only? (Jaime)





slope 2.2

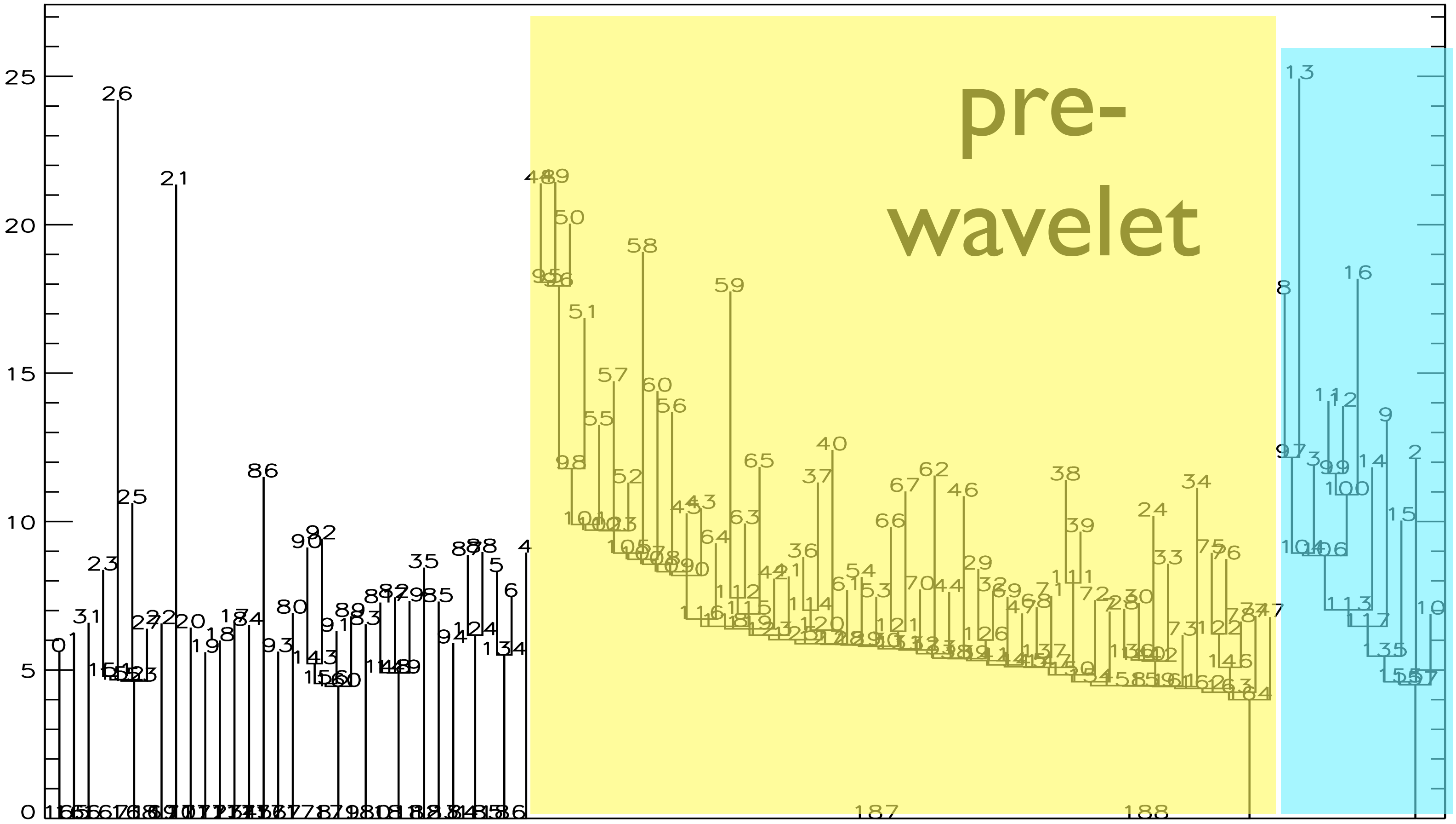
DENDRO MASS-RADIUS

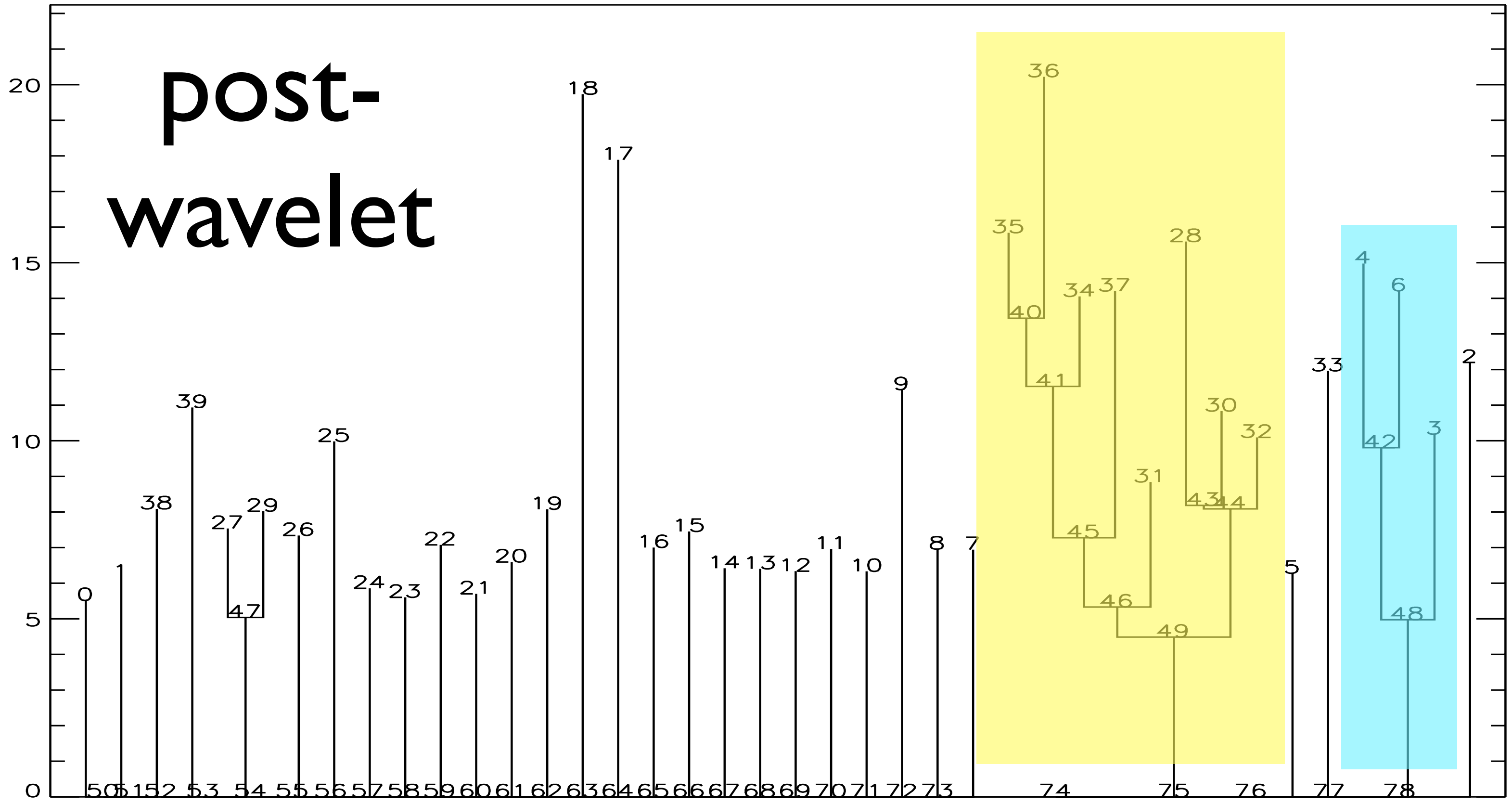
Special Bonus

courtesy Jens Kauffmann...

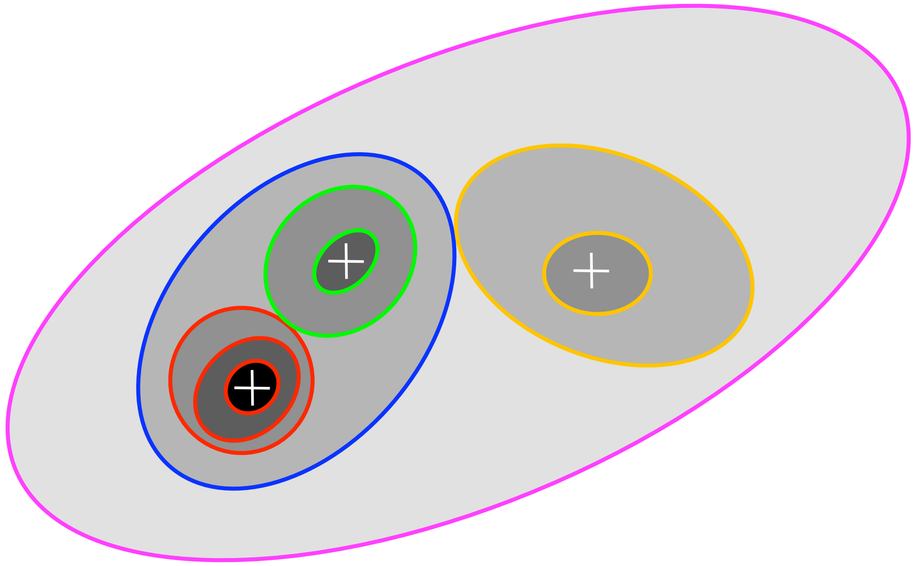
(work in progress!!)

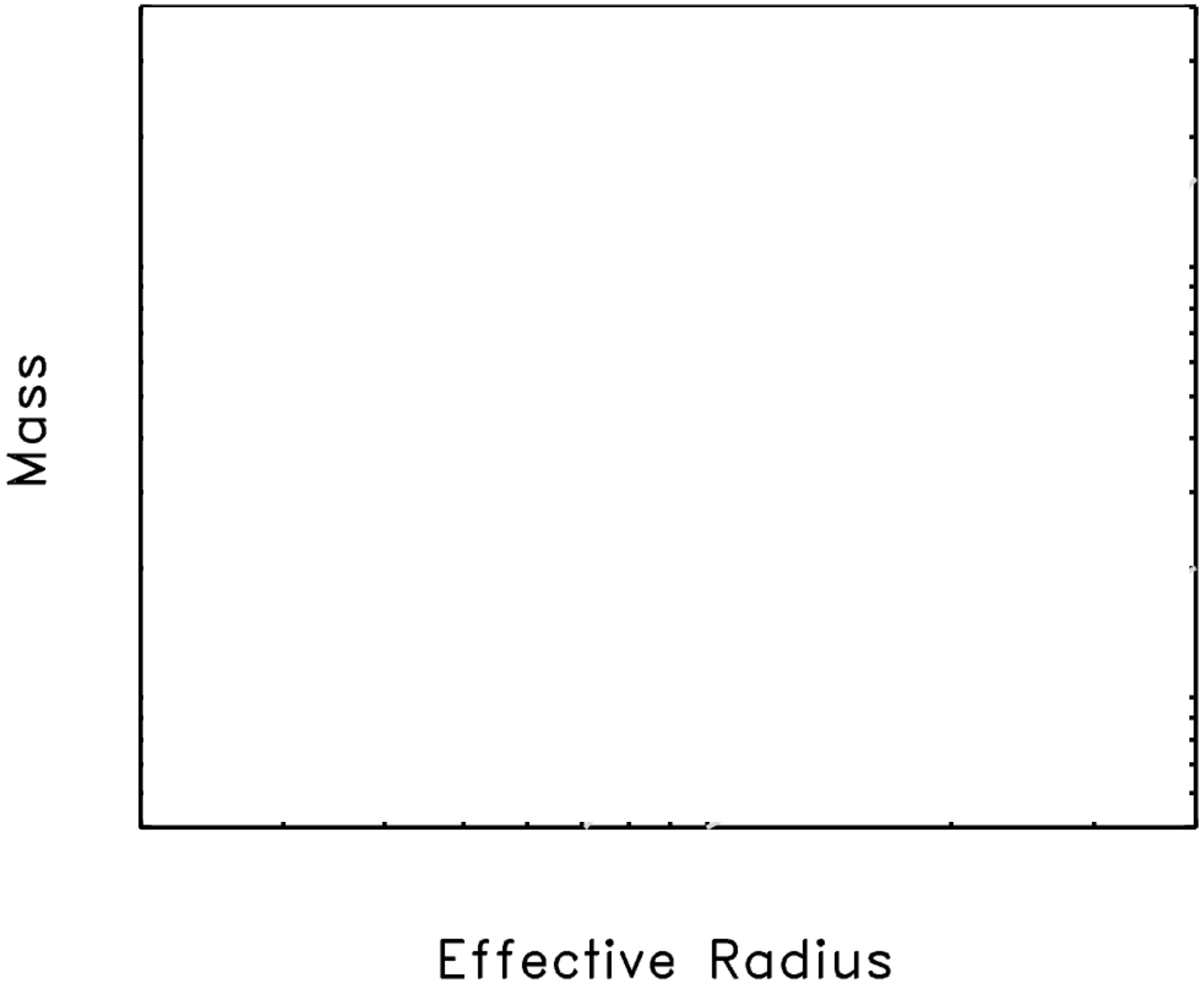
Jens' "pruned" dendrograms...





