The Dialogue with Observation: New Tools and Data Sets to Study Molecular Cloud Evolution

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Collaborators

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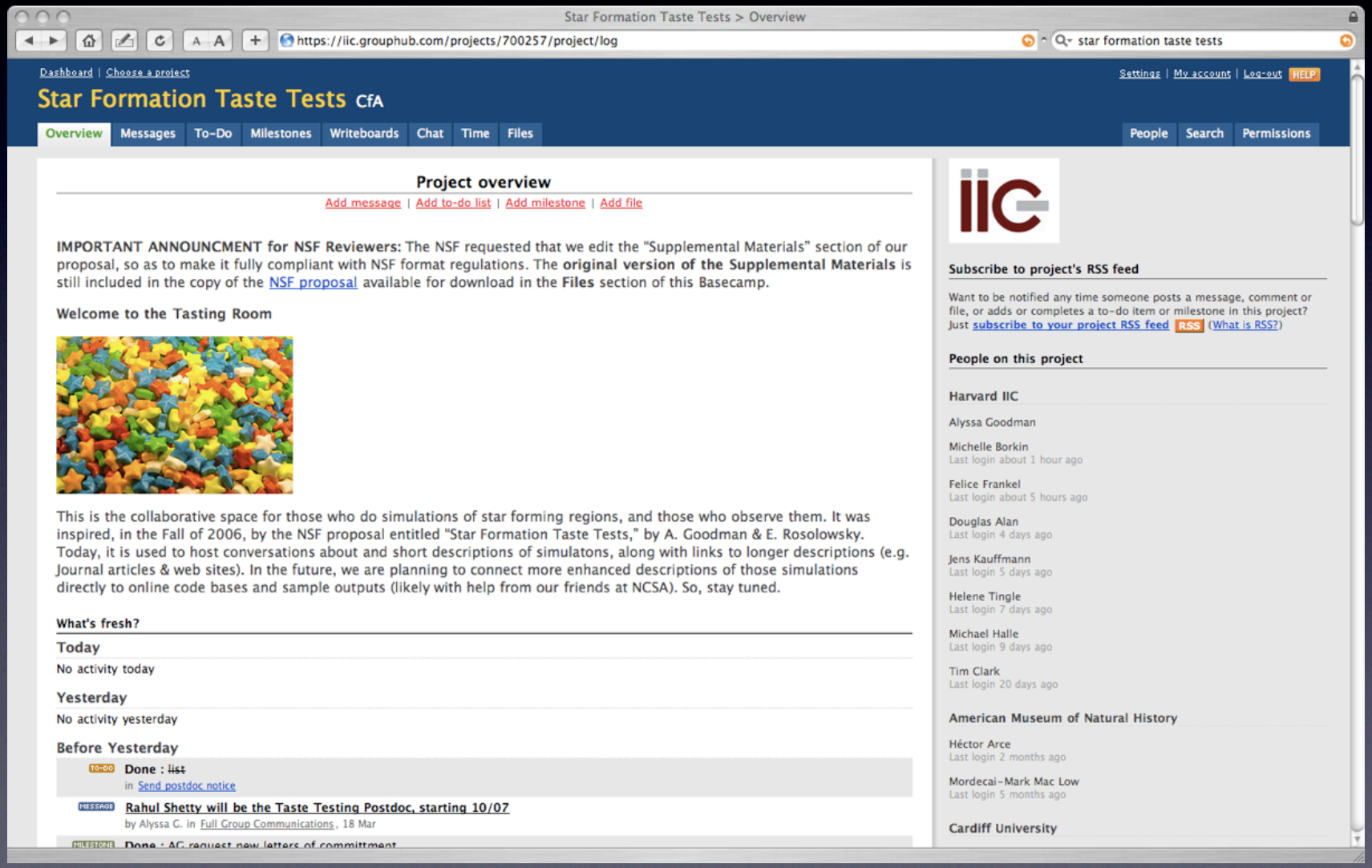
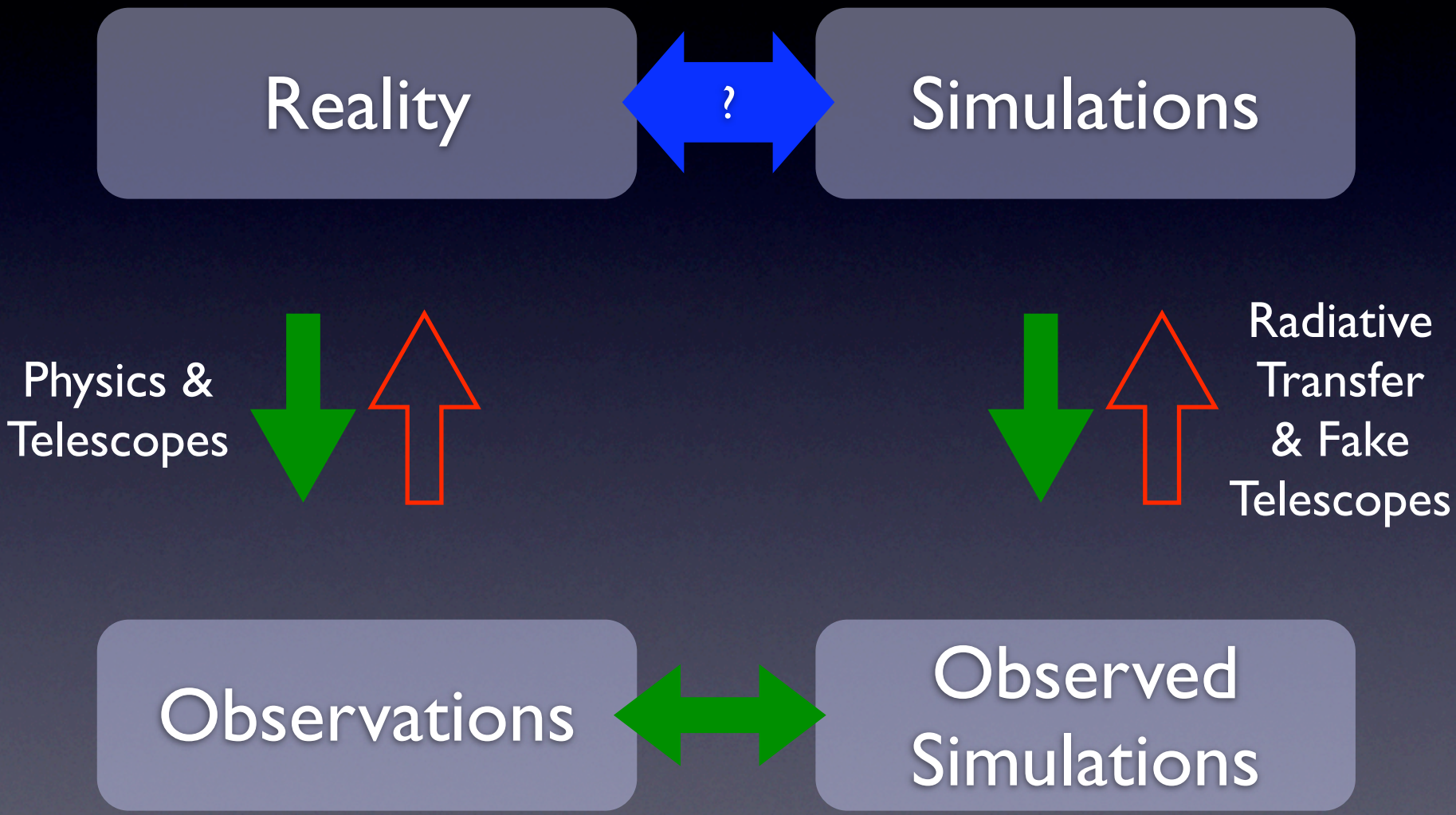
The Taste Testing Project



