Characterizing Physical Properties of Hierarchical Structure in Star-Forming Regions

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Question(s): How do the derived physical properties of structures in star-forming regions depend upon the data and hierarchical structure analysis technique used to identify them? What biases and uncertainties underlie these methods?

Our Data:

1. NH_3 **integrated-intensity**, $\mathbf{I}(NH_3)$, maps[1,2] of Gould Belt star-forming regions
   - Resolution: 31” & 6.10 kHz
2. N_{H_2} **column density** maps[3] of Gould Belt
   - Resolution: 36.4”
   - Herschel pixel-by-pixel SED fitting

Dendrograms: The Basics

- Tree-like diagrams that divide data into structures
- 2 critical parameters of *astrodendro* Python package
  - ***min_value***: Minimum flux value to be considered “real”
  - ***min_delta***: Minimum flux difference for neighboring structures to be independent

Sample Structure Decomposition

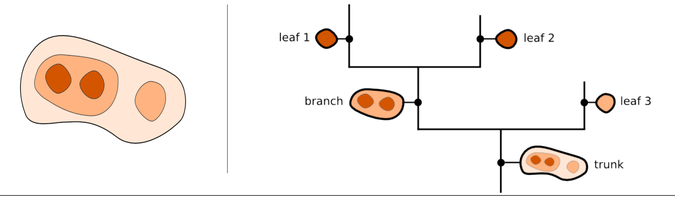


Figure 1. Sample molecular cloud structure **(left)** Decomposition of sample structure into dendrogram with trunk, branch, and three leaves **(right)**

Example Structure Decomposition

Comparing Structures:

- Different structures identified for different datasets (see below)
- Shared structures not identical

Astrodendro of $\mathbf{I}(NH_3)$ | **Astrodendro of N_{H_2}**

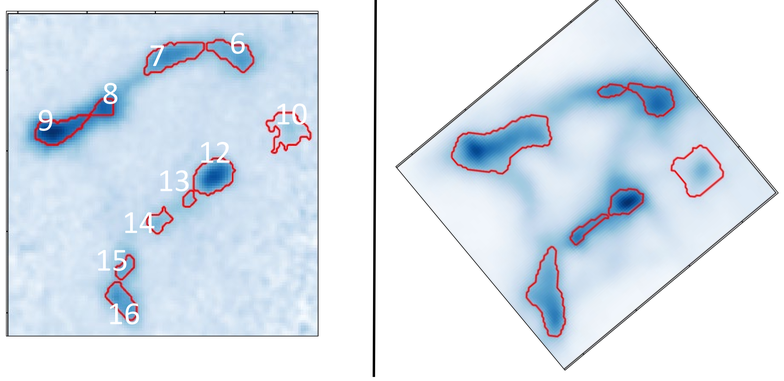


Figure 4. From left to right. A) **Leaves** identified in B10 at 3σ level for $\mathbf{I}(NH_3)$ **map[1]**. B) **Leaves** identified in B10 at 3σ level for N_{H_2} **map[3]**

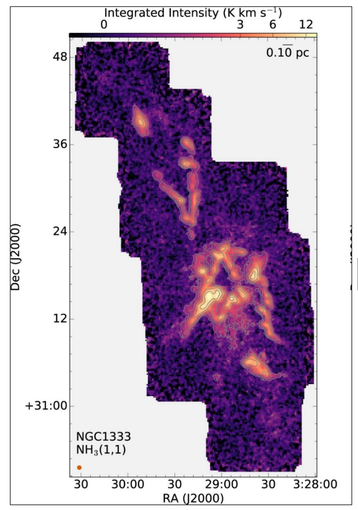


Figure 2. **Integrated intensity** (0th moment) map[2] of **NGC1333**. Mapped with the ammonia (1,1) transition.

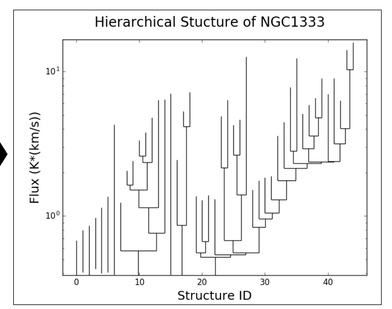
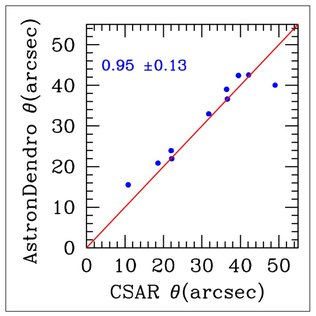
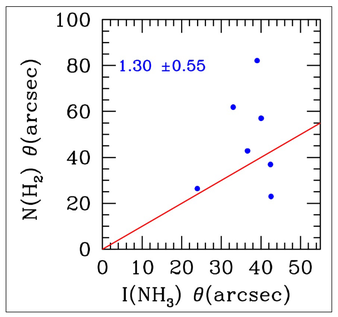


Figure 3. **Dendrogram of NGC1333**. **Structure intensity** plotted on y-axis. **Structure ID** plotted on x-axis. Densest components are leaves. Diffuse components are branches/trunks.

What Did We Find?:

- Different **techniques** measure **similar** radii
- Different **datasets** yield **different** radii
- **RMS** is useful **metric** for *astrodendro* **parameters**





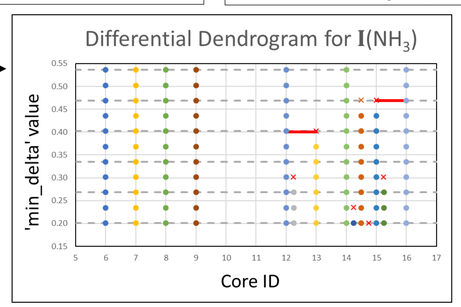


Figure 5. From left to right. A) **Comparison** of leaf size between ***astrodendro* and CSAR** B) **Comparison** of *astrodendro* leaf size between $\mathbf{I}(NH_3)$[1] **and** N_{H_2}[3] C) **Tracking** of structure **decomposition** as function of ***min_delta*** parameter (3-8σ) for constant *min_value in* $\mathbf{I}(NH_3)$[1]

References:

1. Seo et al., 2015, ApJ, 805, 2
2. Friesen et al., 2017, ApJ, 843, 1
3. Singh et al. (in prep)

What’s Next?: We shall measure the virial parameters of the leaves in Gould Belt clouds found with *astrodendro* in both the $\mathbf{I}(NH_3)$ and N_{H_2} maps to conduct a one-to-one comparison of *astrodendro structures* and quantify uncertainties of their physical parameters.

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