Method: Analysis of nested Contours





effective radius:

$R = (A/\pi)^{1/2}$

Jens Kauffmann (in prep.)

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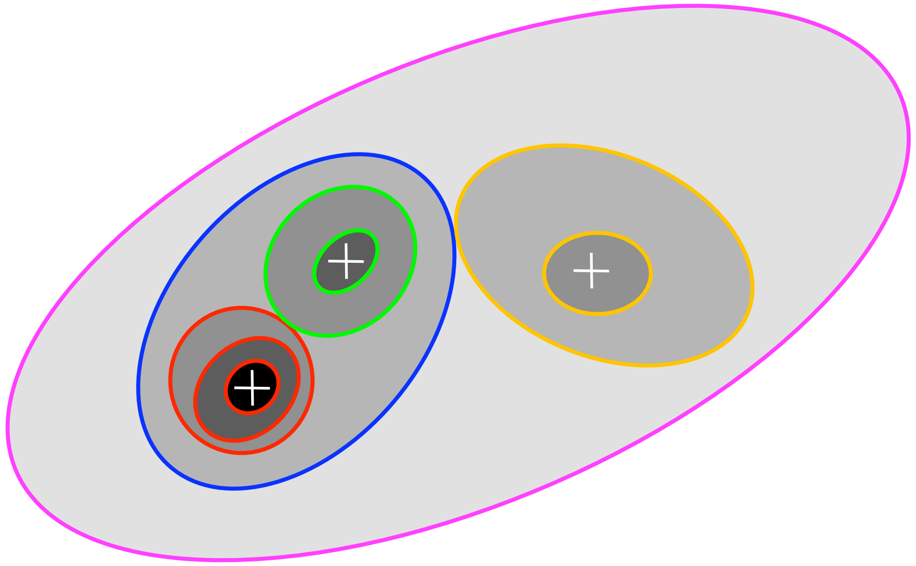
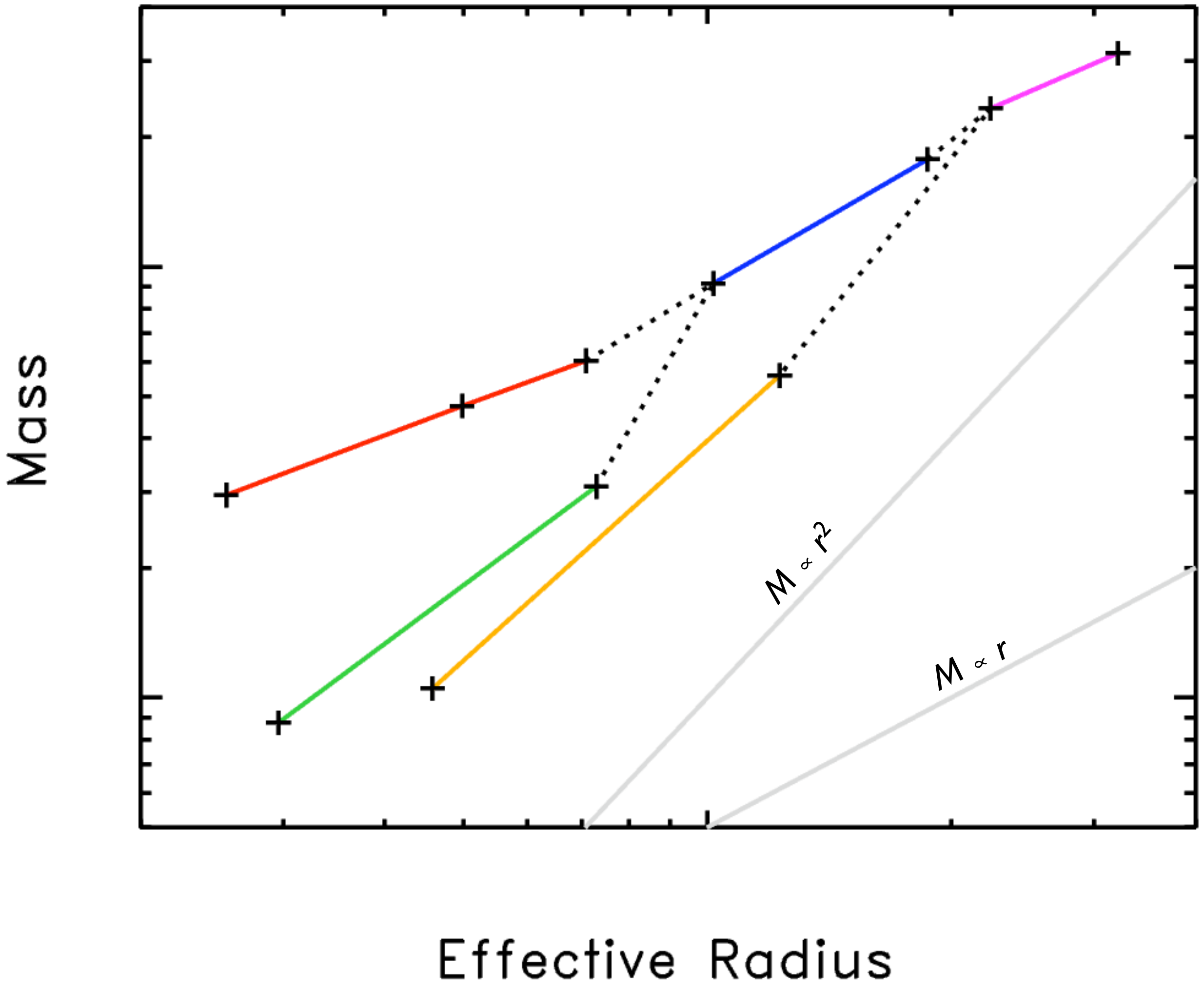


stepping through all contours…



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Jens Kauffmann (in prep.)

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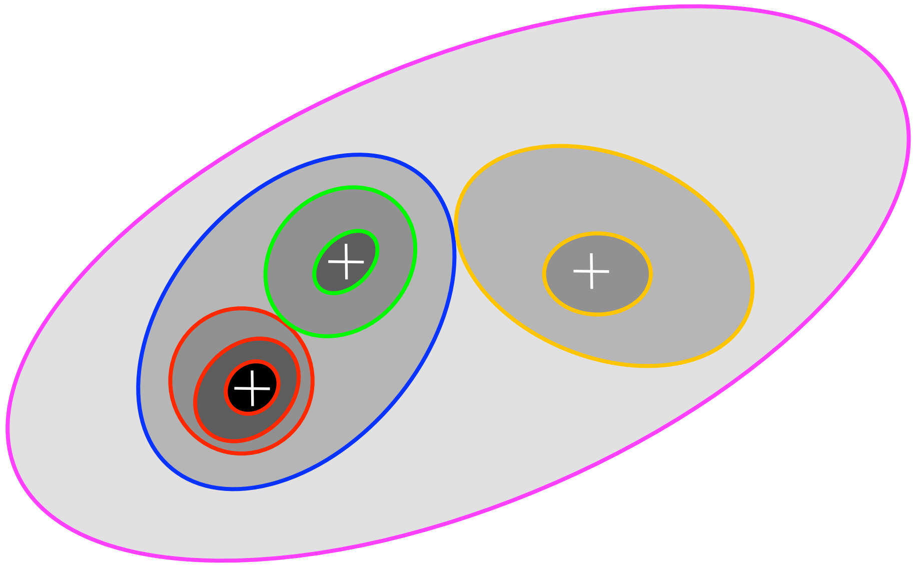
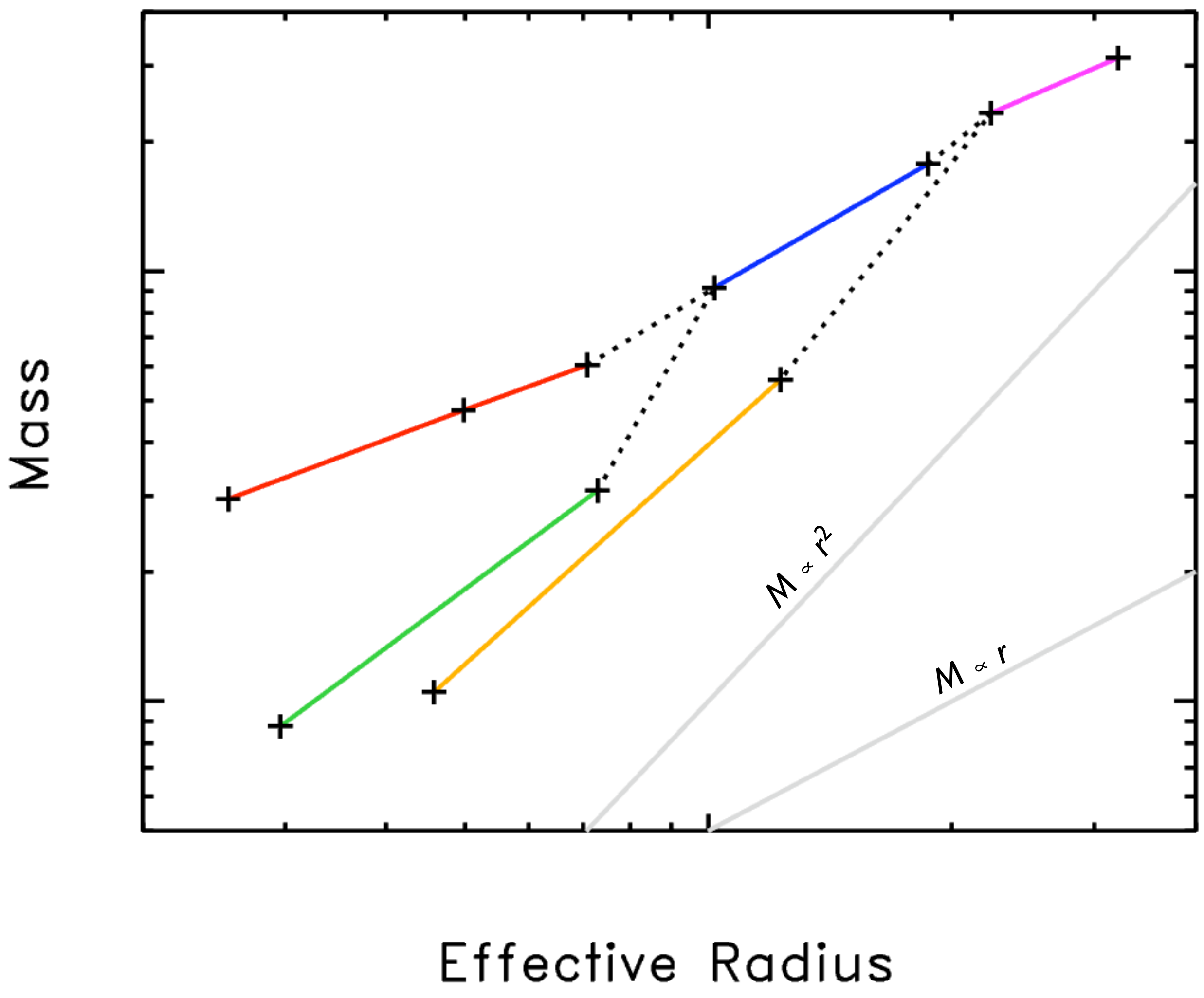