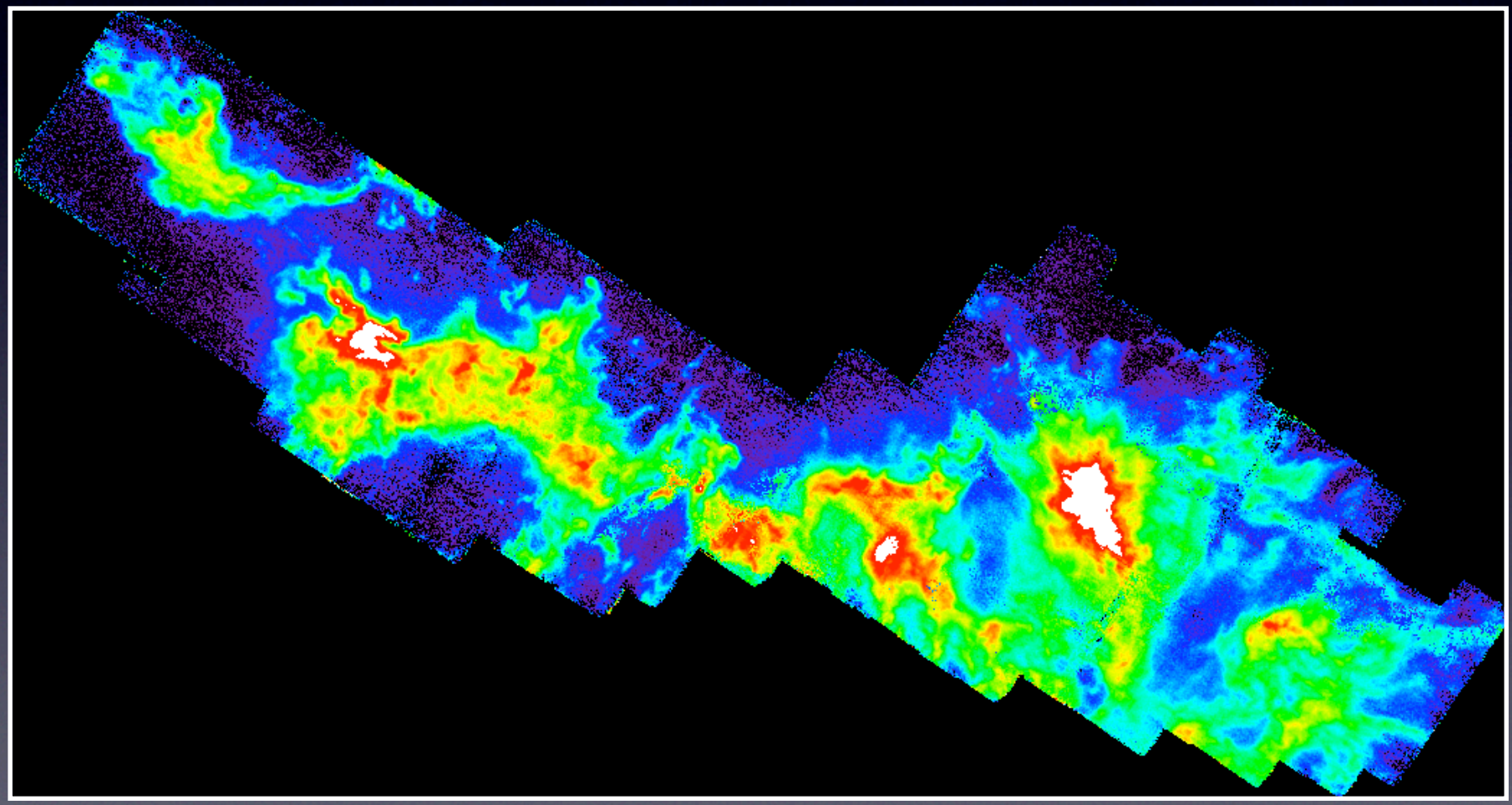
Domains in Astronomy



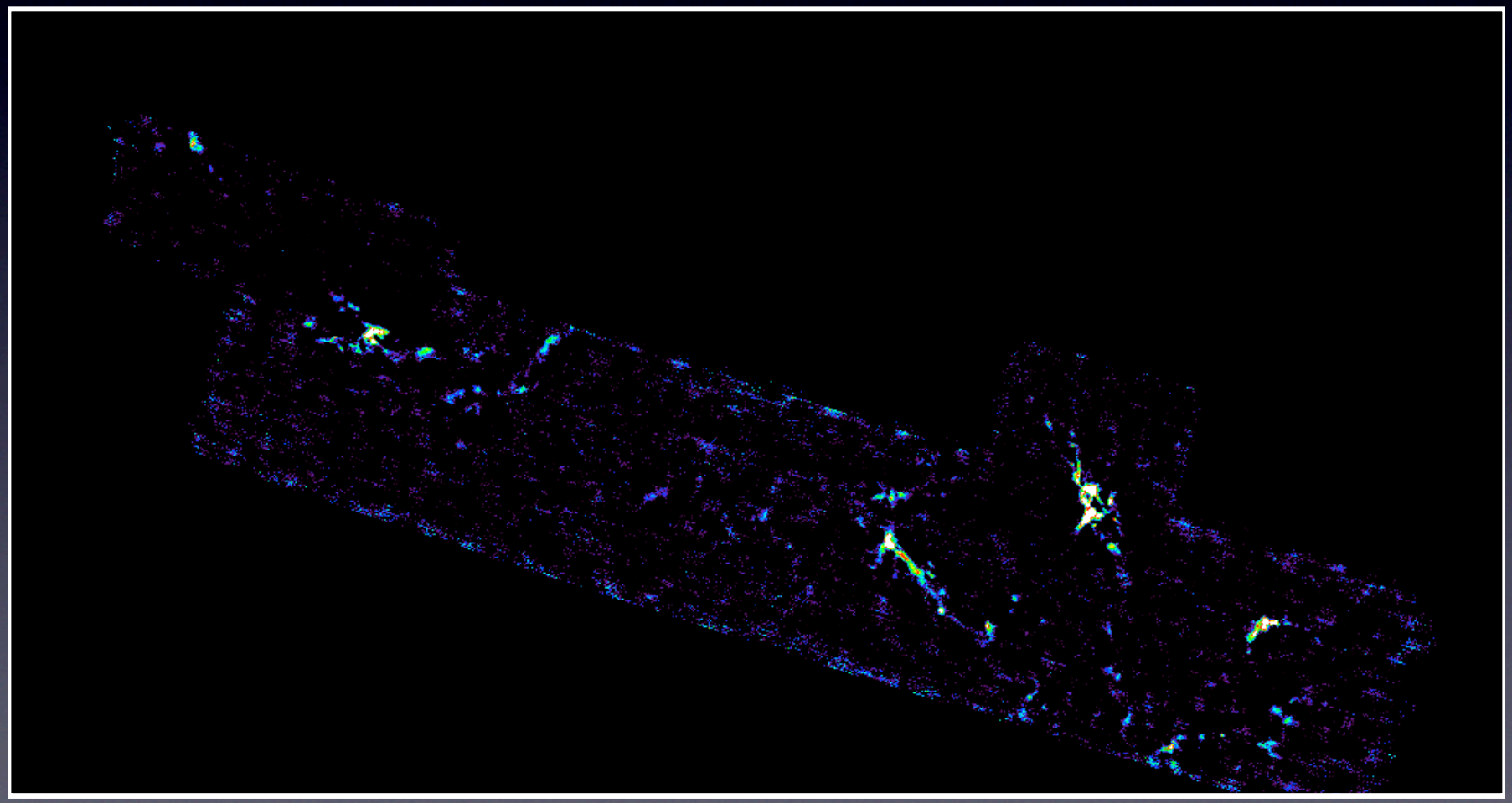
Talk Outline

- Dense Core Ensemble Properties
- Hierarchical Structure in Molecular Emission
- Conclusions & Solicitations

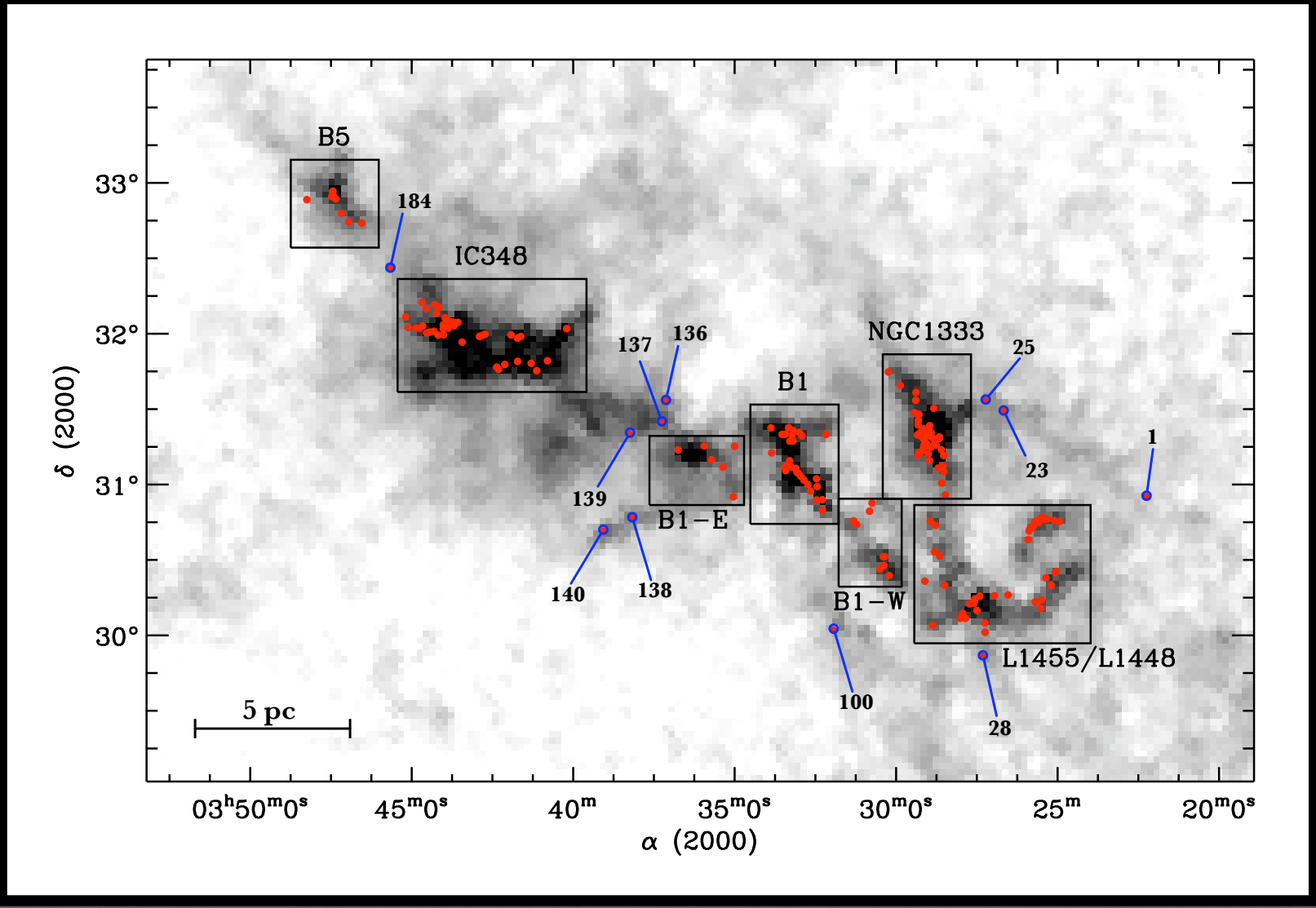
Dense Cores in Perseus



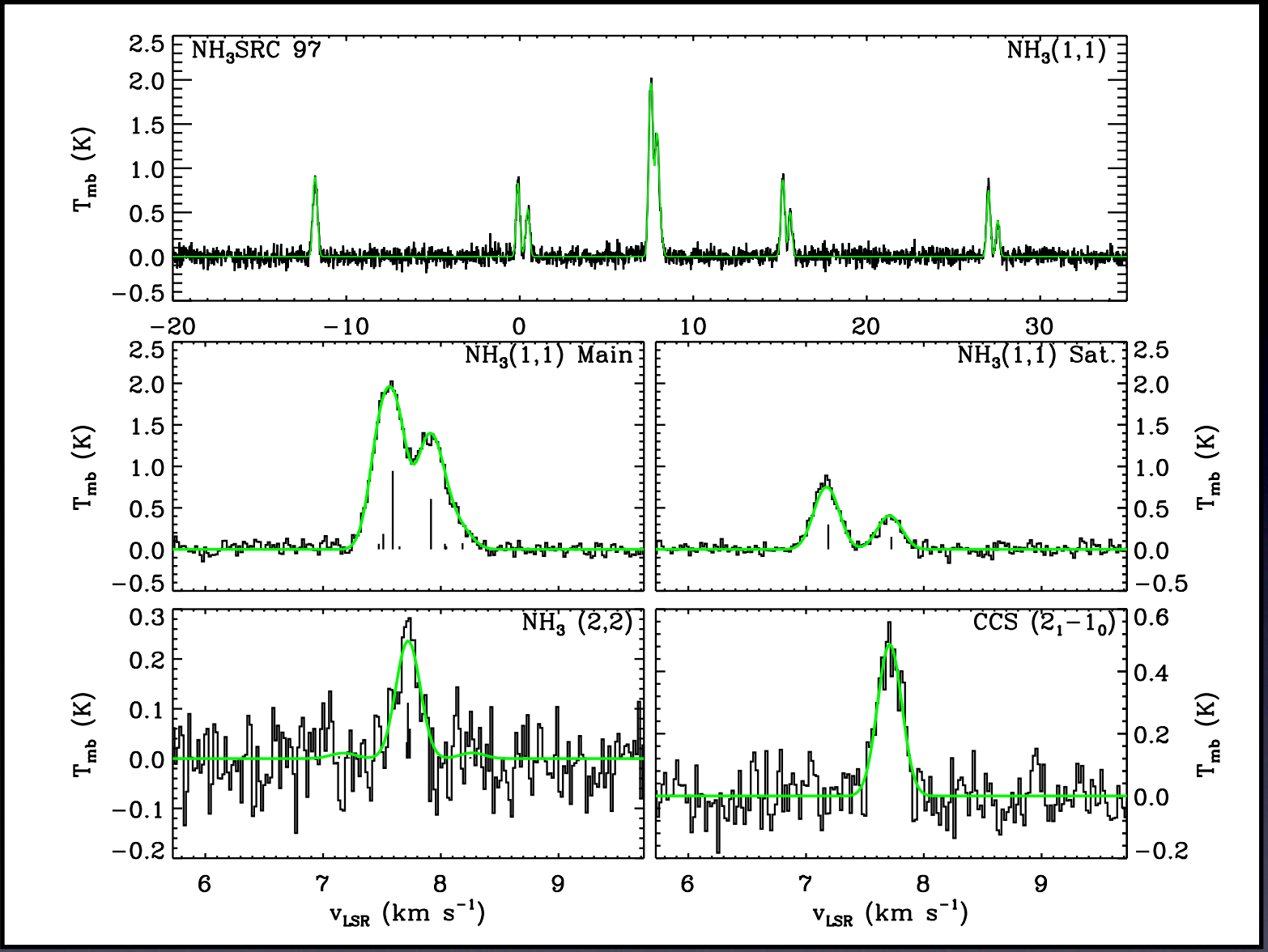
Dense Cores in Perseus



Dense Cores in Perseus

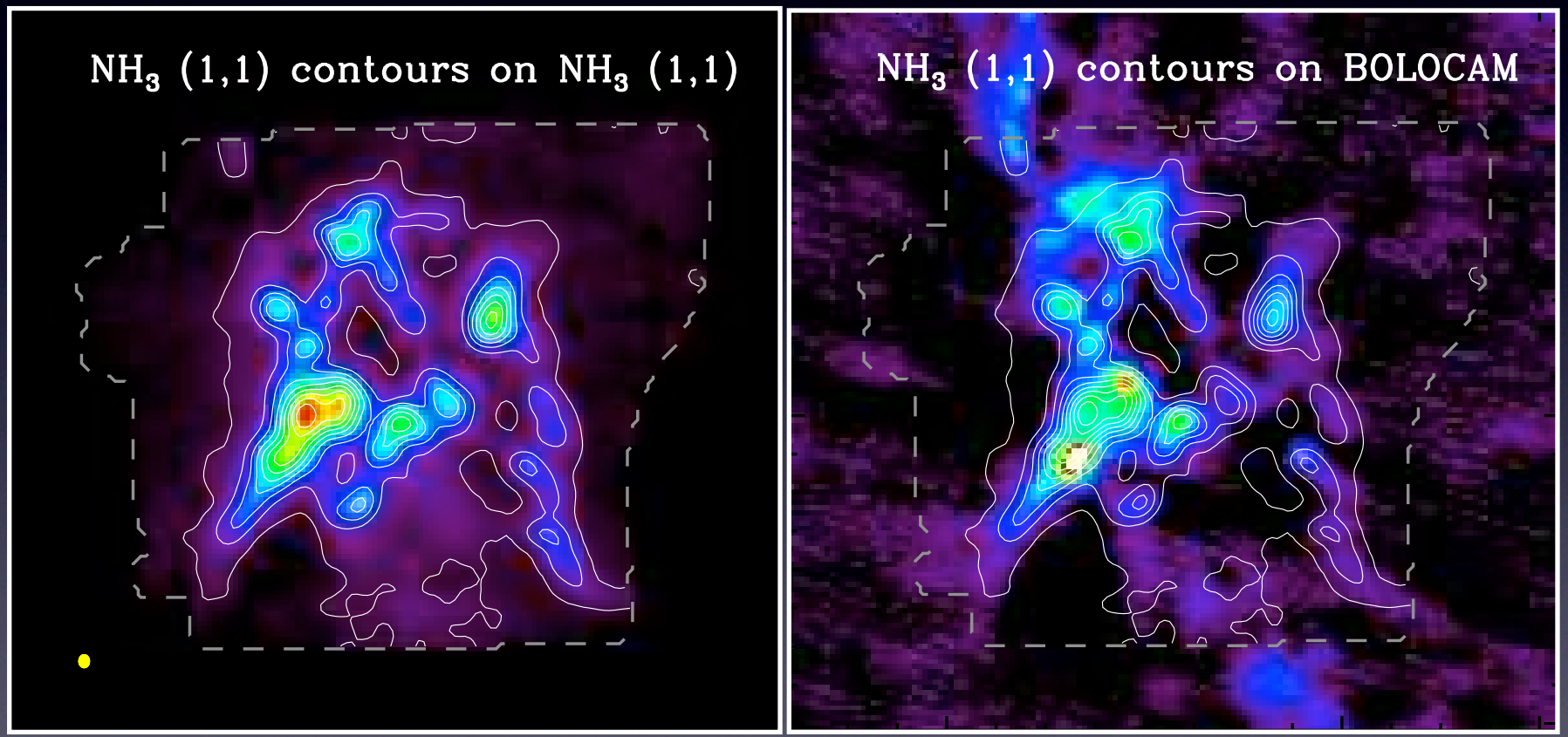


- 193 Dense cores
- Drawn from (sub)mm emission, FIR features.
- Close to complete survey of dense core properties in a molecular cloud.
- Observations in $NH_3(1,1)$, $NH_3(2,2)$ and C_2S.
- C_2S traces early time vs. NH_3 traces late time.
- Starless vs. Protostellar information from c2d.



Fit for T_k, σ_v, v_{lsr}, τ, T_{ex}, $N(NH_3)$, $N(C_2S)$ (plus R, M from dust continuum)

Dust continuum vs. NH_3

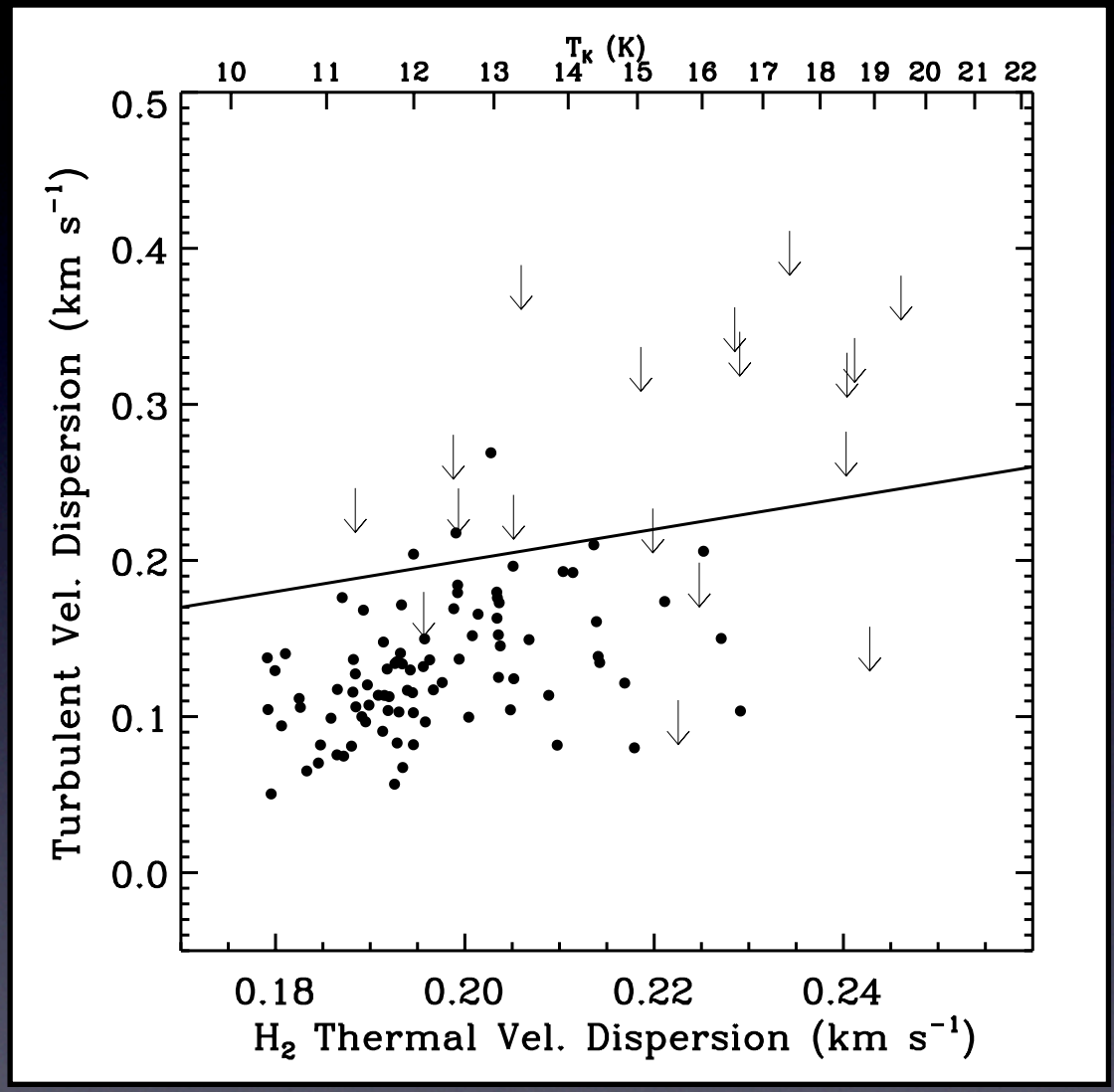


NGC 1333

Core Line Width

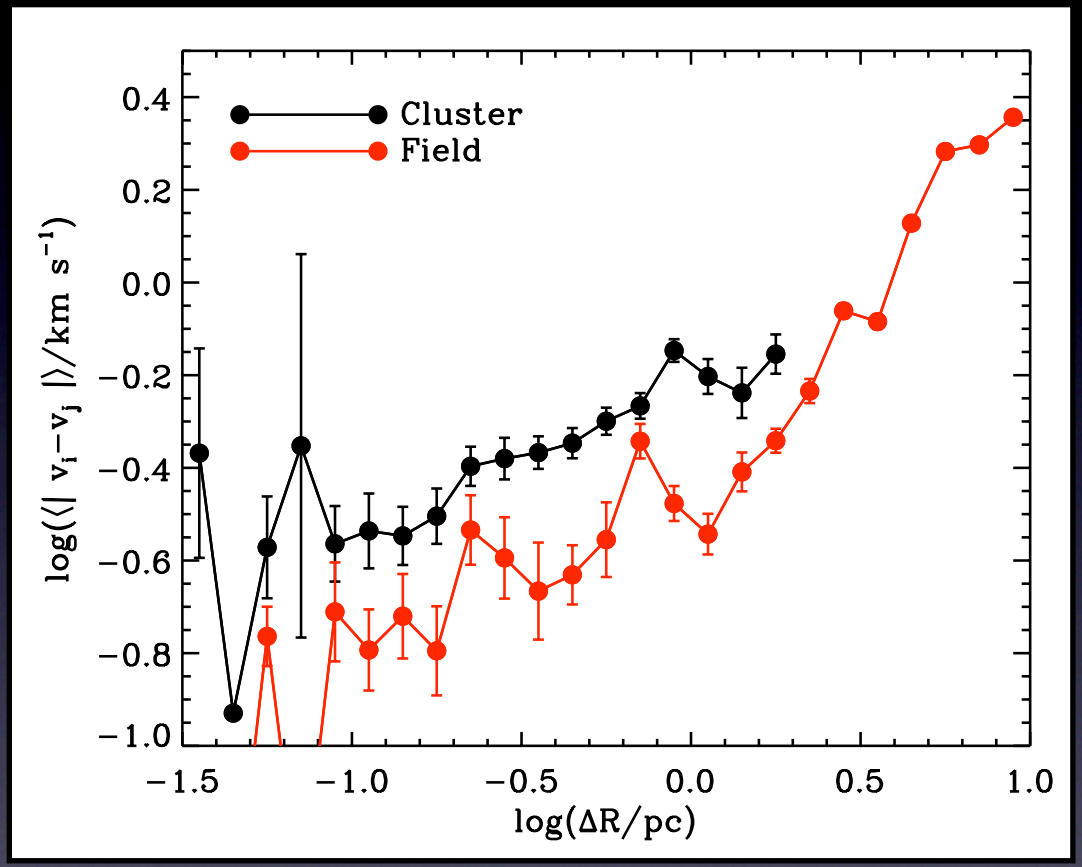
Comparisons of thermal and non-thermal contributions to the line width.

Most cores have subsonic nonthermal motions.