stepping through all contours…

✓ consideration of all spatial scales



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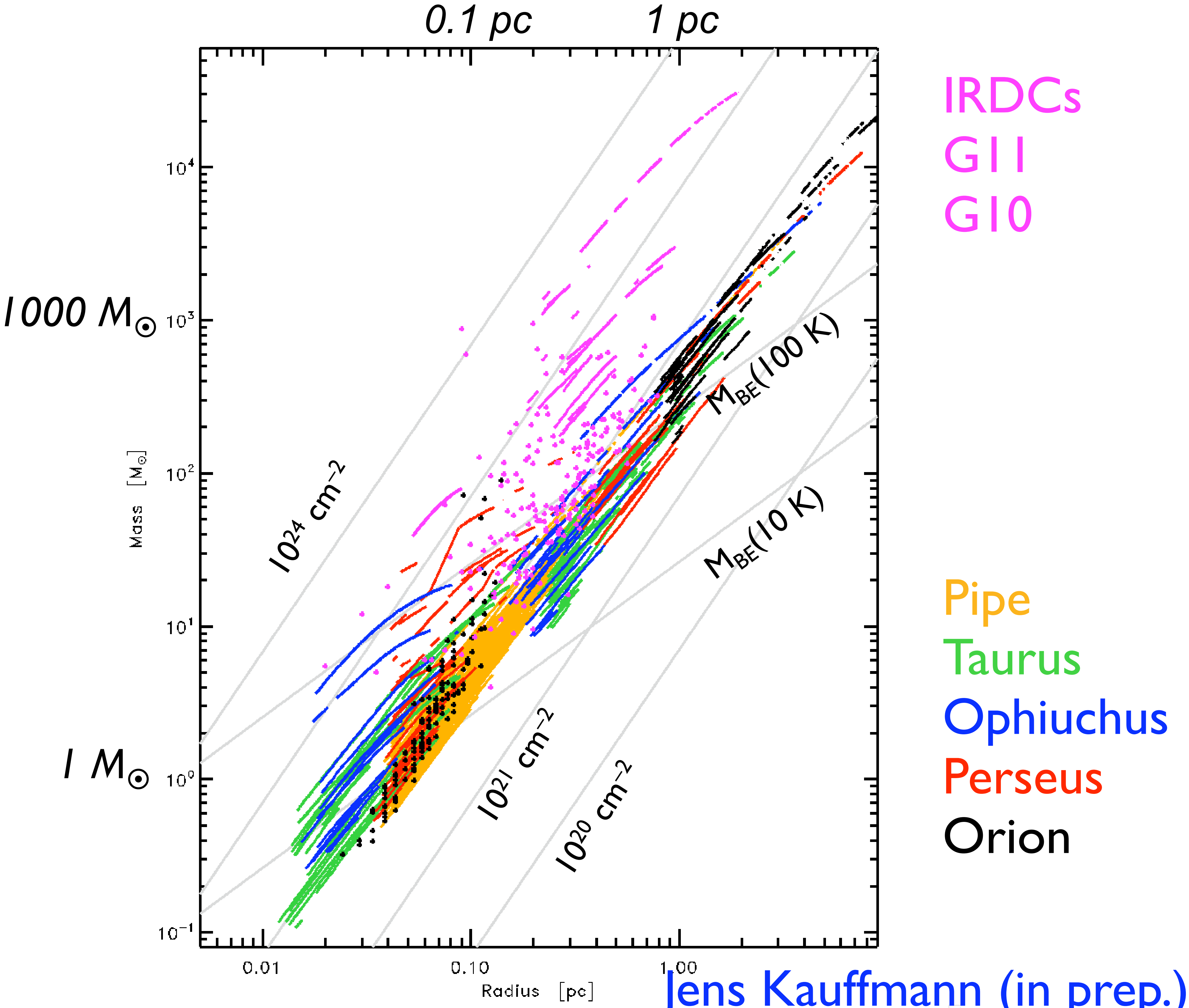
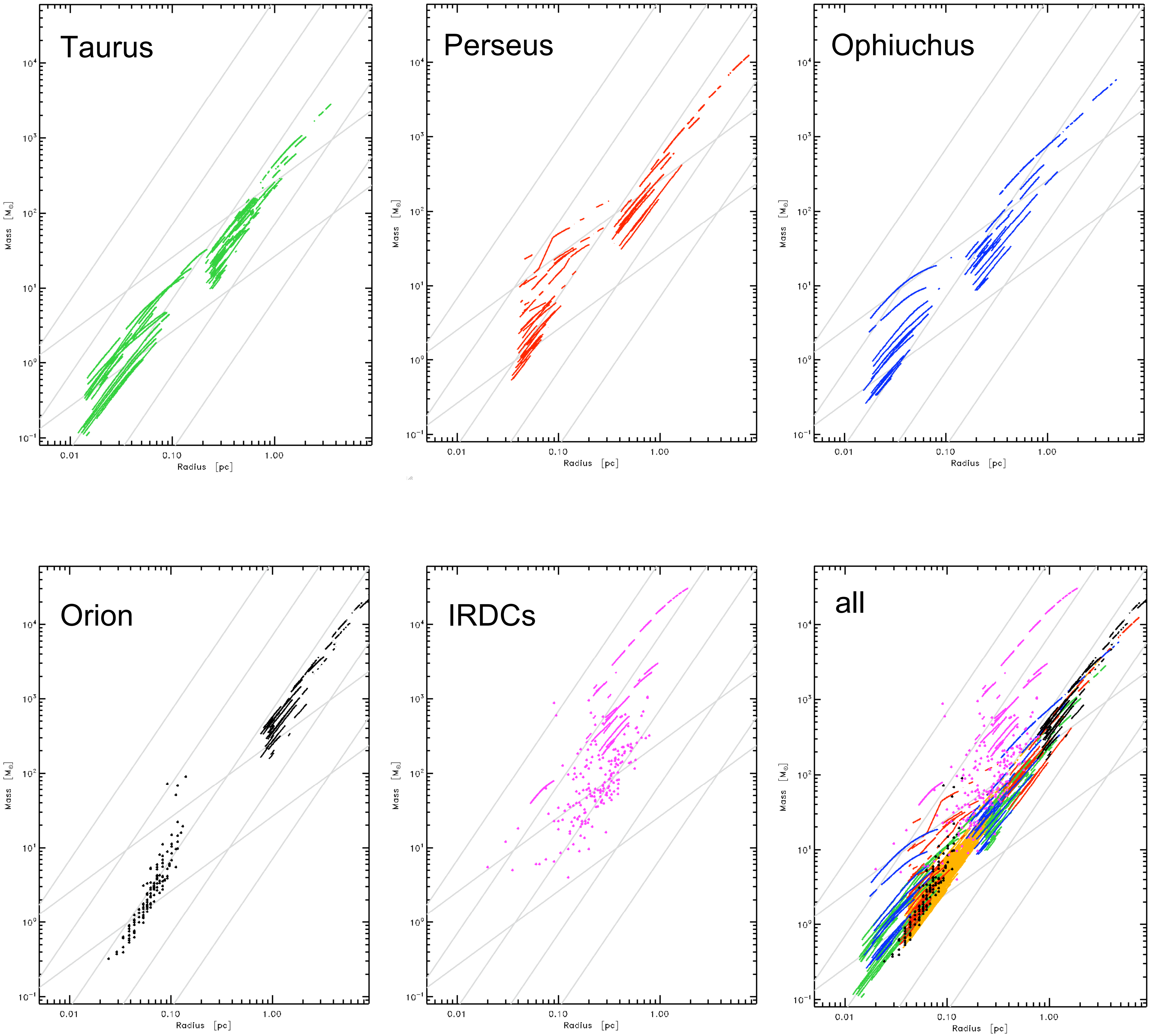
Jens Kauffmann (in prep.)

Regions Studied so far



Jens Kauffmann (in prep.)

Regions Studied so far



Pipe

Taurus

Ophiuchus

Perseus

Orion

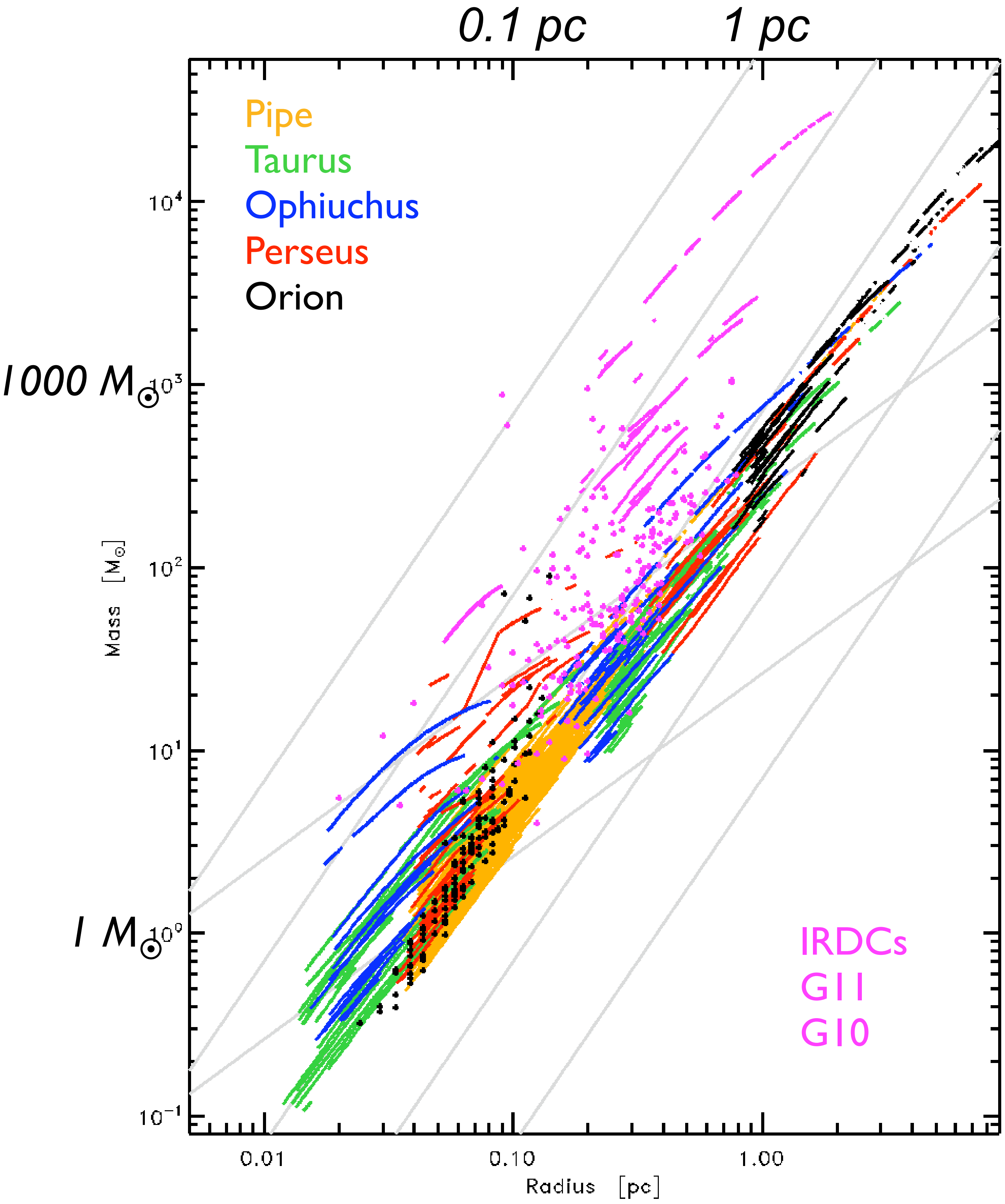
IRDCs

G11

G10

Jens Kauffmann (in prep.)

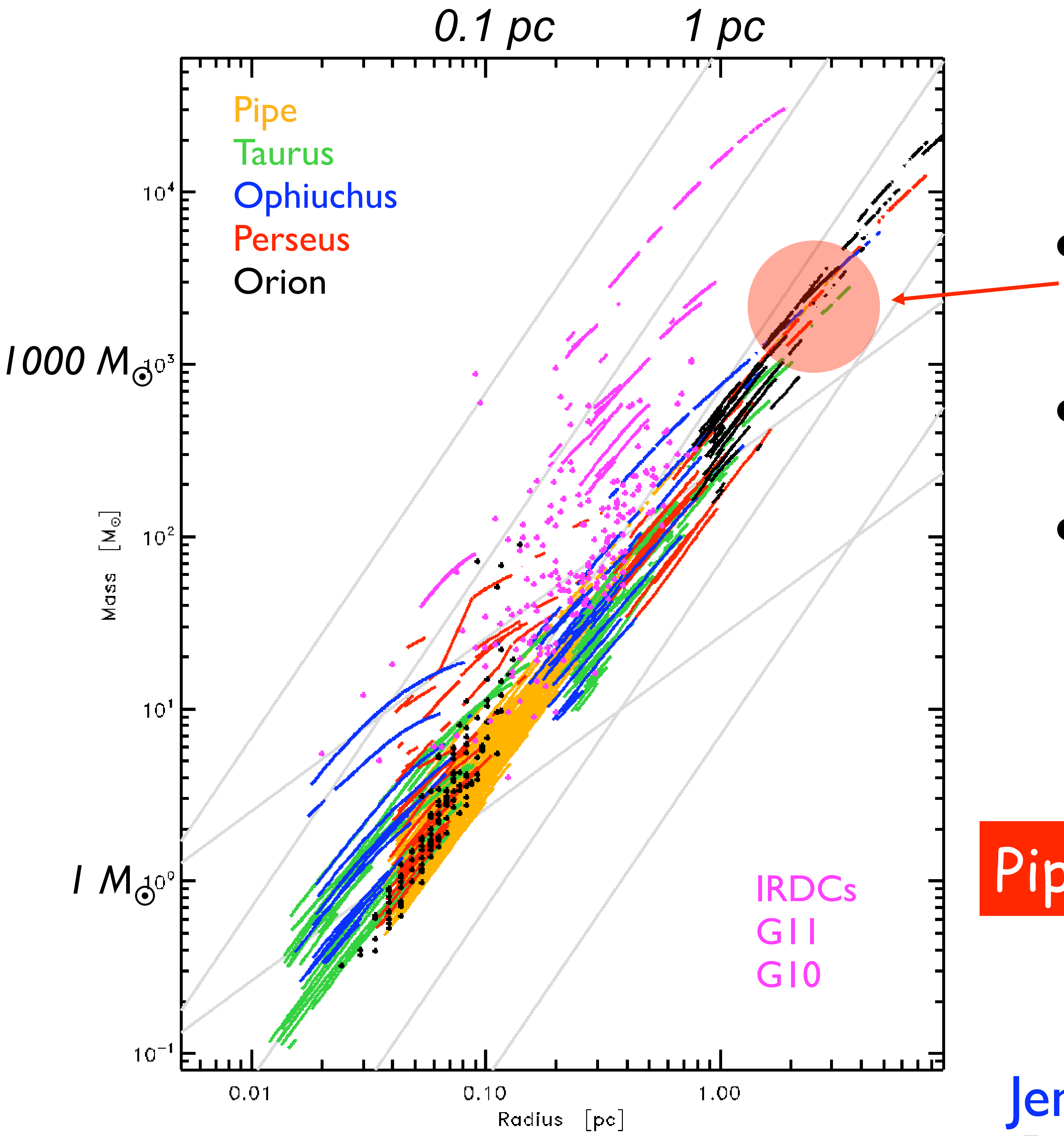
Interesting Trends



- at sizes ~1 pc, all nearby clouds (<500 pc) behave similarly
- at smaller sizes, they diverge in their behavior
- IRDCs don't behave so "regularly"

Jens Kauffmann (in prep.)