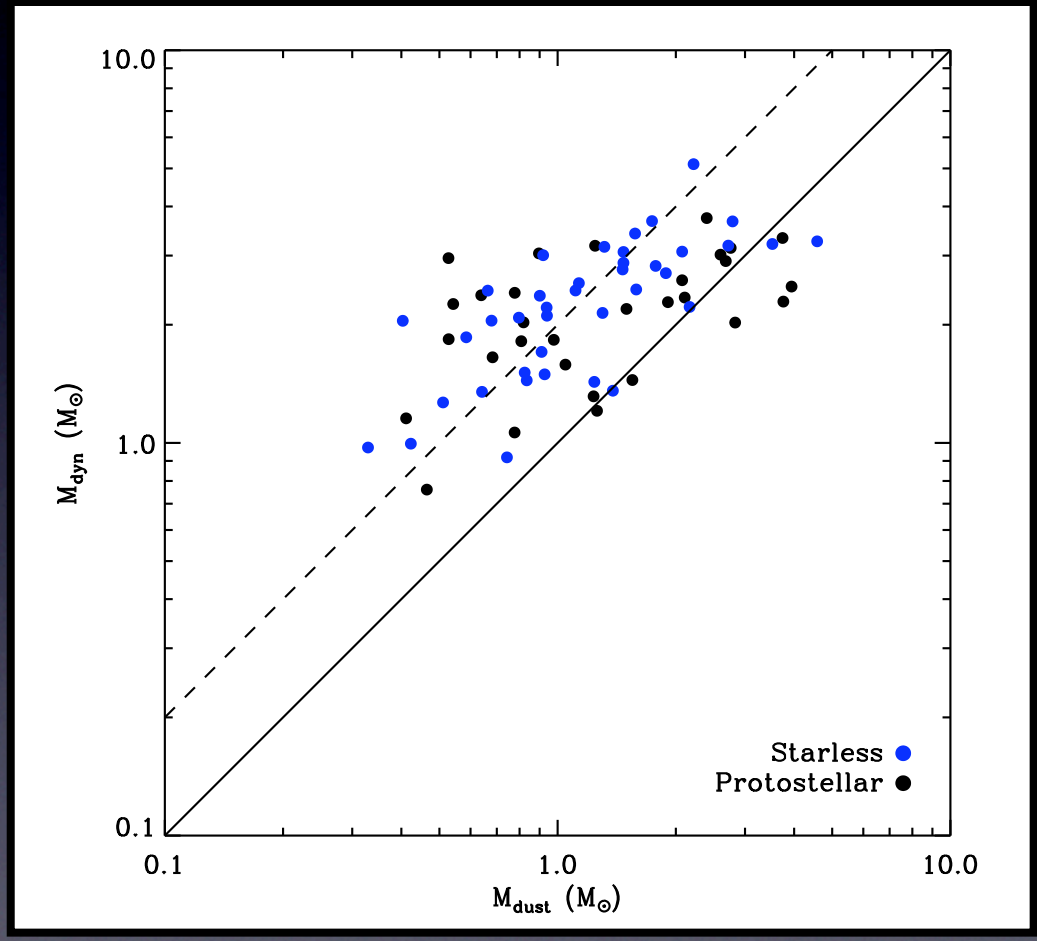
Velocity Structure Functions

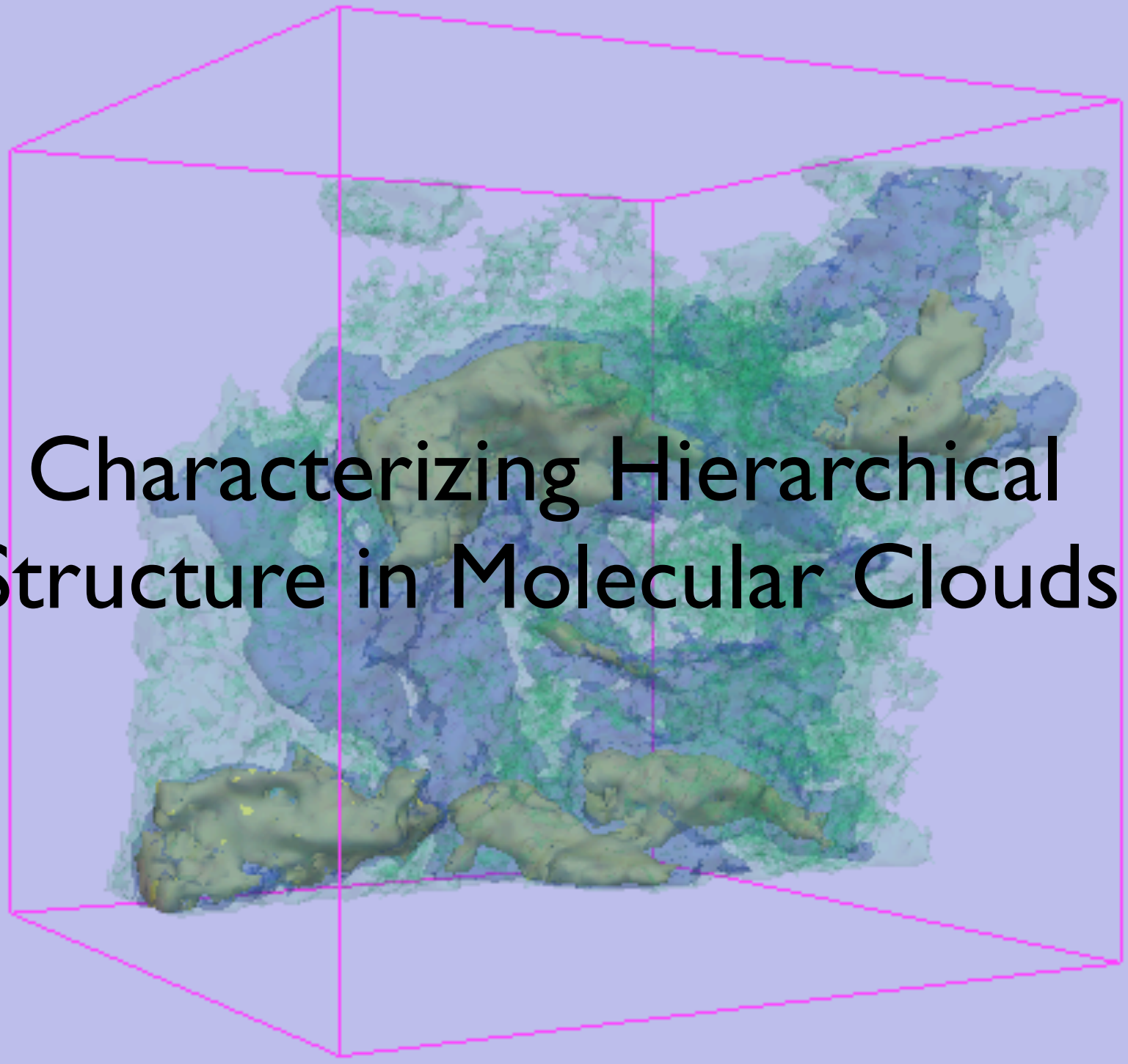
Measure the relative motions of of dense cores relative to each other.



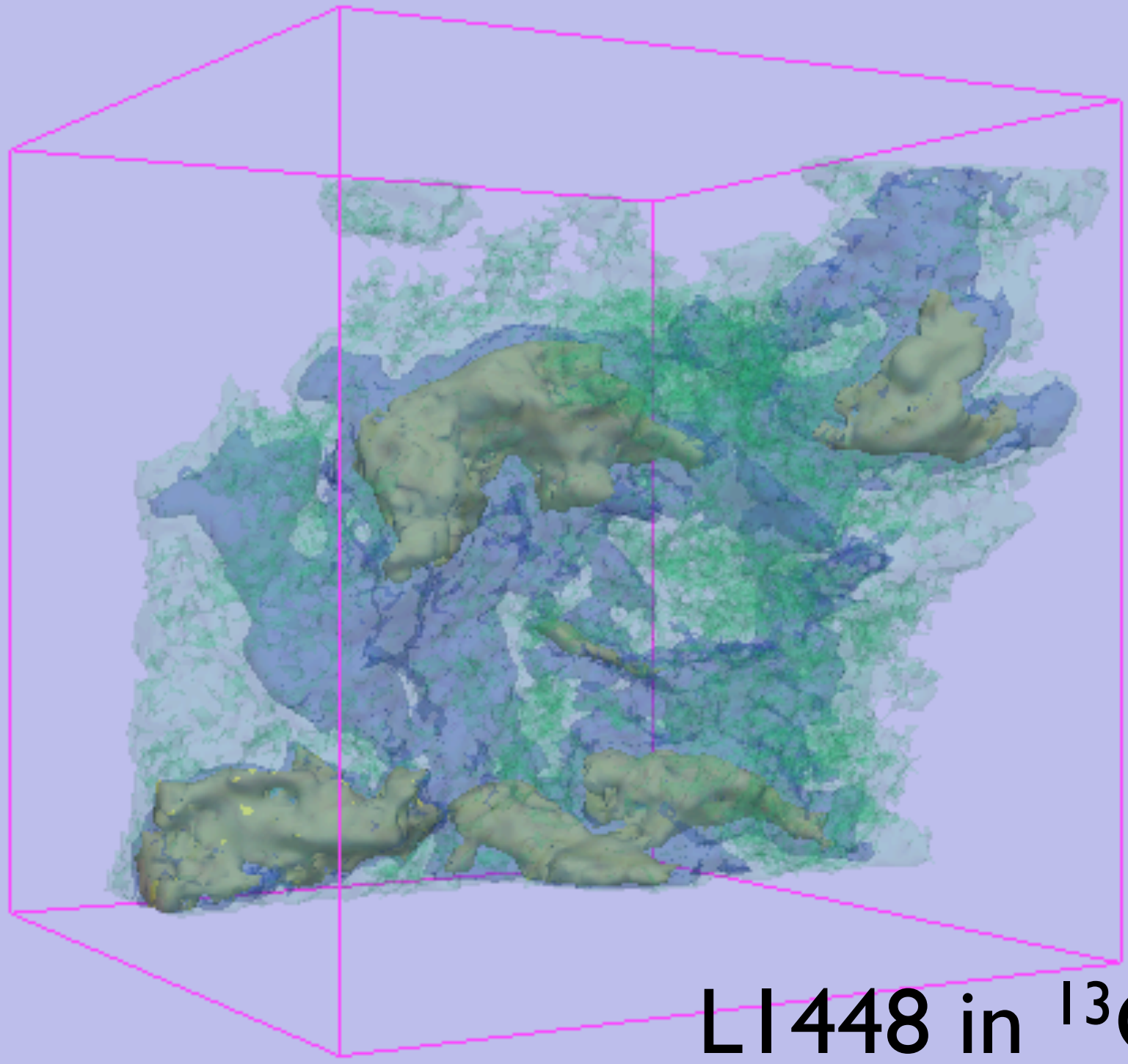
Dynamical State of Dense Cores

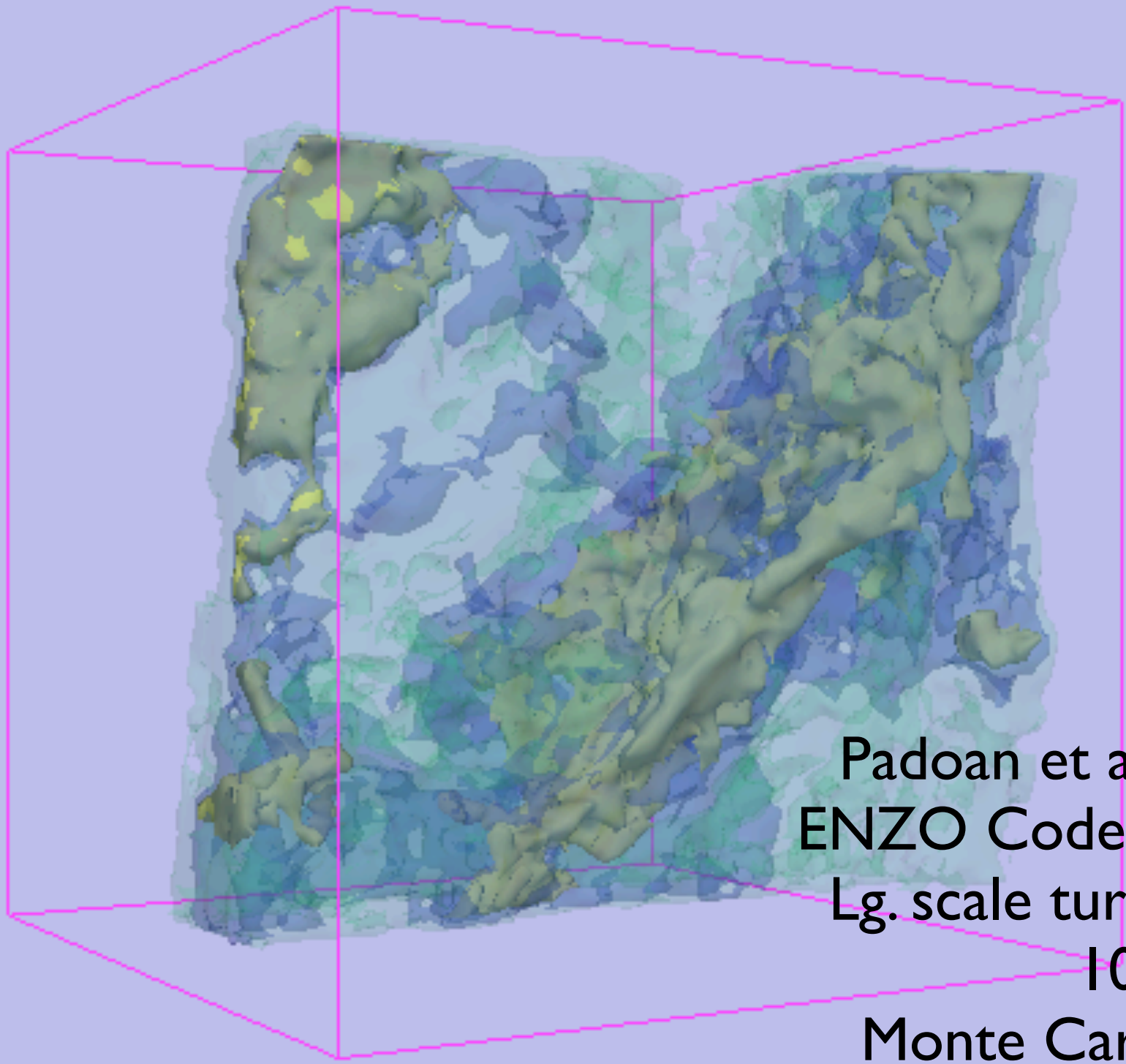
- Compare dynamical and luminous mass values.
- Luminous mass and size from dust continuum
- Line width from NH_3 data
- Stellar content from c2d
- NO external pressure in mass est.



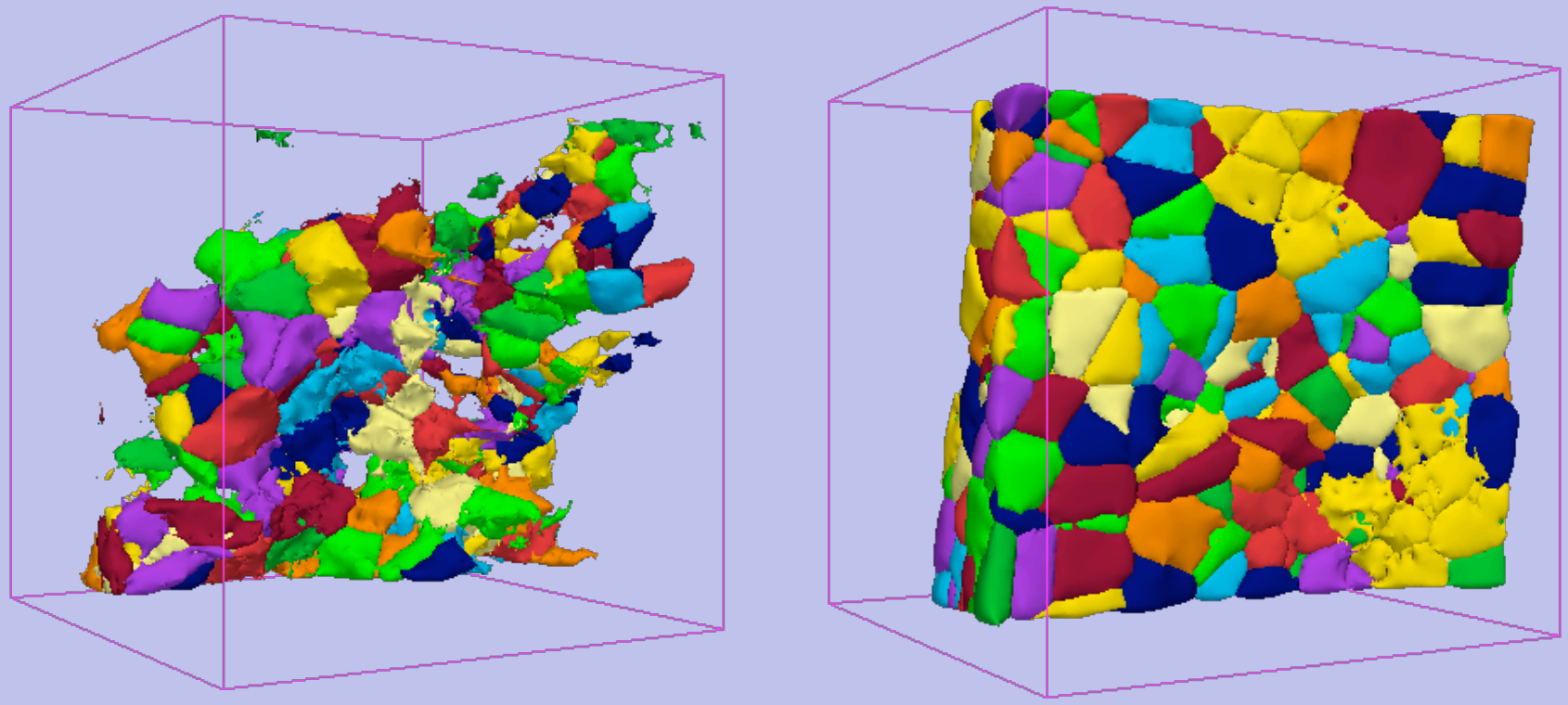


Characterizing Hierarchical Structure in Molecular Clouds


L1448 in ^{13}CO

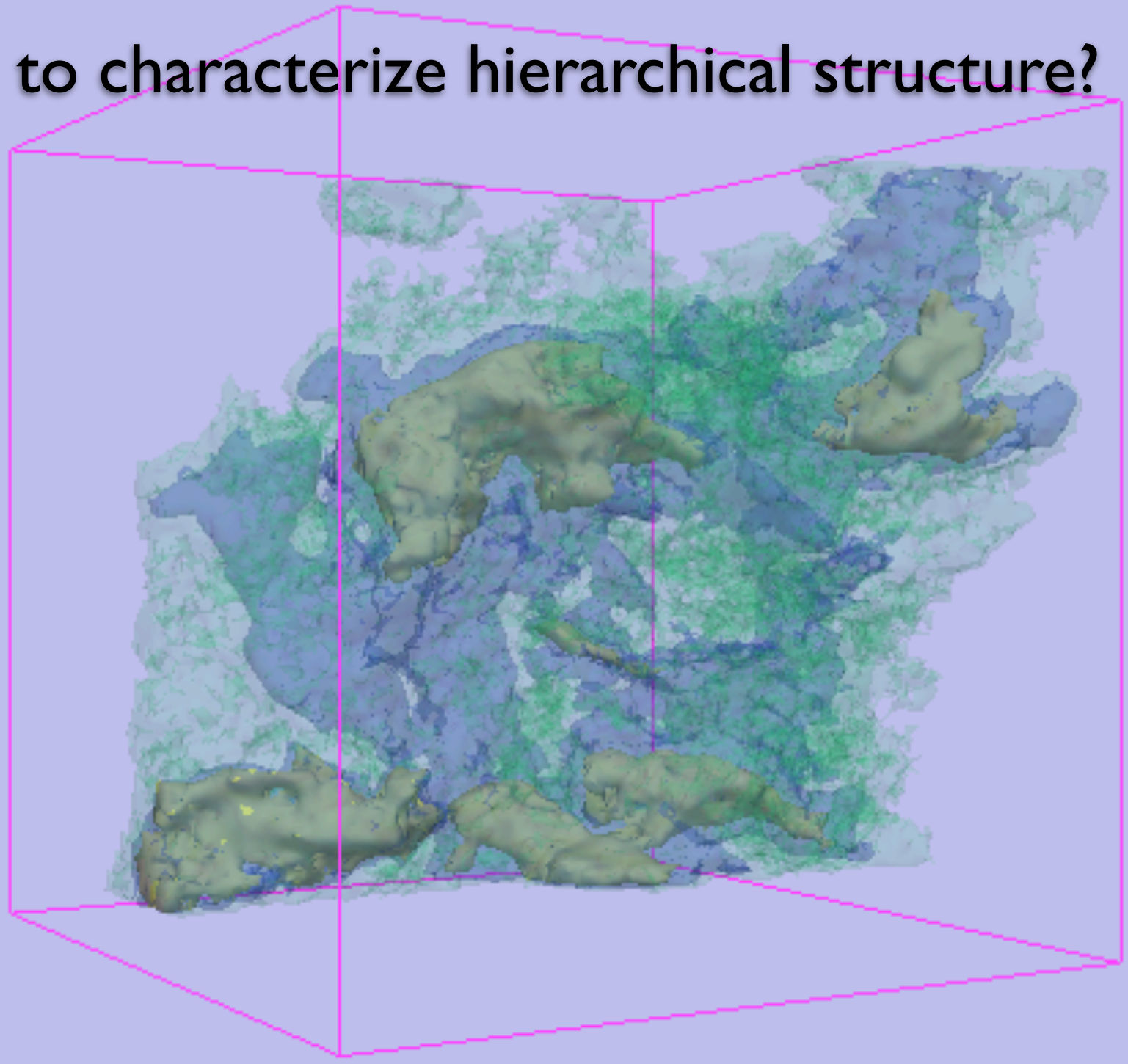


Padoan et al. simulations.
ENZO Code (Eulerian, HD)
Lg. scale turbulent driving
1024^3
Monte Carlo Rad. Xfer



The industry standard CLUMPFIND segments the emission into small scale objects governed by structure (specifically, the local maxima) in the emission cube.