Interesting Trends



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Pipe & Taurus ~ Orion!

Jens Kauffmann (in prep.)

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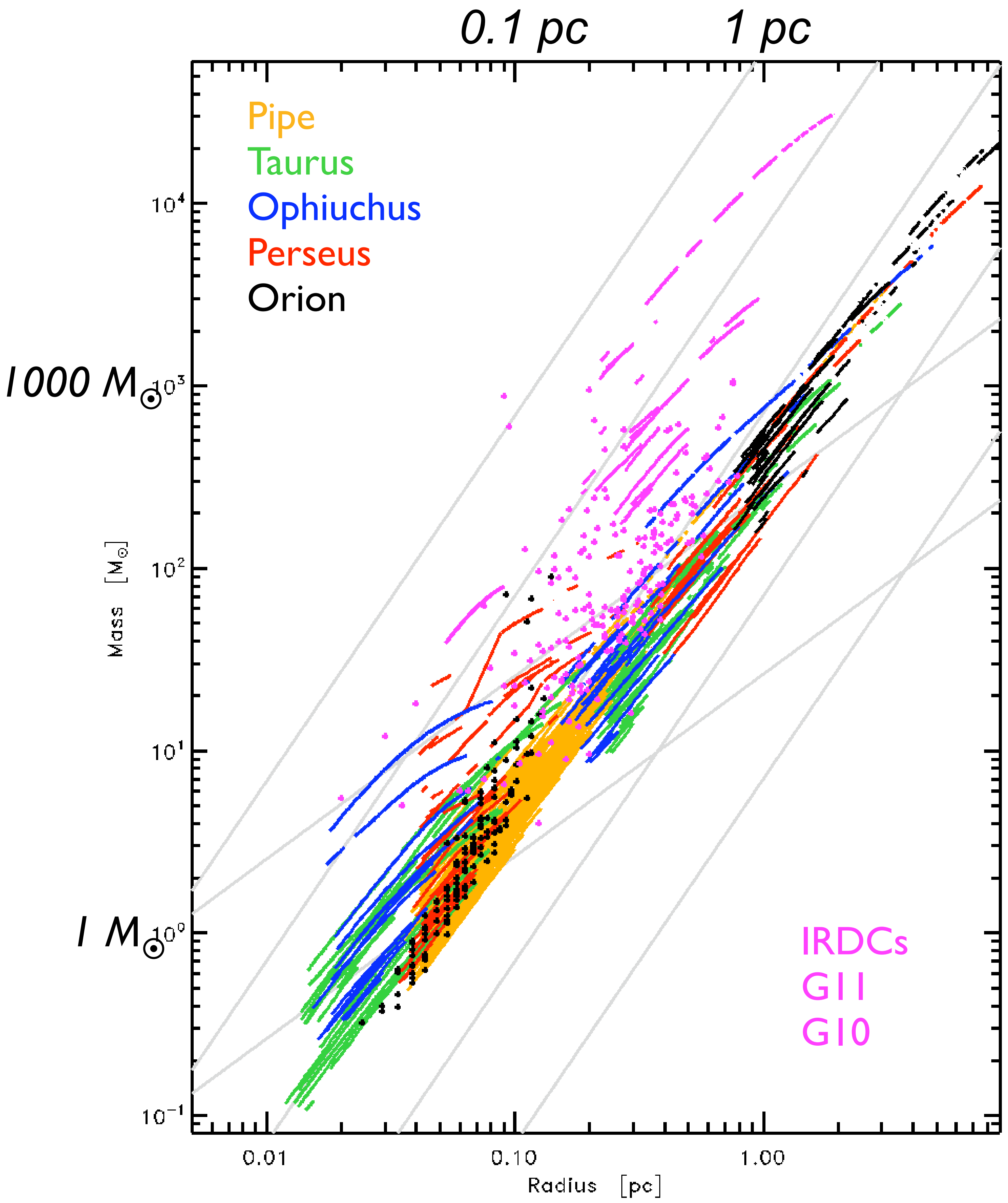

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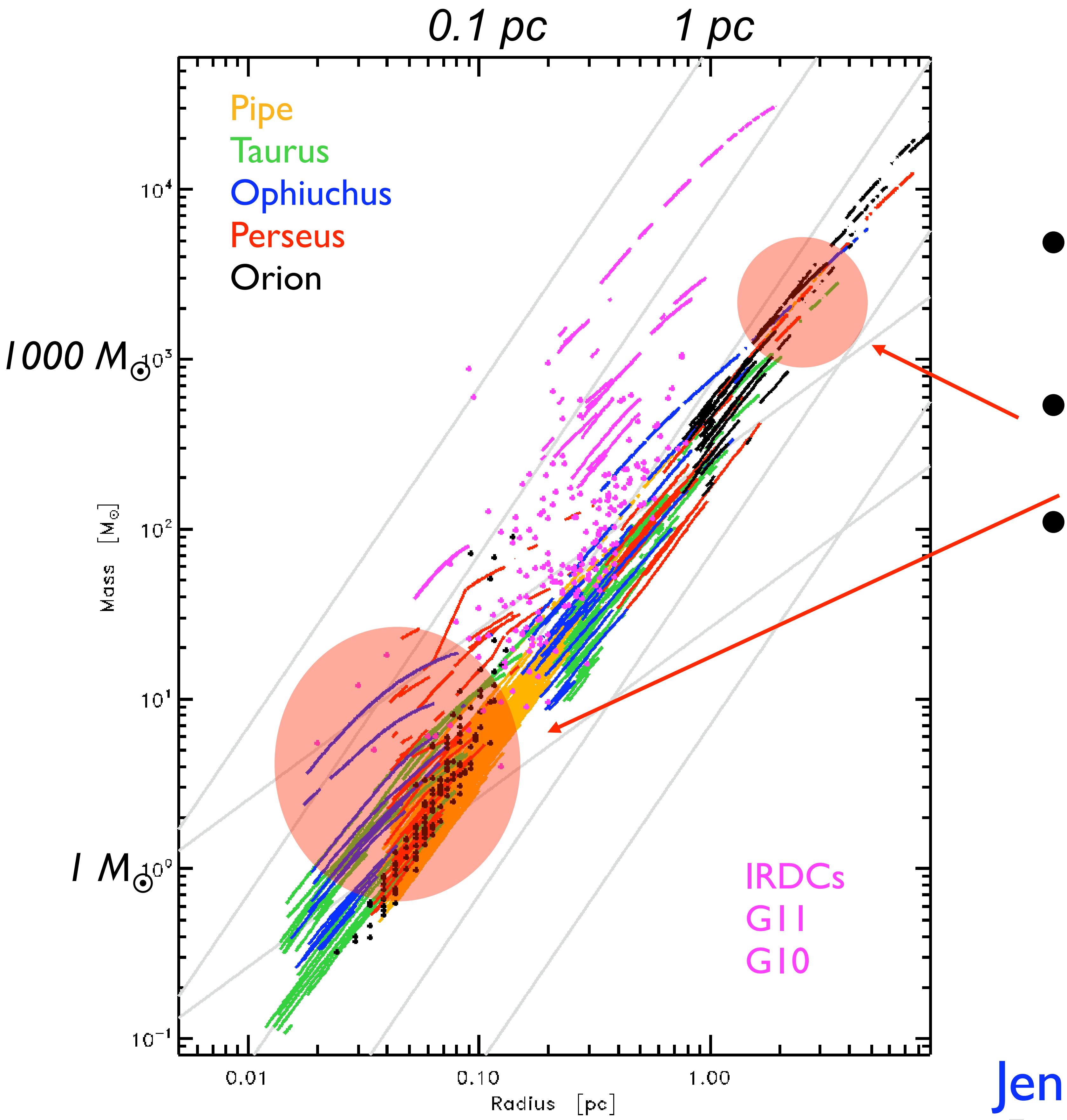

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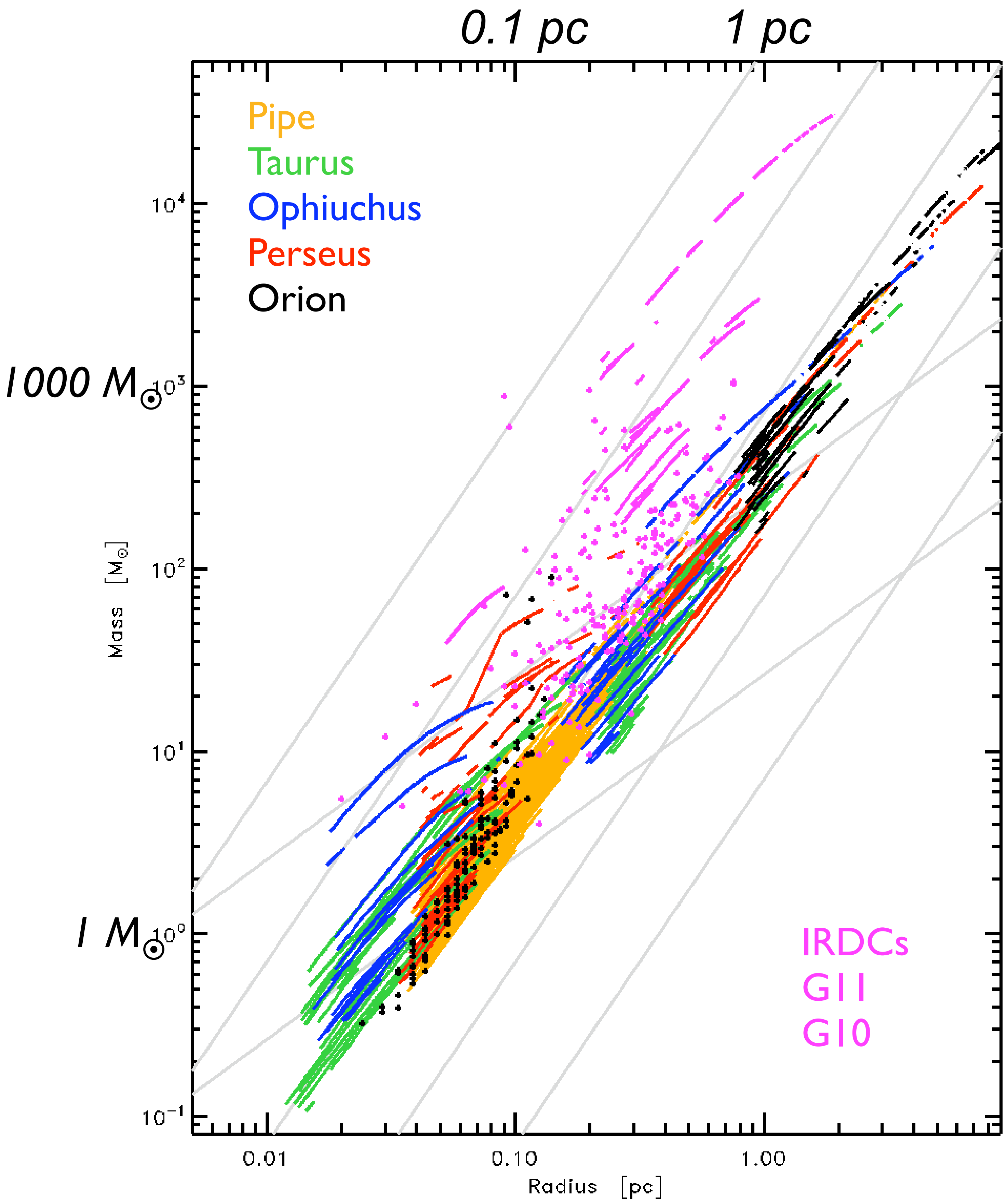