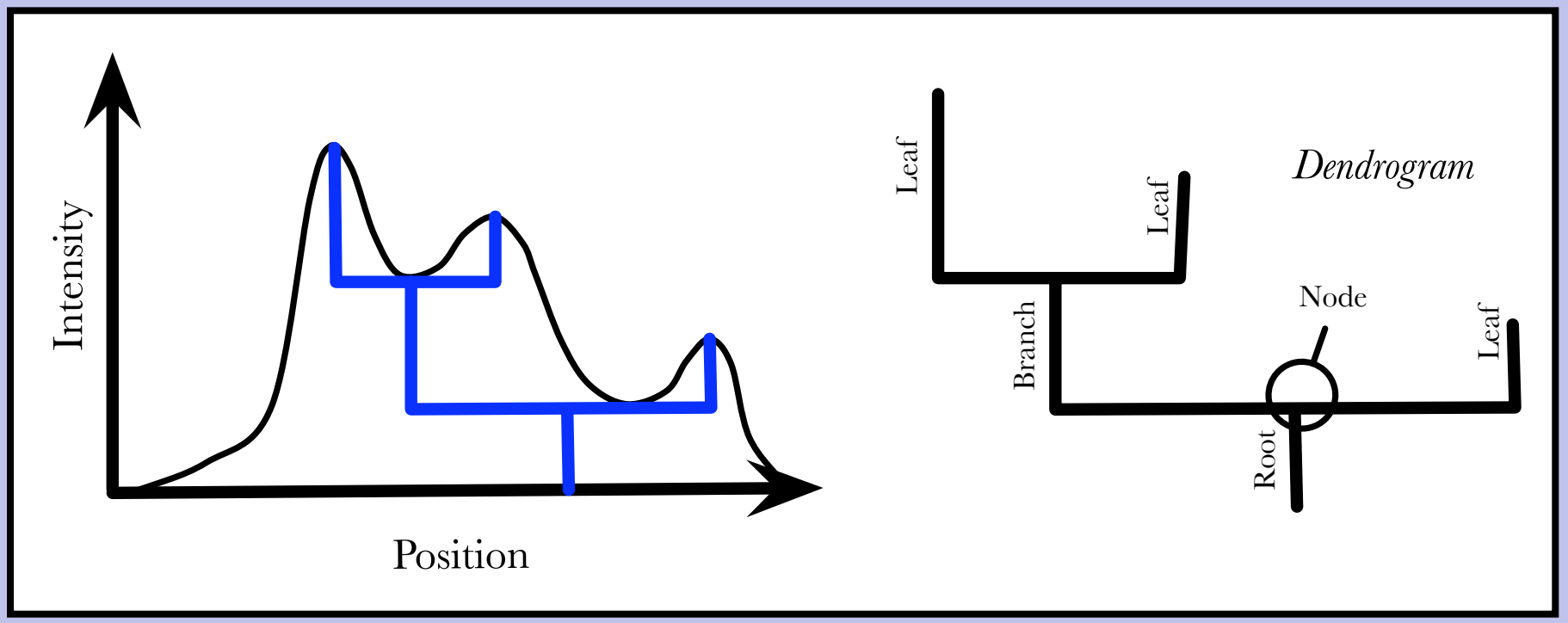
How to characterize hierarchical structure?



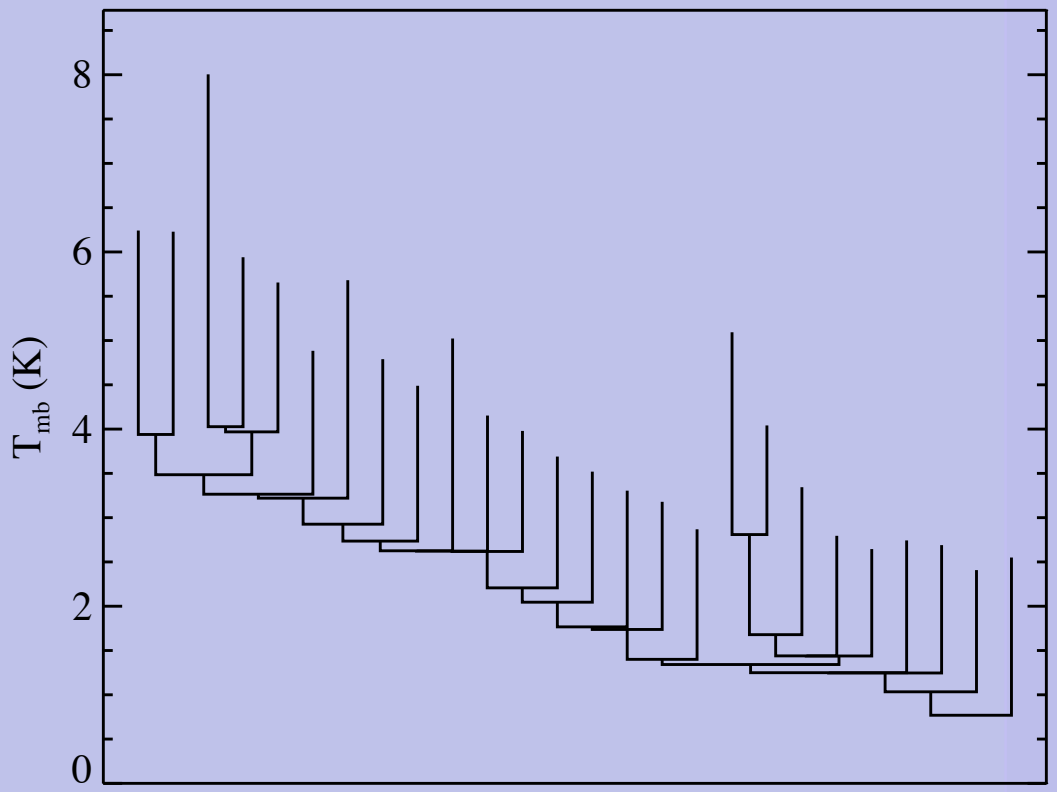
Dendrograms

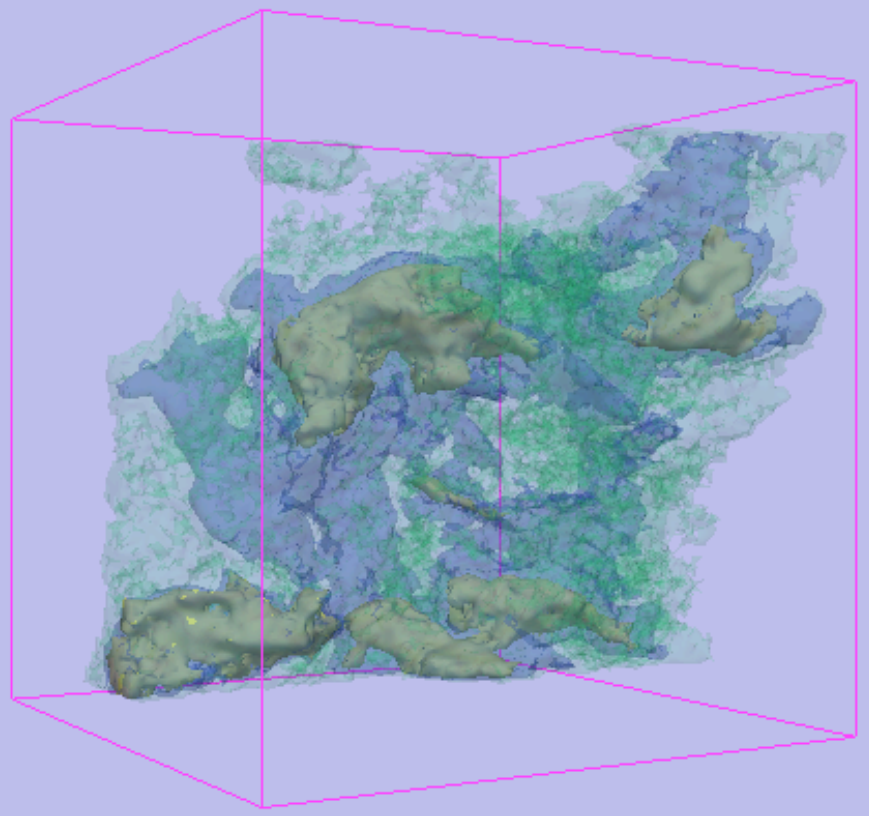
- a hierarchy-preserving abstraction

Heavily inspired by "structure trees" by Houlahan & Scalo (1993)

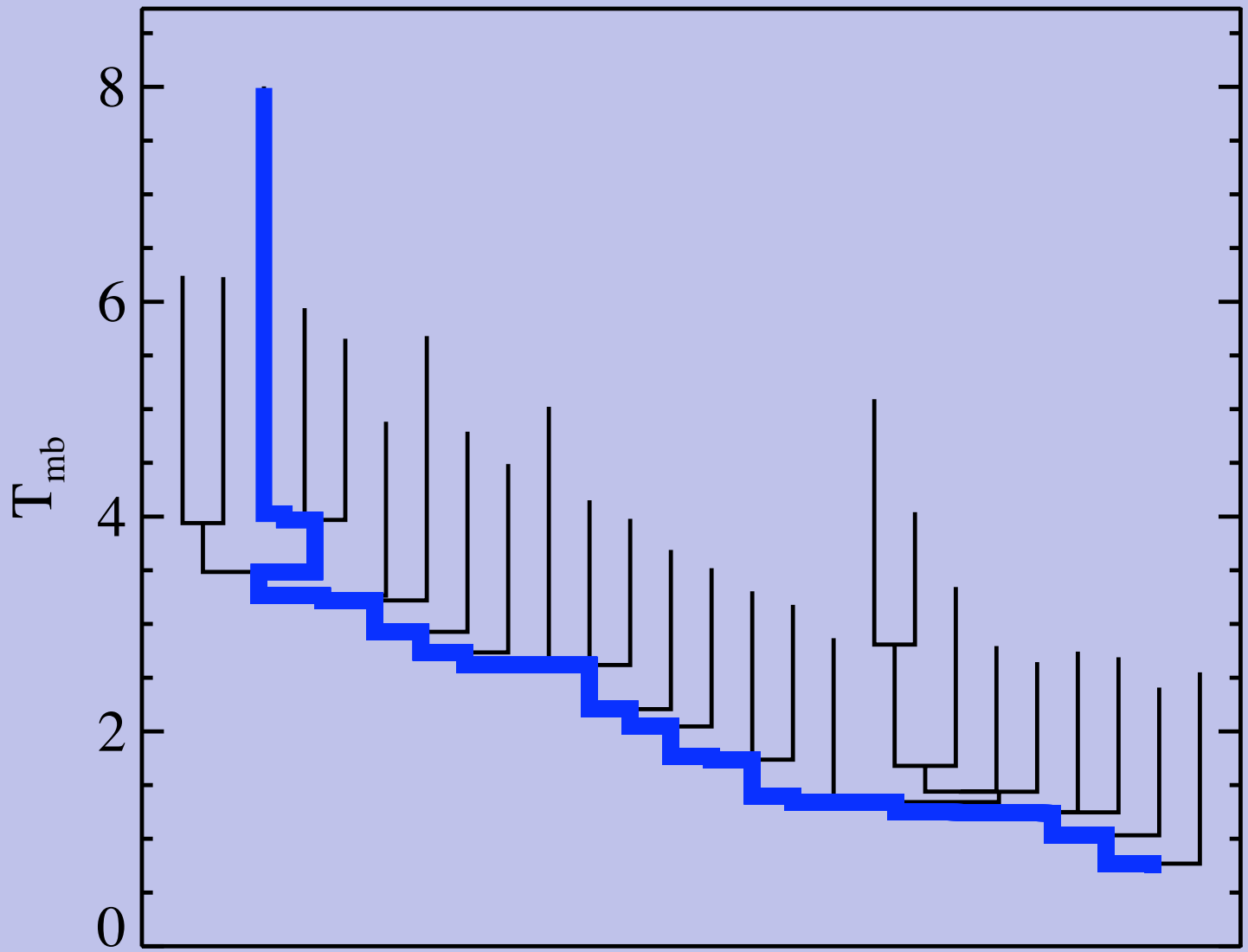


Dendrogram of L1448



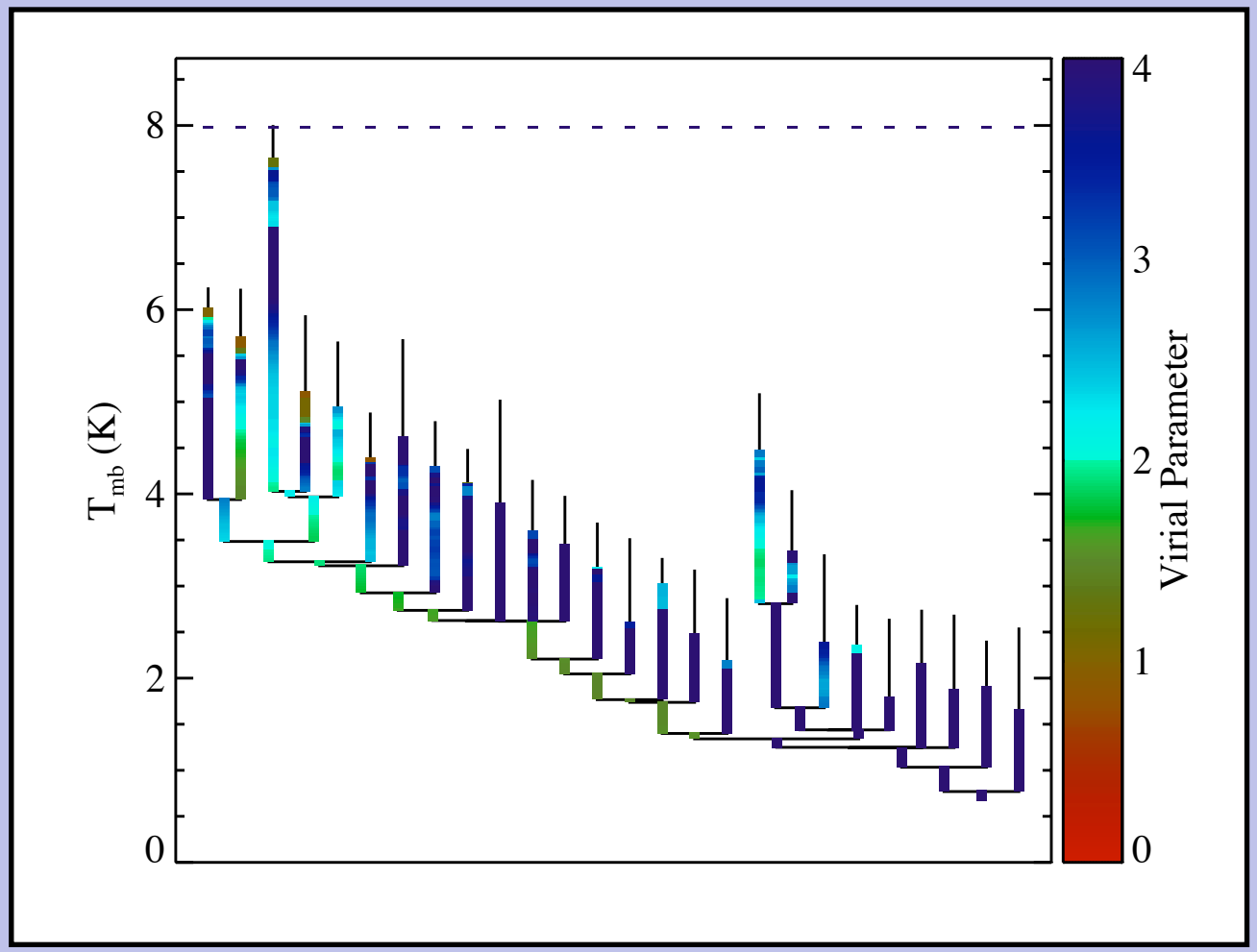


Determination of Branch Properties



Determination of Branch Properties

$$\alpha_{\rm VIR} \equiv \frac{5\sigma_v^2 R}{GM} = \frac{5\sigma_v^2 R}{GXL_{\rm CO}}$$



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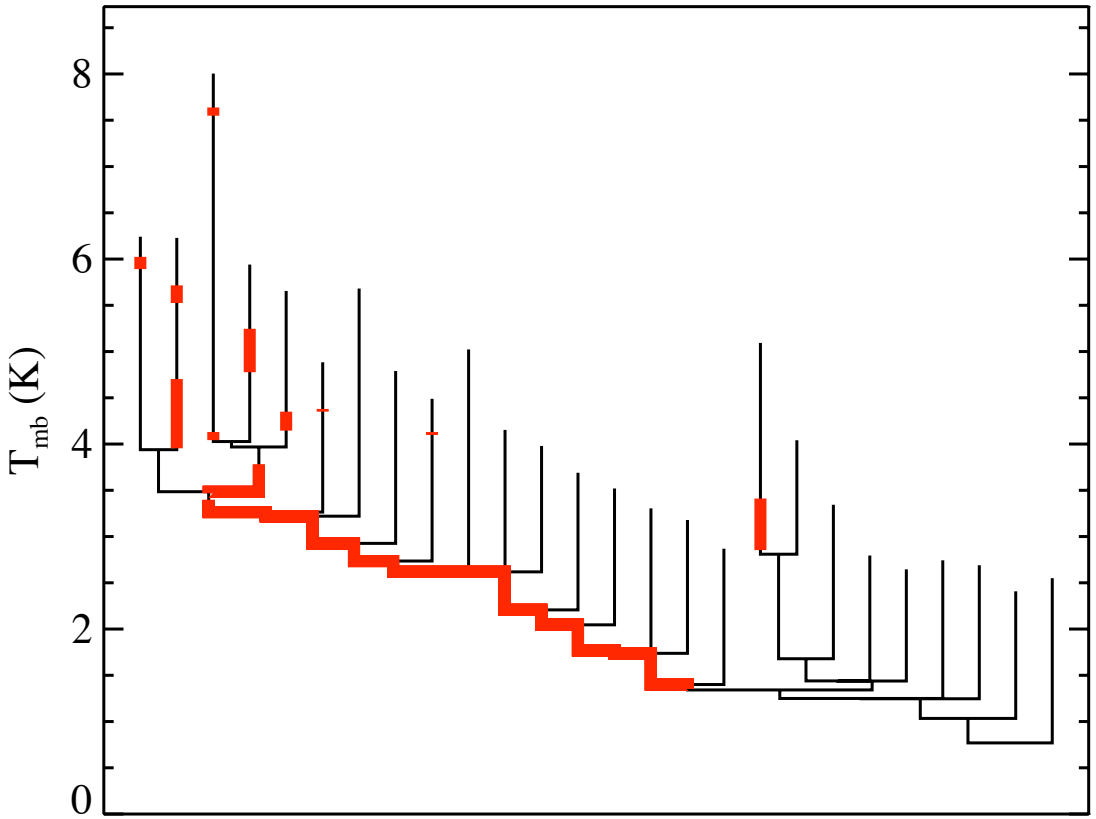
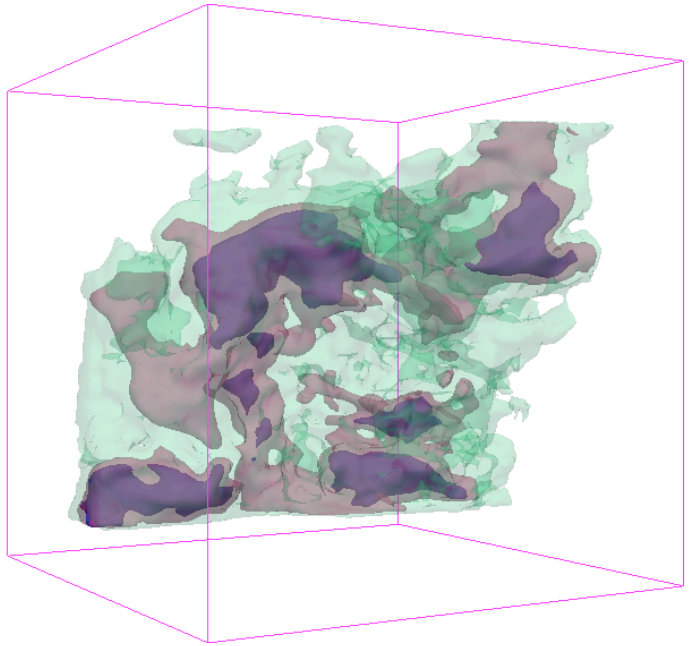
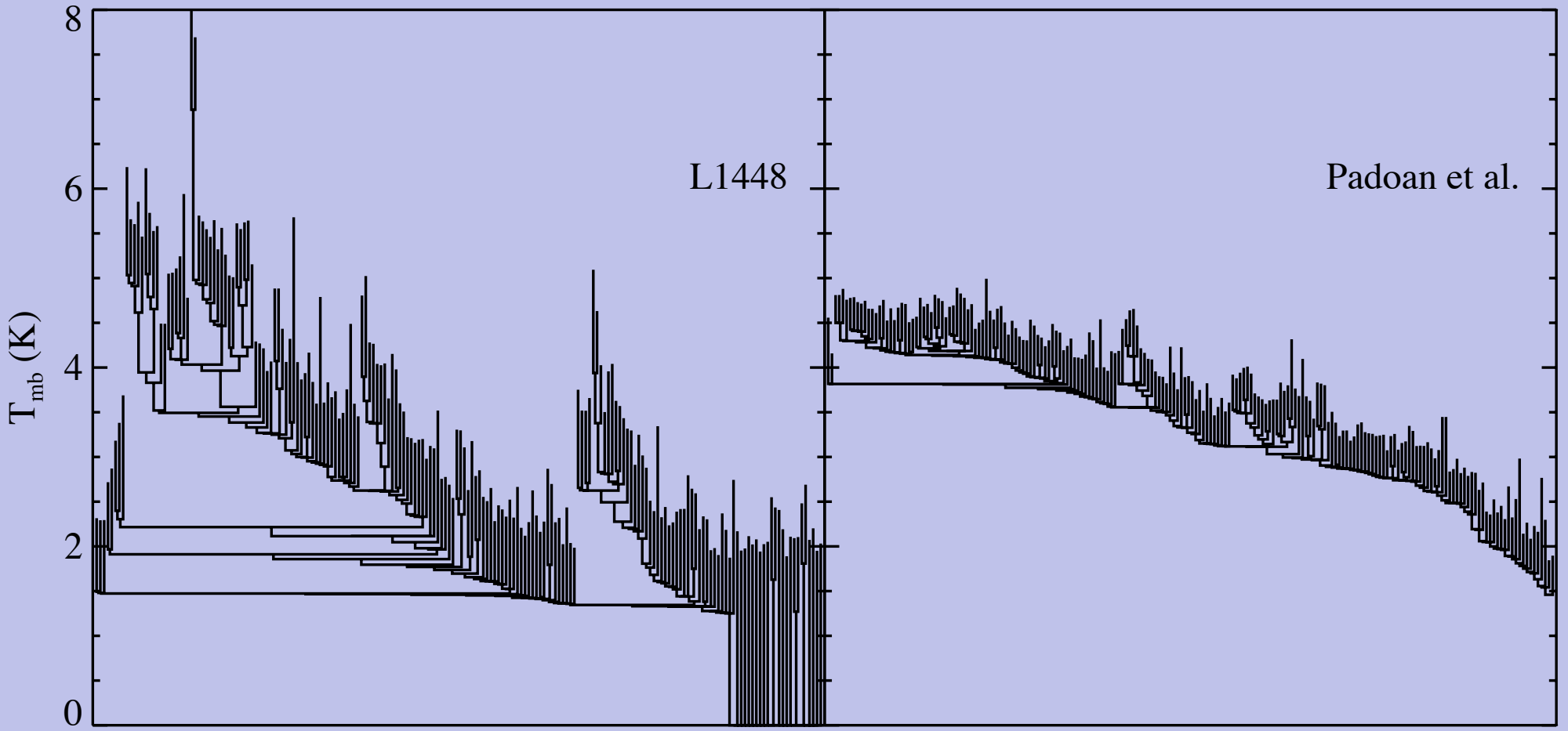