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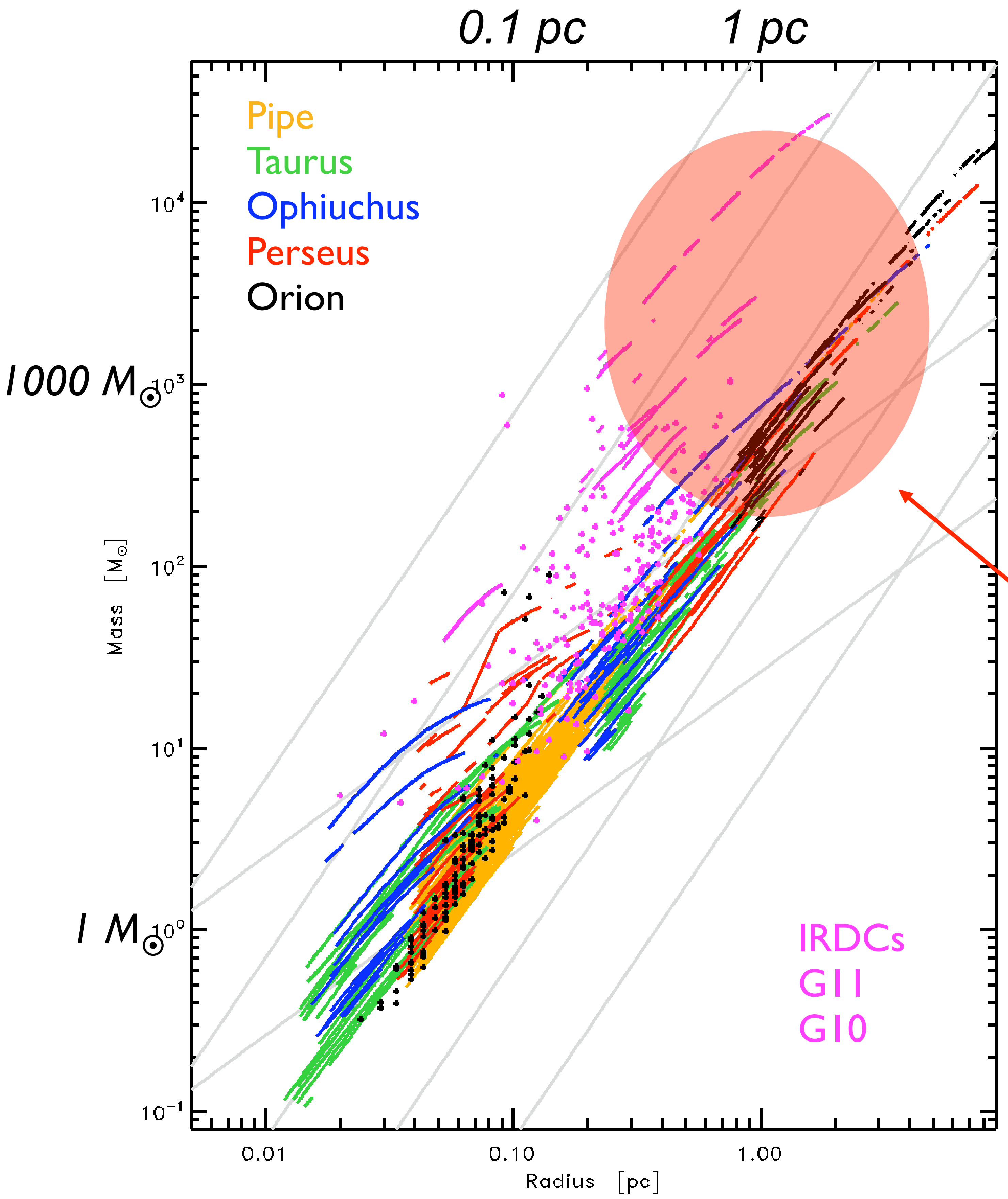

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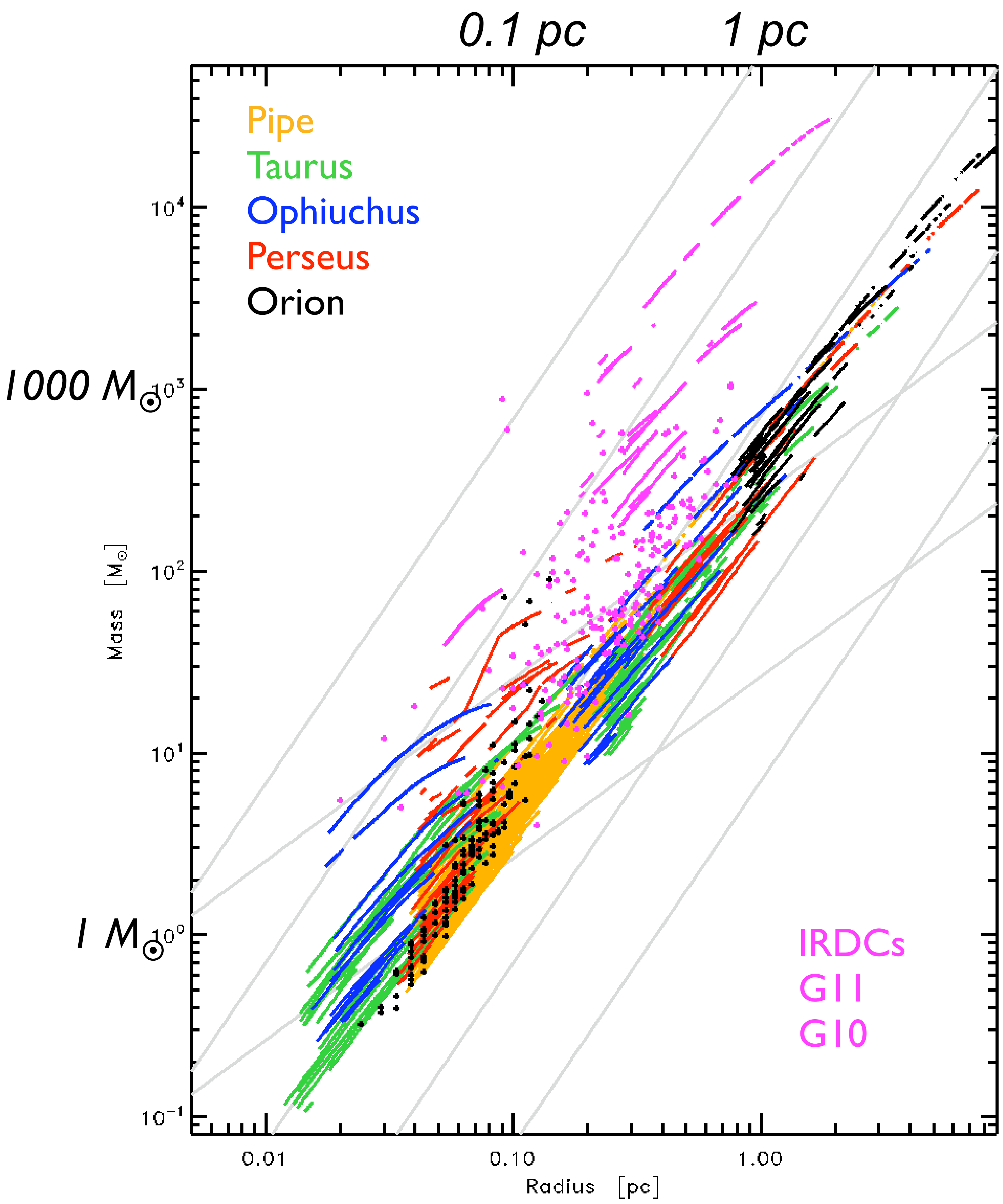
Related Cloud Physics

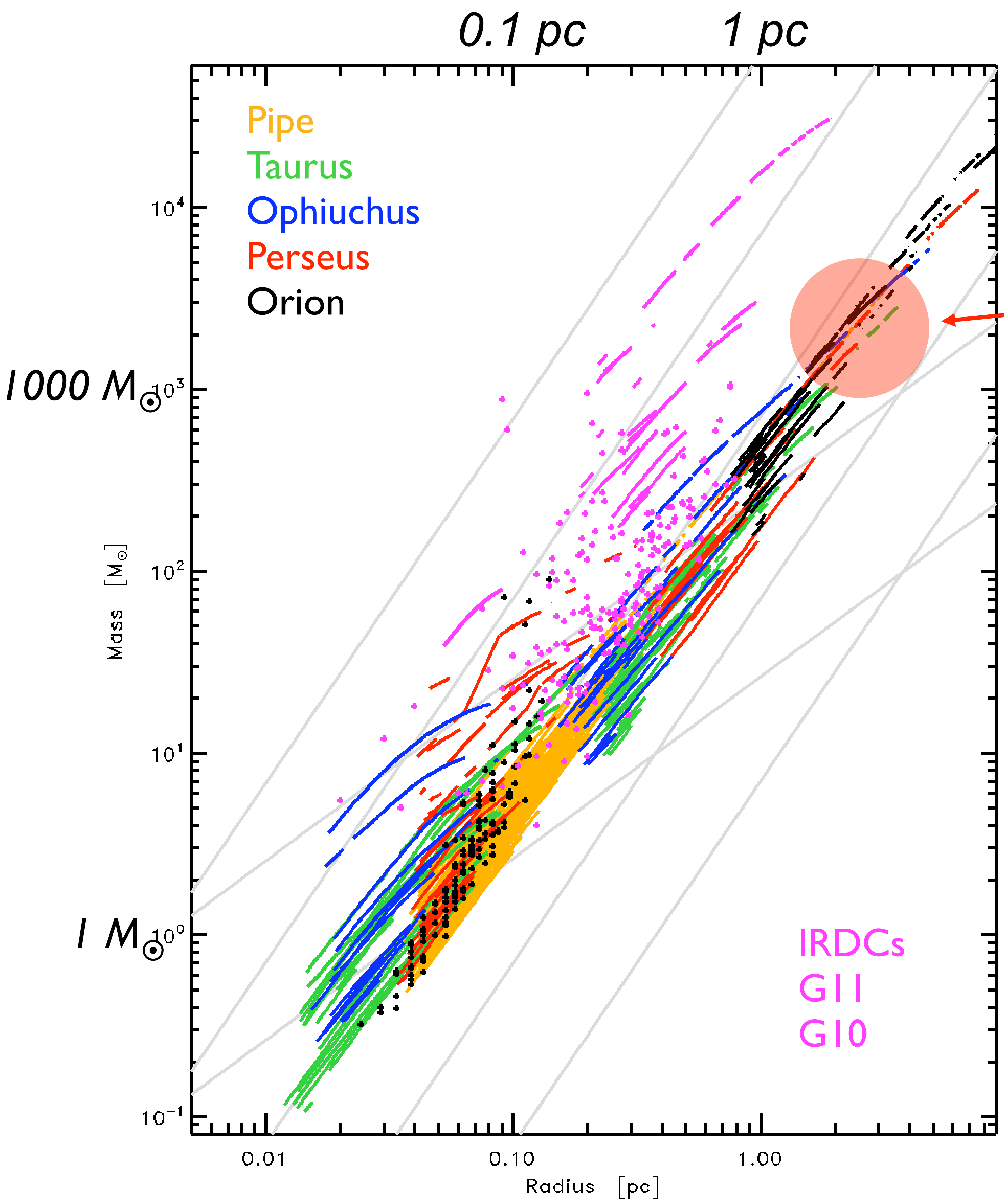


for nearby clouds…

- large-scale structure probably set by galactic environment (pressure, etc.)
- increase of density towards cores, depends on cloud
- usual dense core models

Jens Kauffmann (in prep.)

Related Cloud Physics



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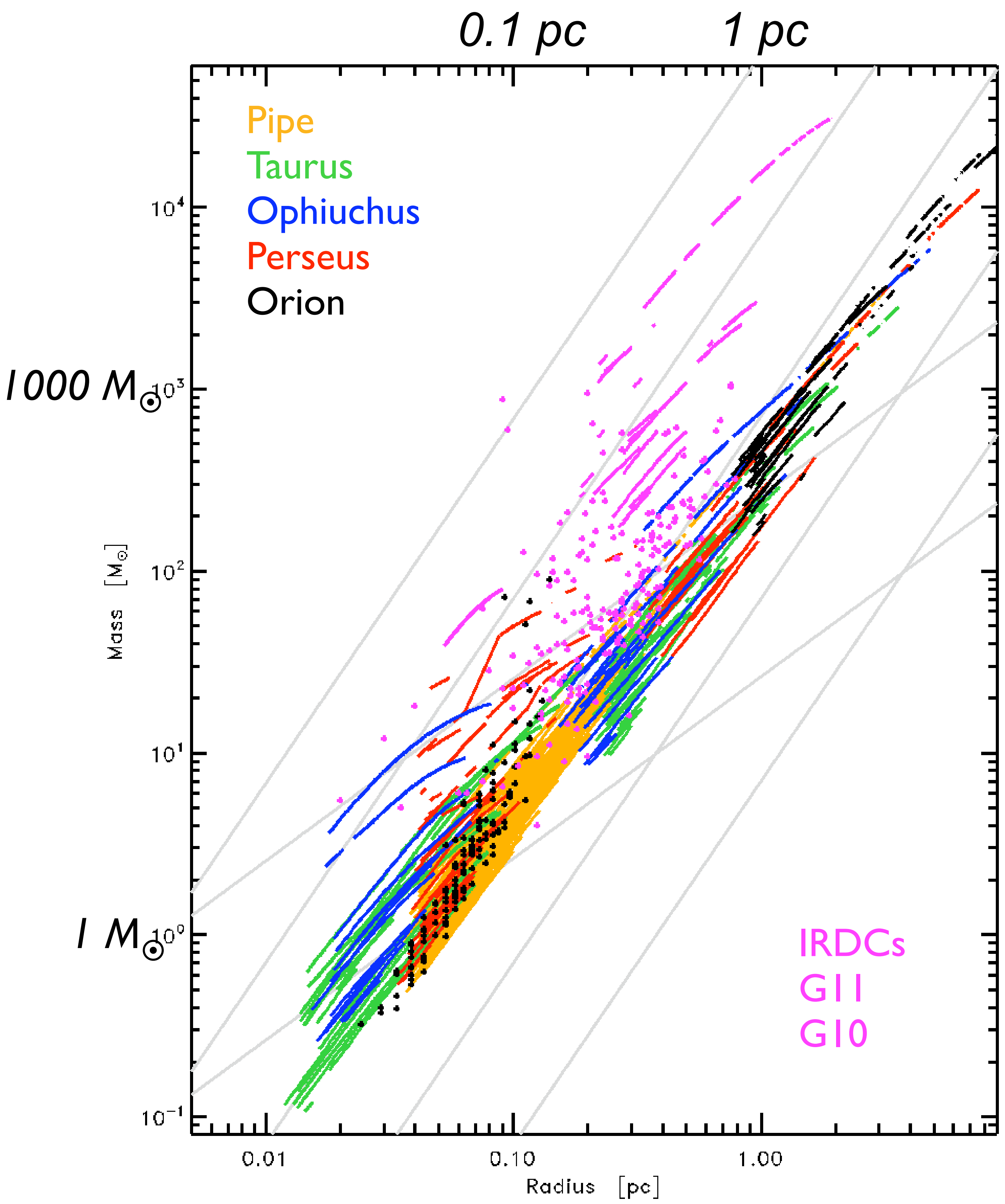

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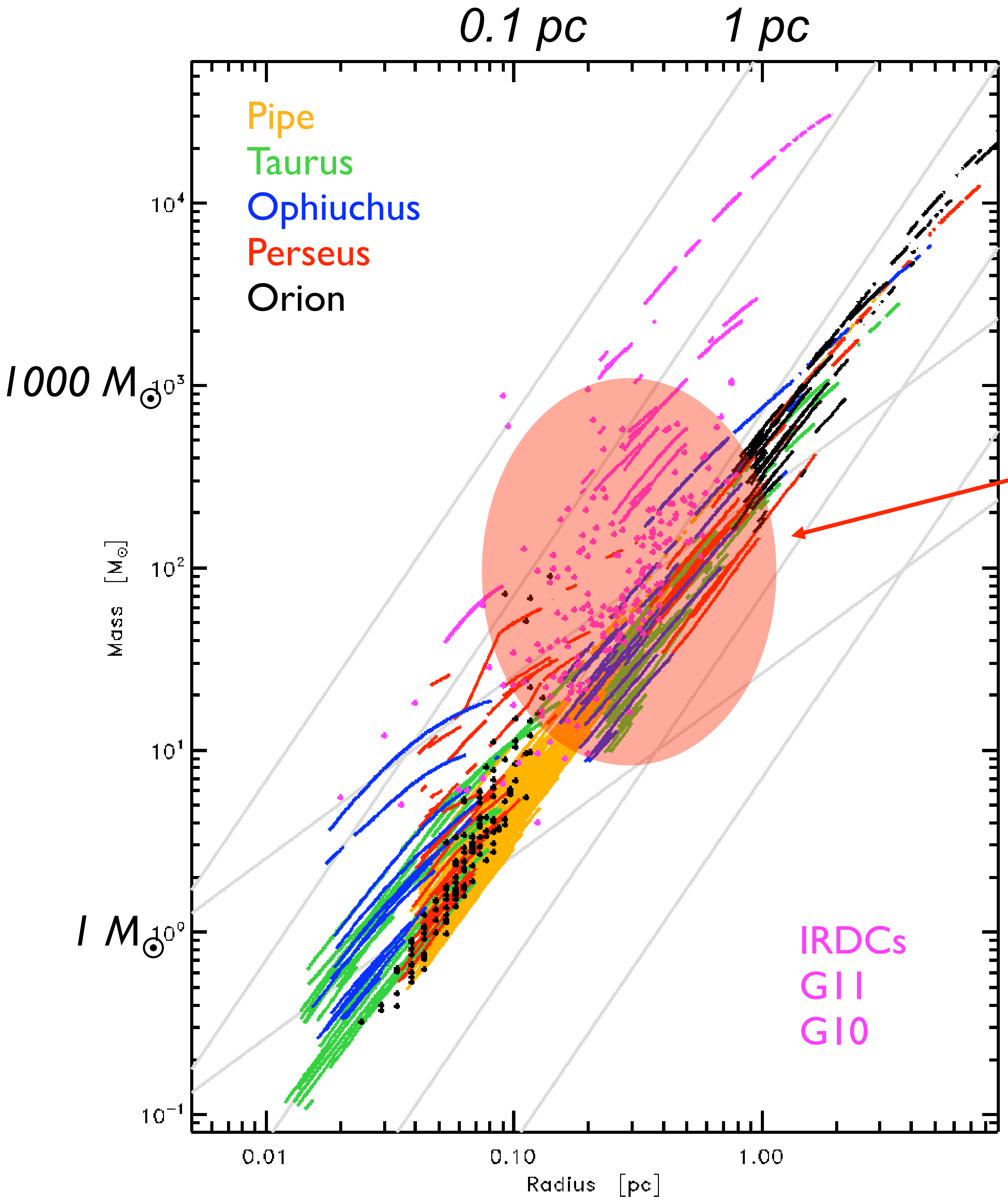

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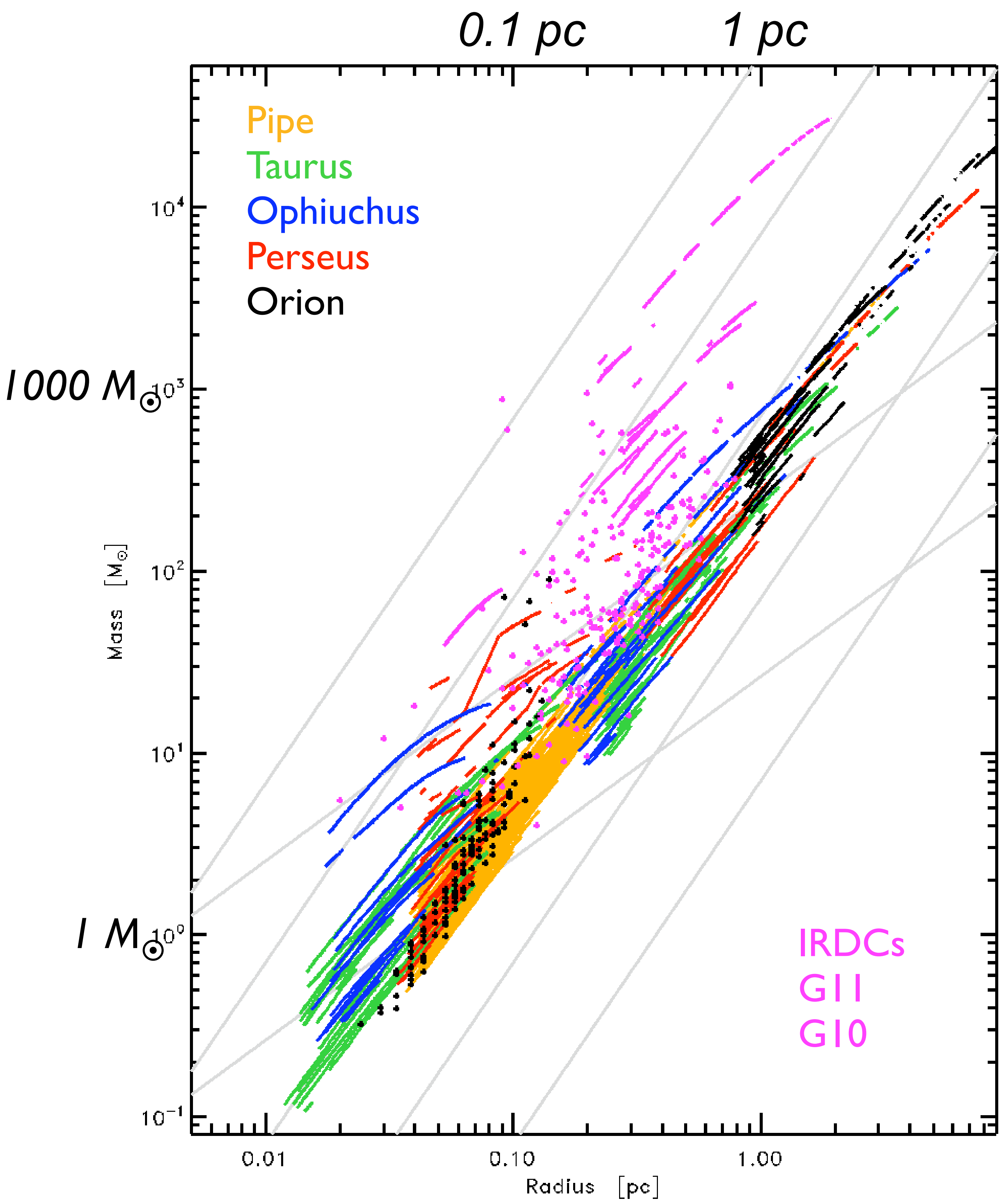
Are cores surrounded by smooth column density profiles? Or is there a sharp jump?

Jens Kauffmann (in prep.)

Related Cloud Physics



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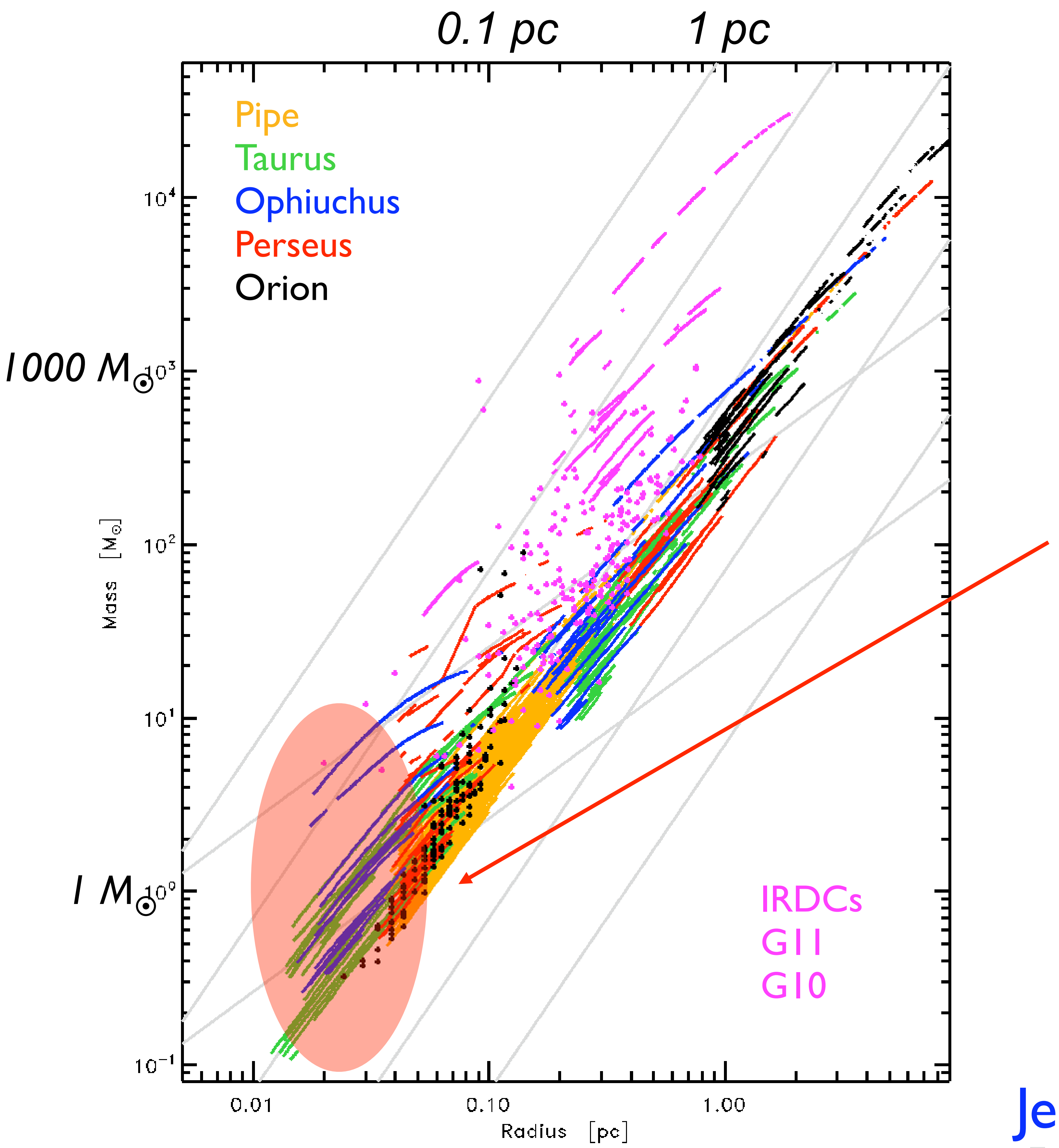