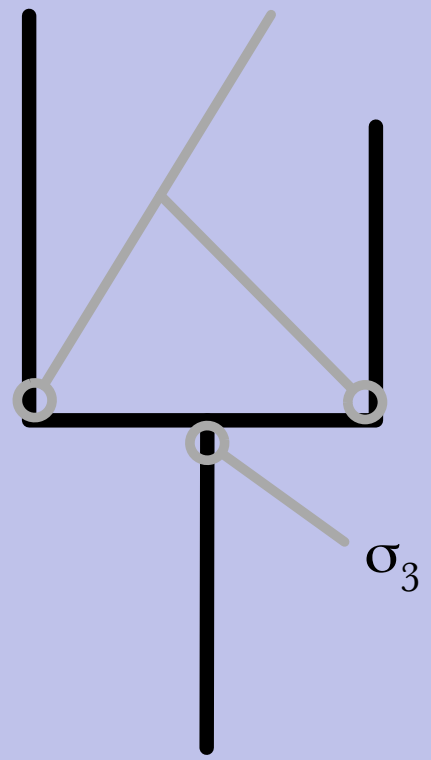


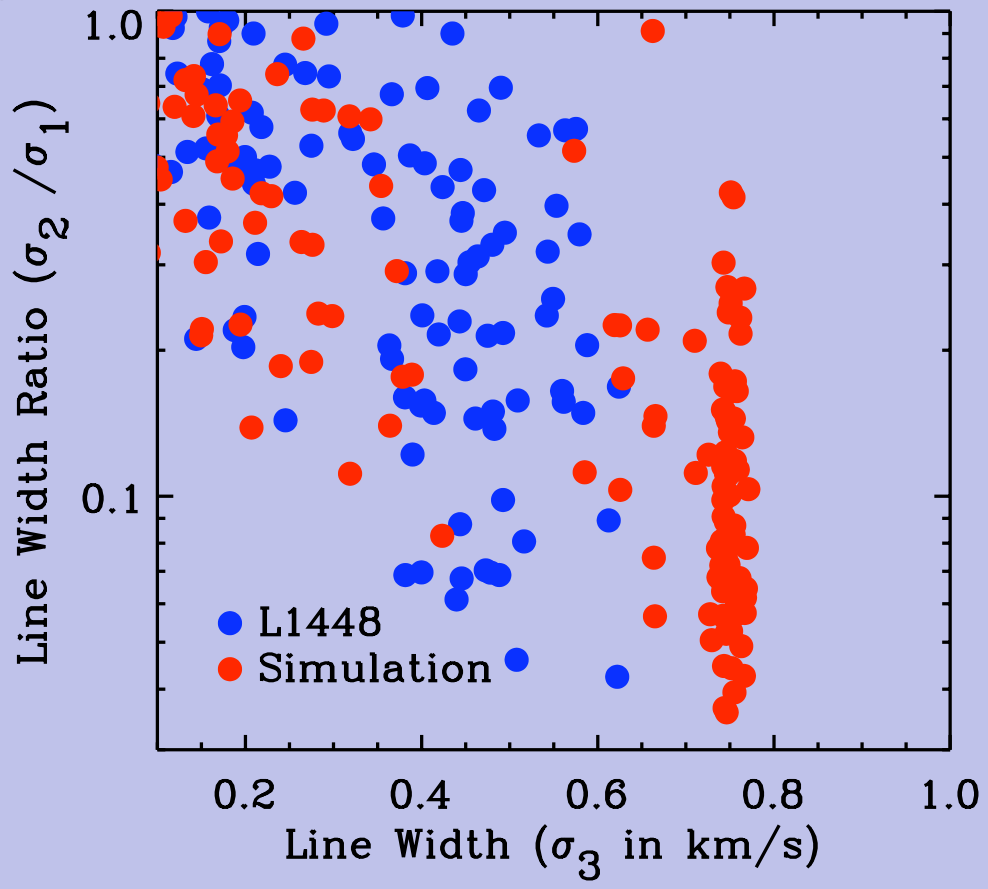
Sensitivity to Noise



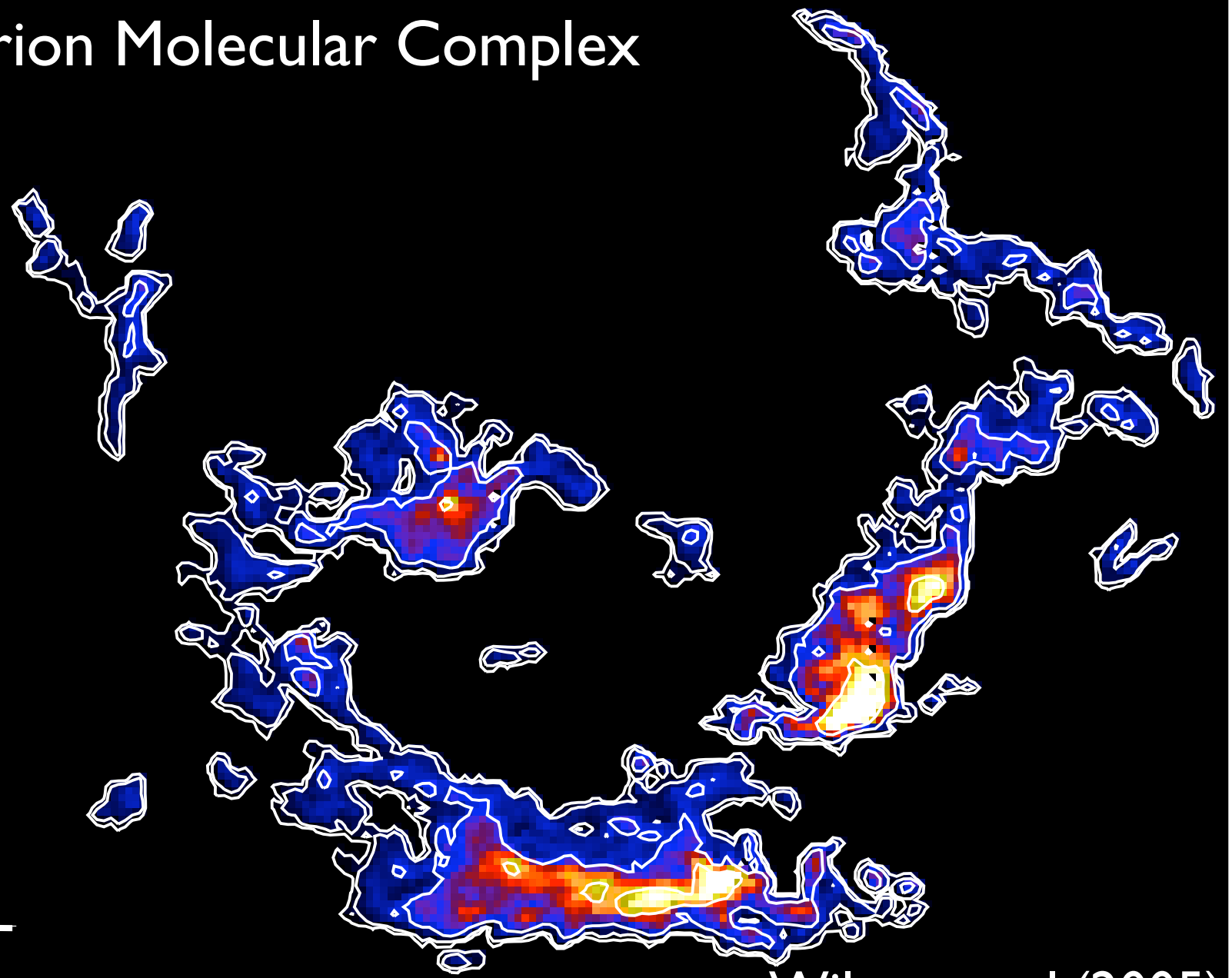
Developing New Statistics

Measure line width above merger.
Define σ_1 as the larger of the two
and σ_2 as the smaller.

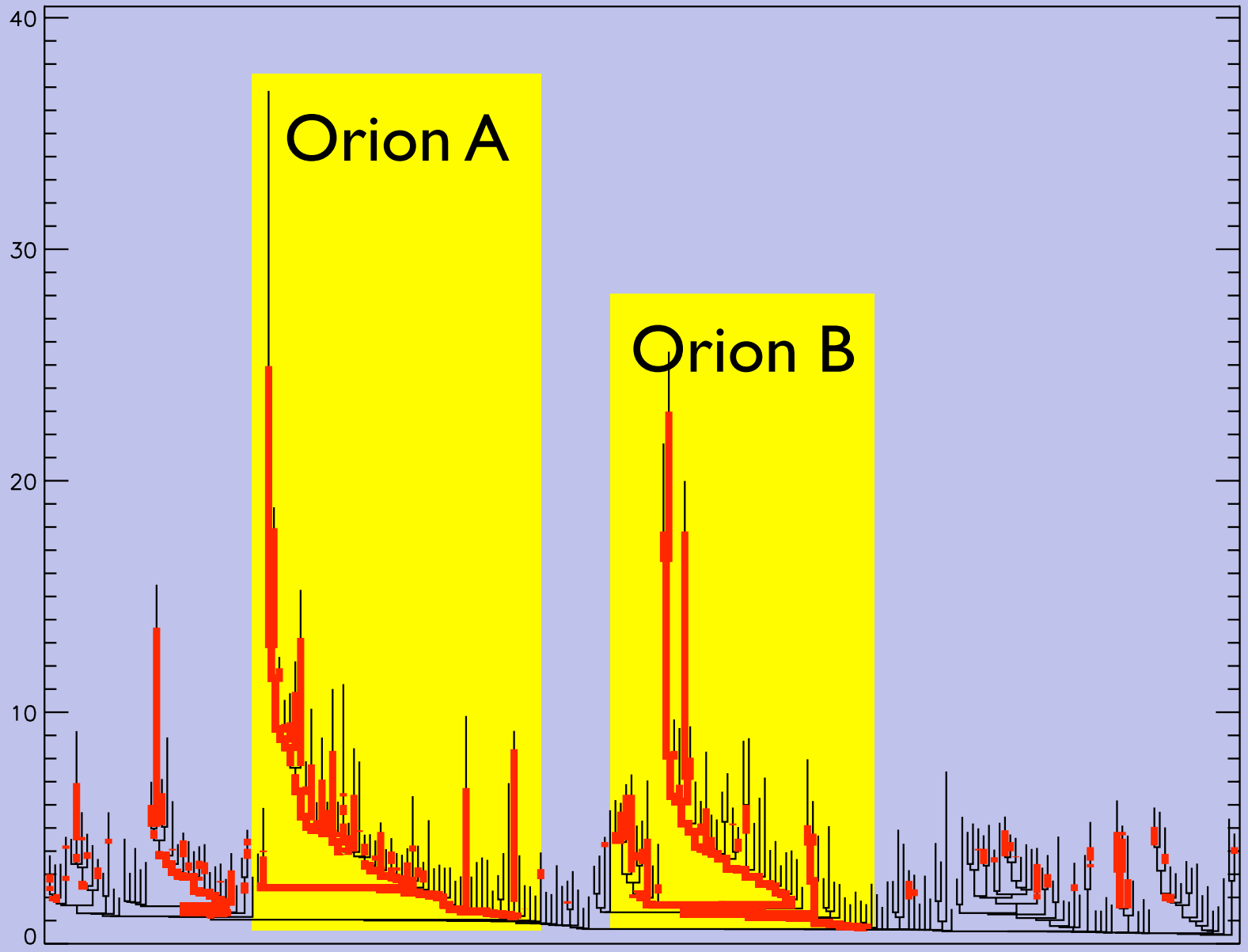




The Orion Molecular Complex



Wilson, et al.(2005)


40
30
20
10
0
Orion A
Orion B

Summary

- Ensemble properties of dense cores
  - Most are thermally dominated, show velocity structure fcn.
- Hierarchical structure
  - Still half-baked. Suggestions welcome.