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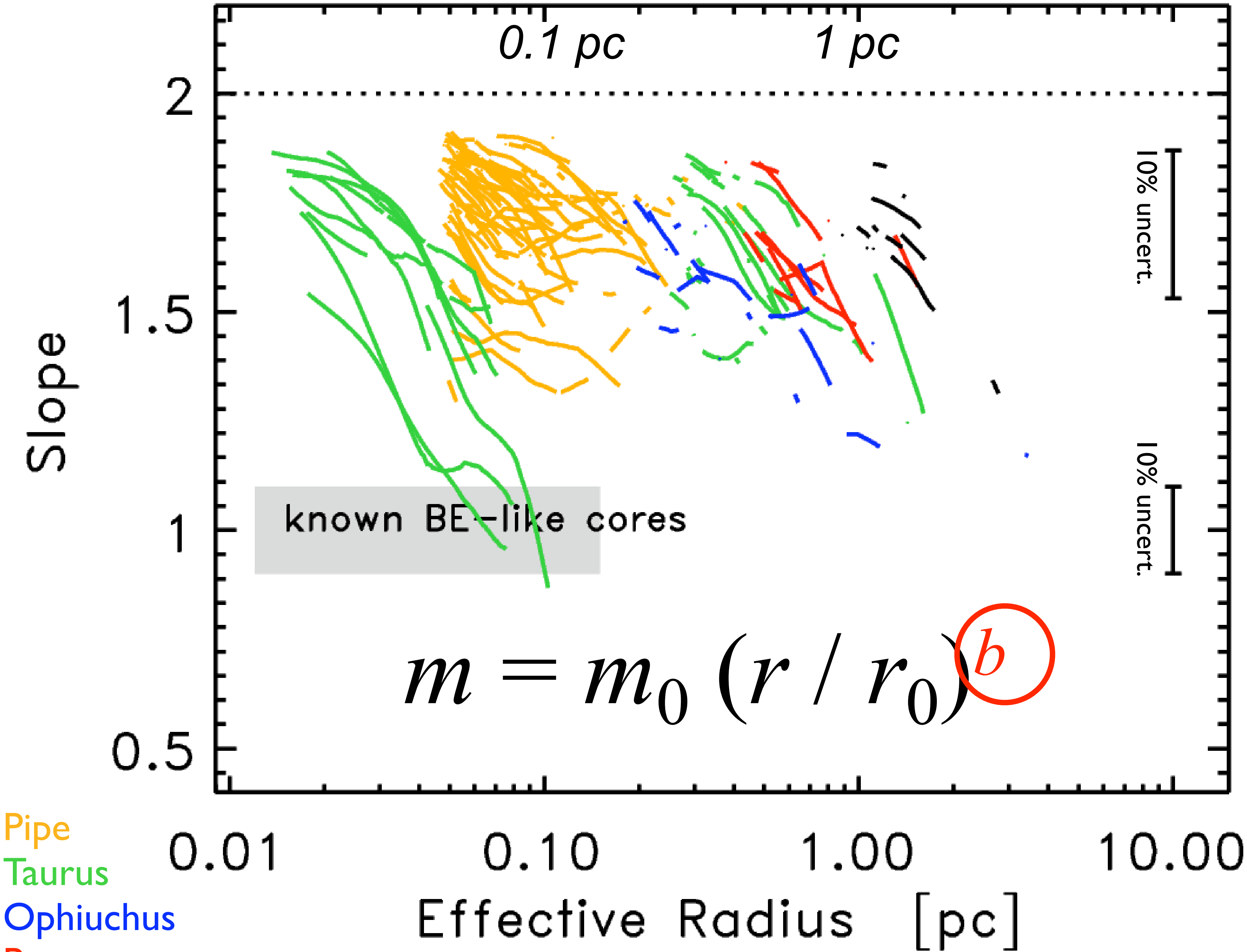
Jens Kauffmann (in prep.)

Detailed Cloud Physics I

first m-r slope measurement using single tracer/single region



$$m = m_0\,(r\,/\,r_0)^{\bigcirc\!\!\!\!b}$$

singular polytrope:

$\rho \propto r^{-k}$, $P \propto \rho^{\gamma}$

$\Rightarrow b = (4 - 3\gamma)/(2 - \gamma)$

$\Rightarrow \gamma$

$\Rightarrow$ cloud physics from b!

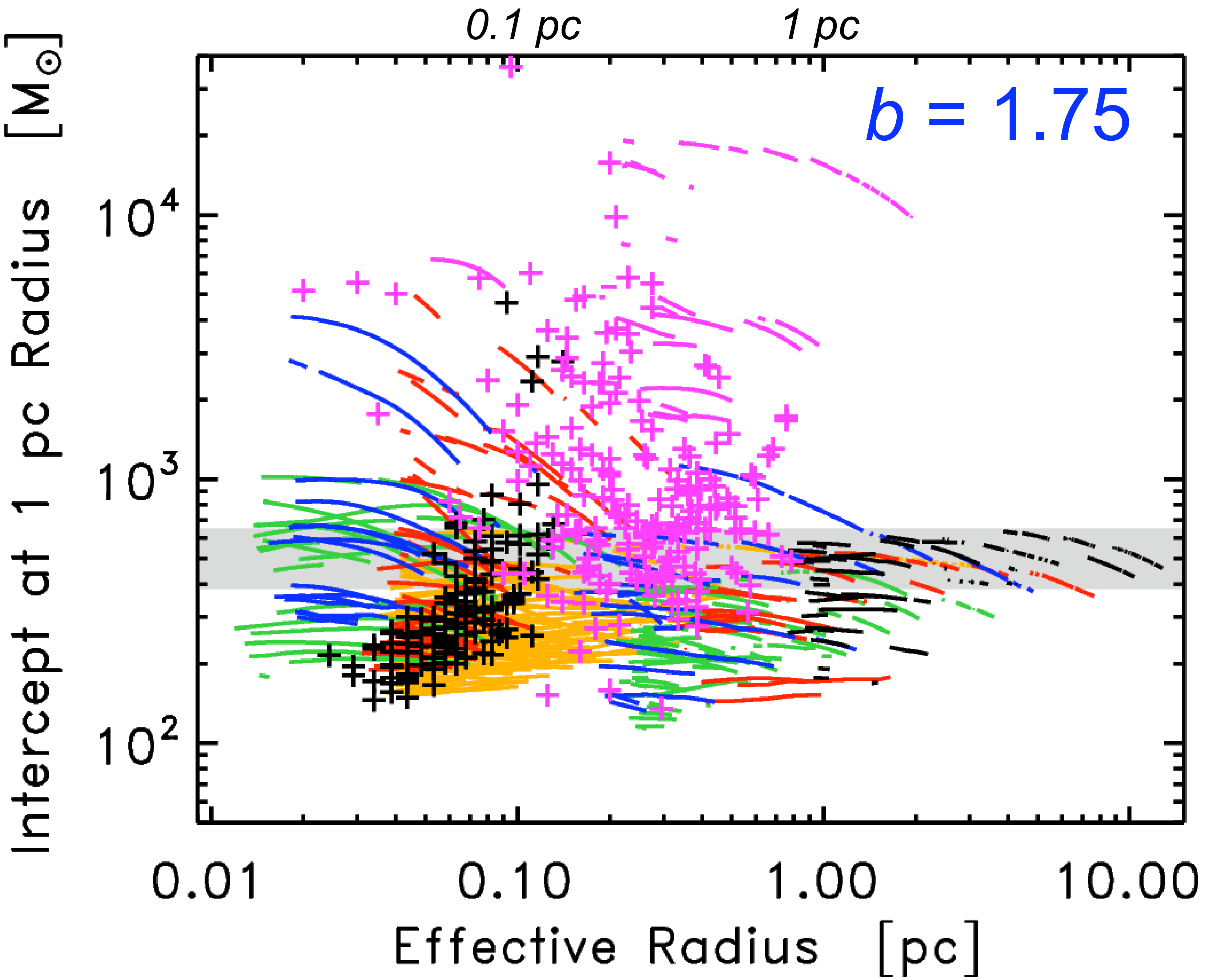
Jens Kauffmann (in prep.)

Detailed Cloud Physics II

IRDCs
G11
G10

Pipe
Taurus
Ophiuchus
Perseus
Orion

m = 500 $M_\odot$ $(r/pc)^{1.75}$ as a limiting relation…



- describes all nearby clouds on large scales
- describes Pipe on all scales
- regions forming massive stars and clusters must evolve with b < 1.75 at intermediate radii

$$m = \boxed{m_0}(r / r_0)^b$$

Jens Kauffmann (in prep.)

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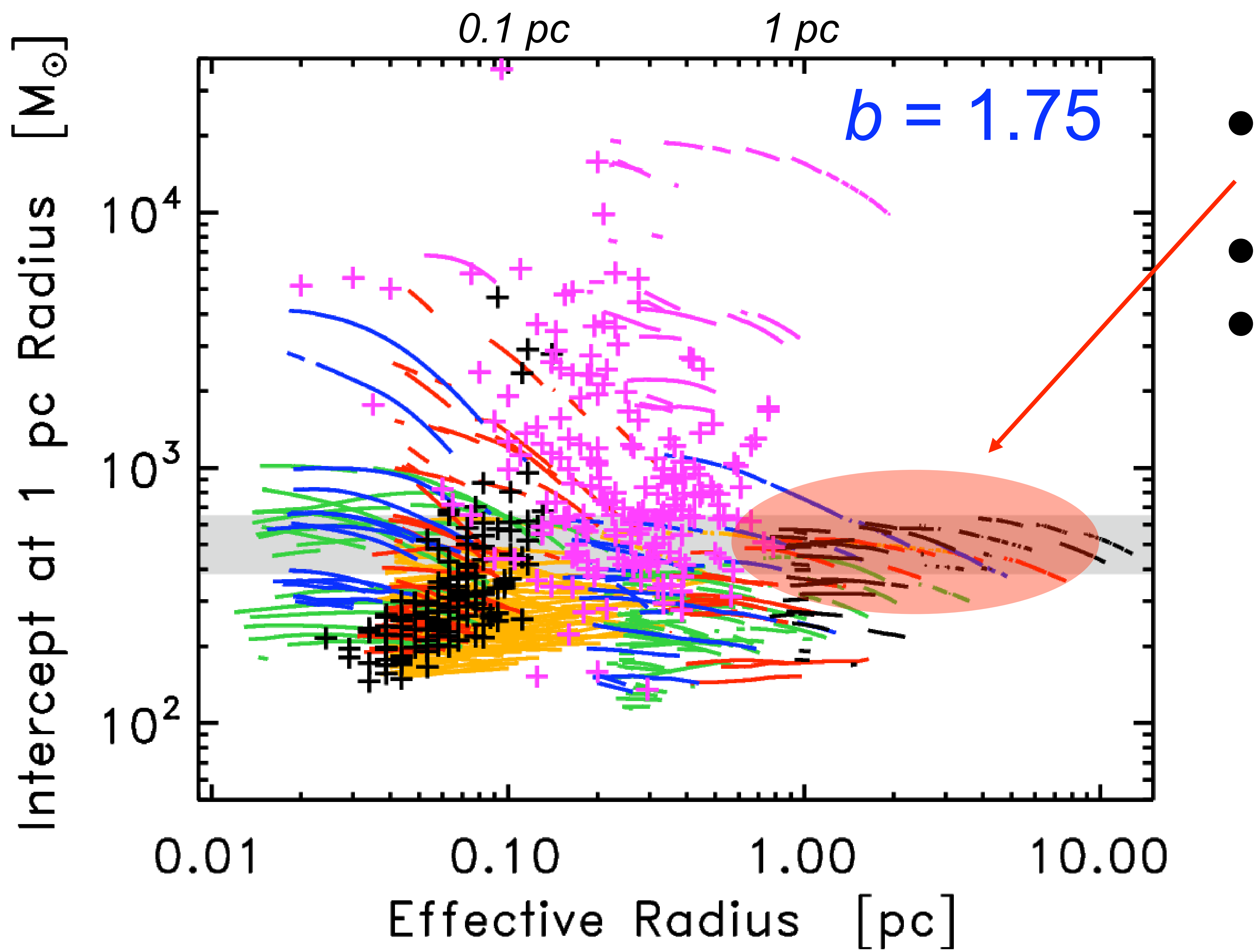

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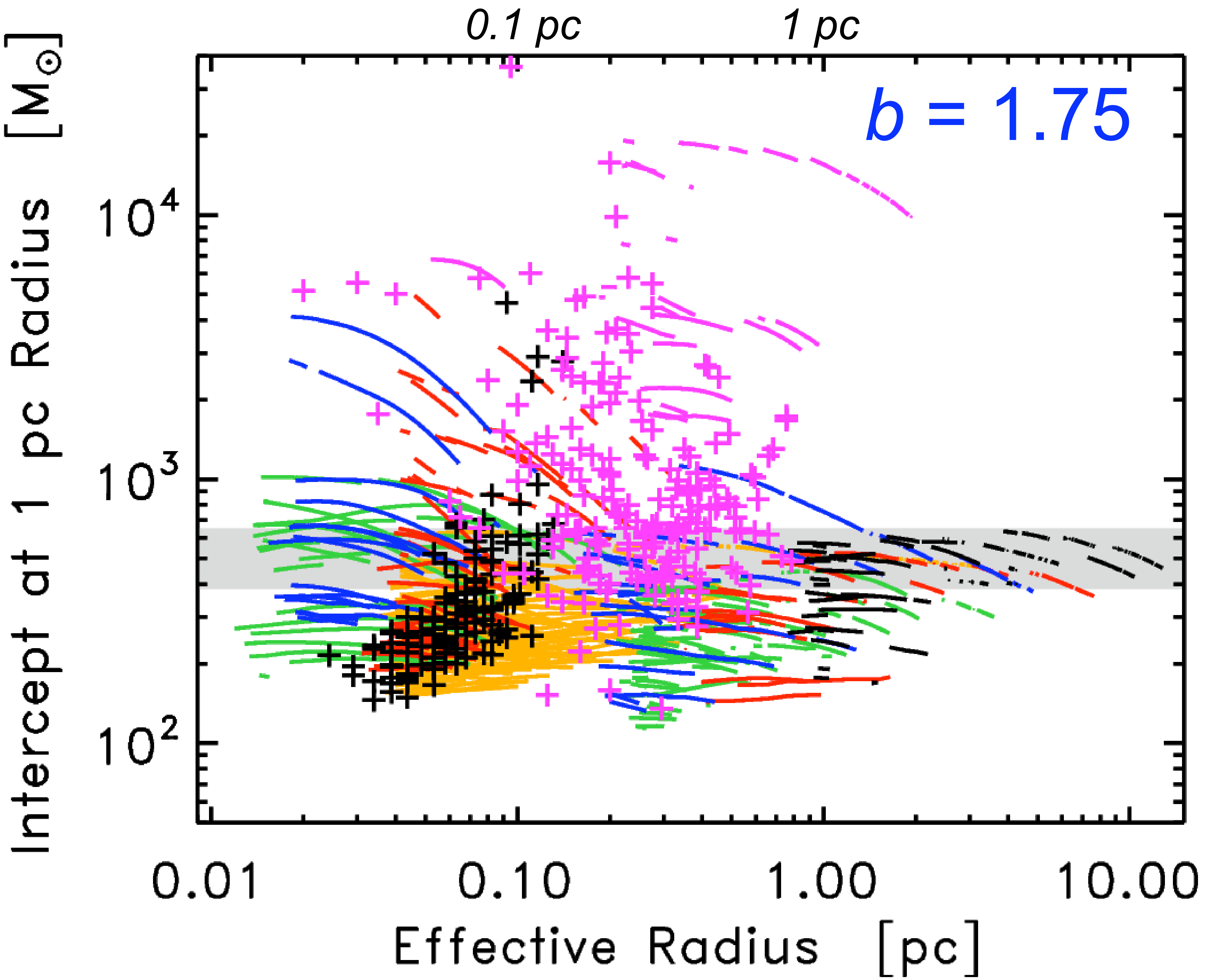

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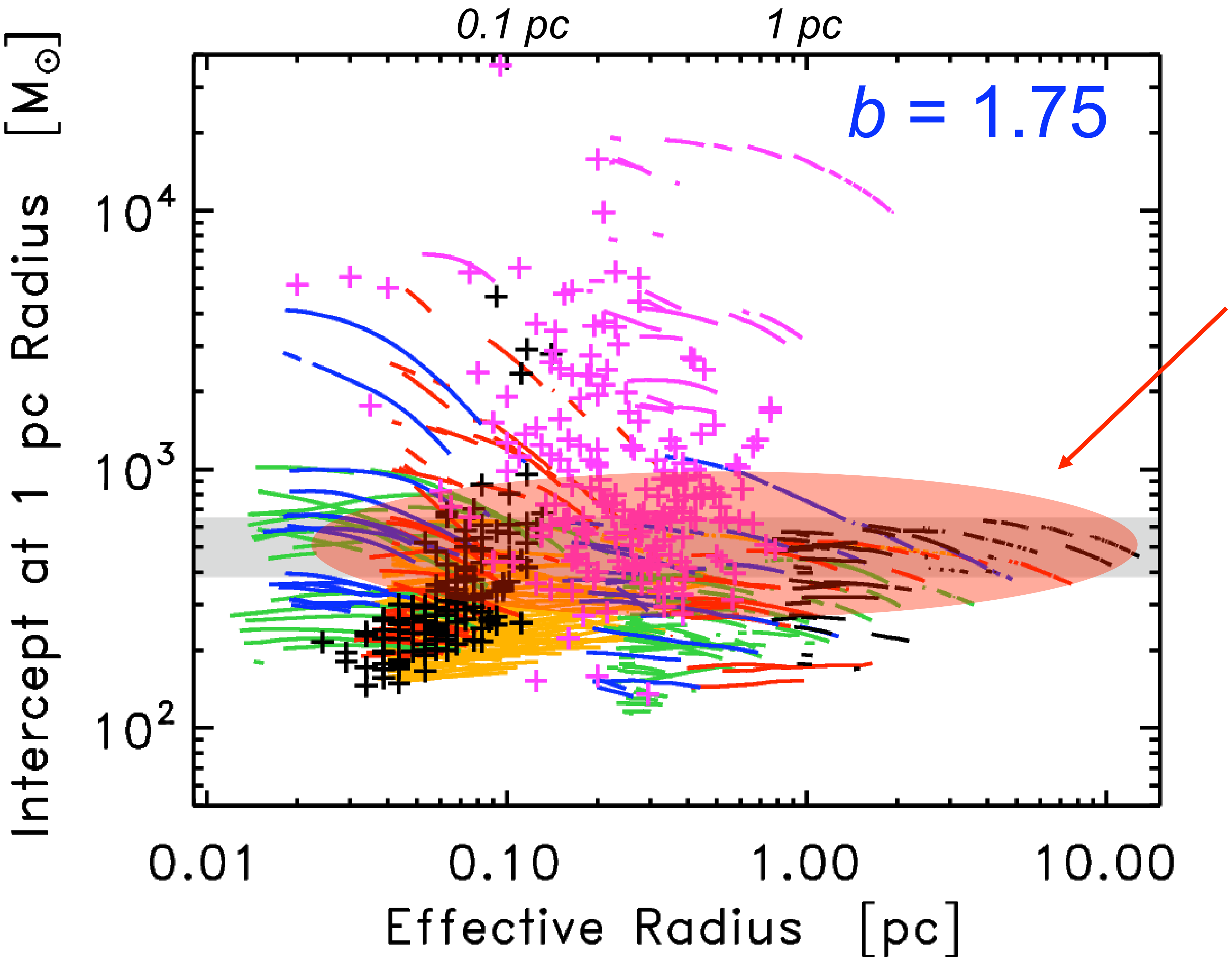

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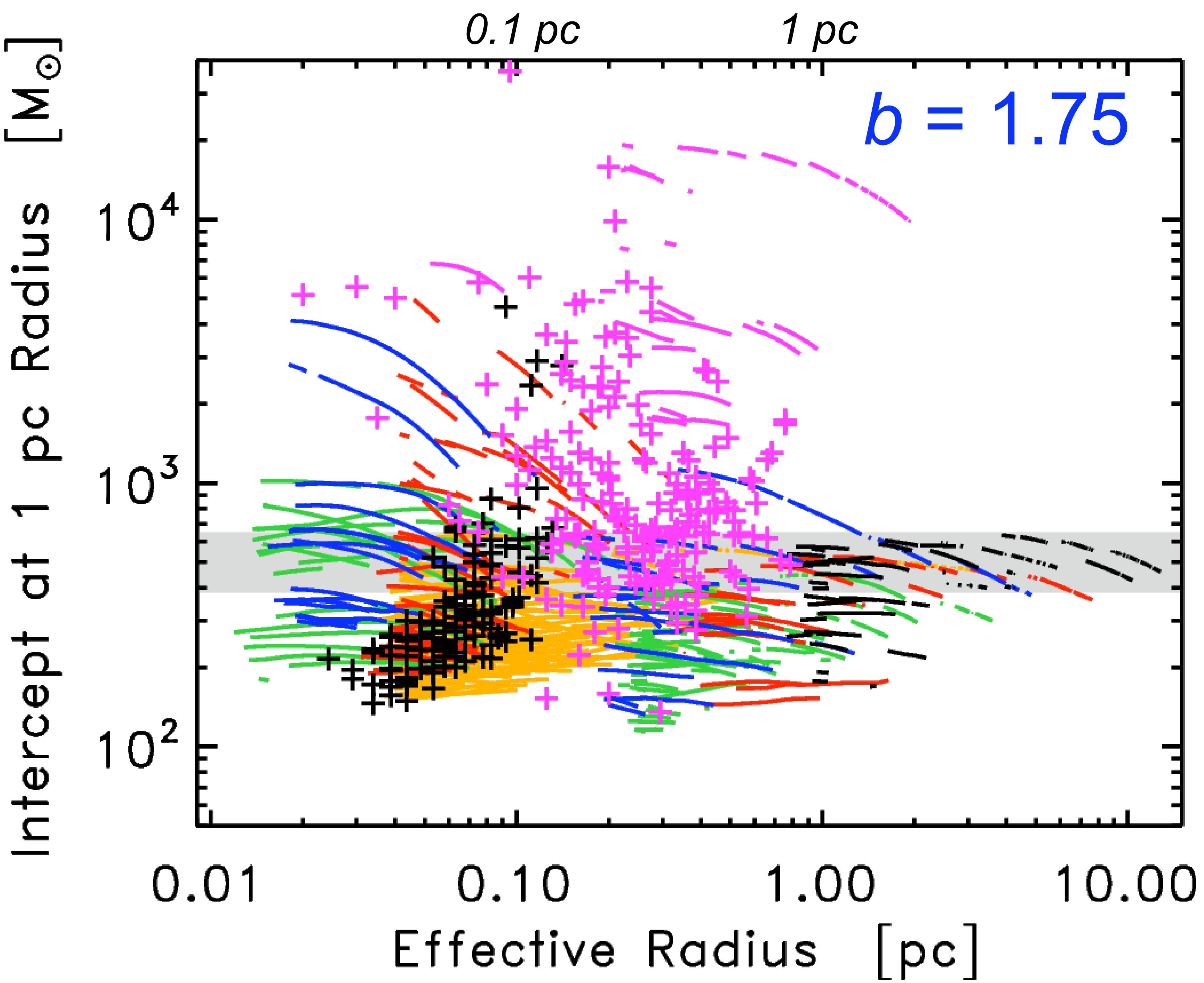

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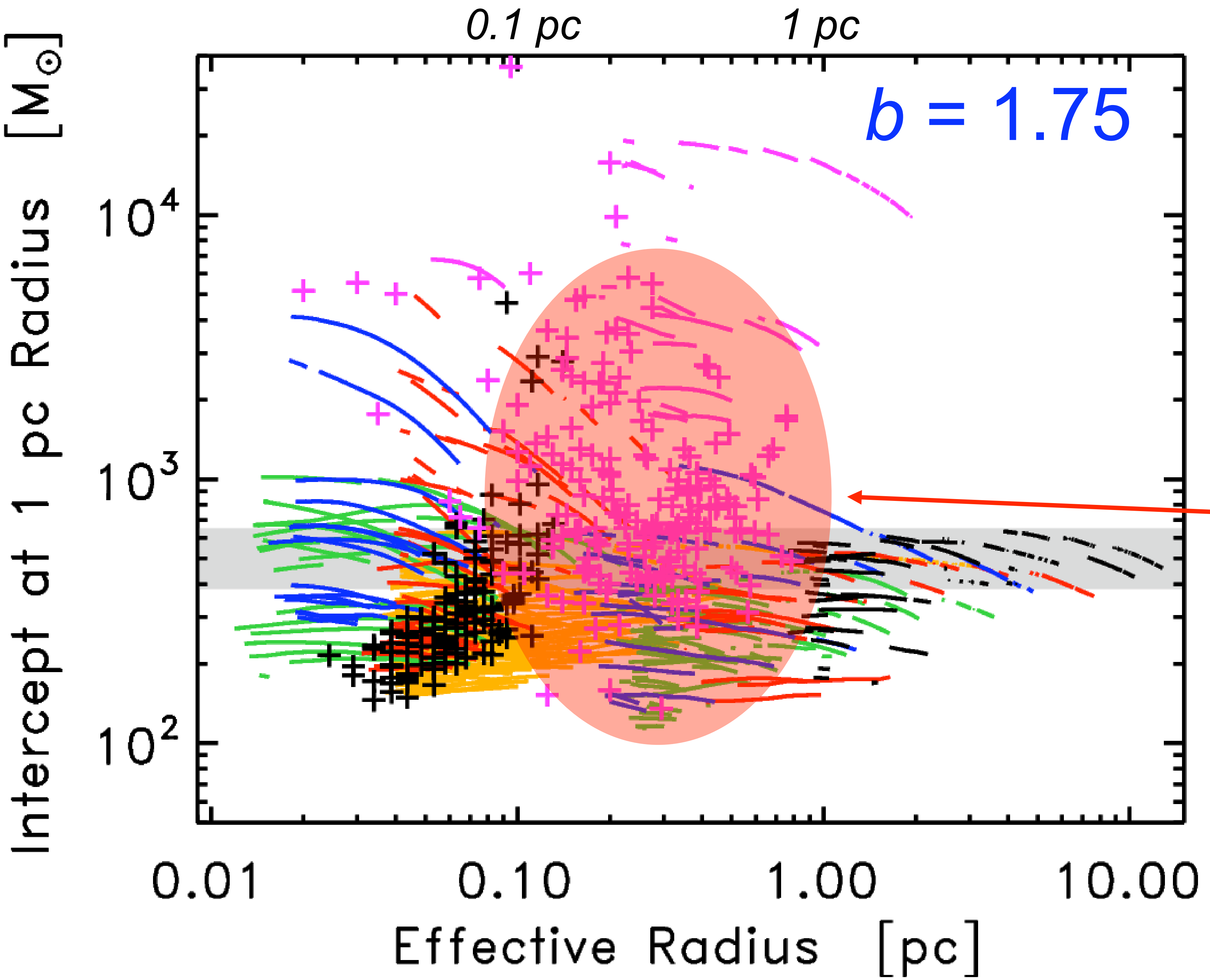

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radius range and slope reflect cloud physics

$$m = m_0 (r / r_0)^b$$

Jens Kauffmann (in prep.)