

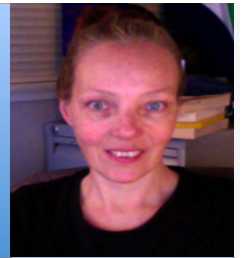
Multiscale spatial (MS) analysis of young stars complex

MS-dbscan clustering algorithm

Joncour^{1,2} I., Moraux¹ E. Duchêne^{1,3} G., and, Mundy² L.

Isabelle.joncour@univ-grenoble-alpes.fr

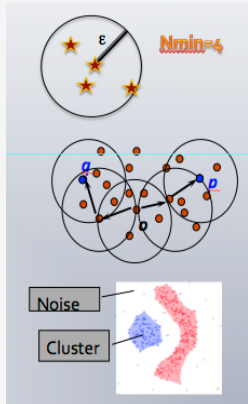
¹University Grenoble Alpes; ²University of Maryland; ³University of Berkeley



Clusters detection in points set

Dbscan idea

Ester+, 1996



Dbscan cluster: set of all points that are connected through a chain of neighbored points, separated successively by at most a distance of ϵ and having individually at least N_{\min} neighbors in radius ϵ .

- + $O(n \log n)$ time complexity
- + Noise /outliers detection
- + Partial clustering
- One scale detection
- **Problem with density gradient \rightarrow ML-dbscan**

Multiscale structural analysis of points set

MS-dbscan Joncour+, in prep

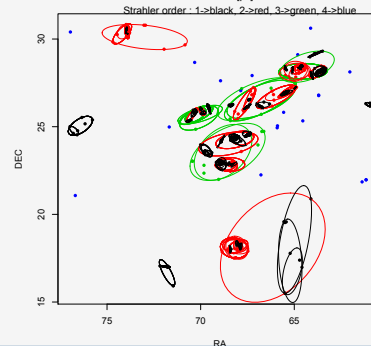
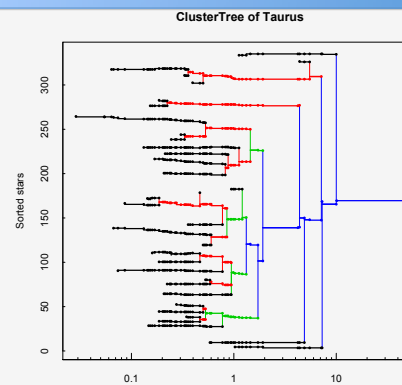
MS-Dbscan : recursive call on ϵ -dbscan to build a full multi-level analysis

- Step 1 : At each level ϵ detection of connected components from the whole set of points (this avoids to a built-in hierarchy)
- Step 2 : ClusterTree conception: how the components connect from a level to the next
- Step 3 : hierarchy complexity measure, we introduce the (Horton-)Strahler index (Horton, 1945; Strahler, 1952) and multiscale spectrum, the number of components function of the local scale
- Step 4: substructure shapes \rightarrow convex hull and minimum spanning ellipsoid

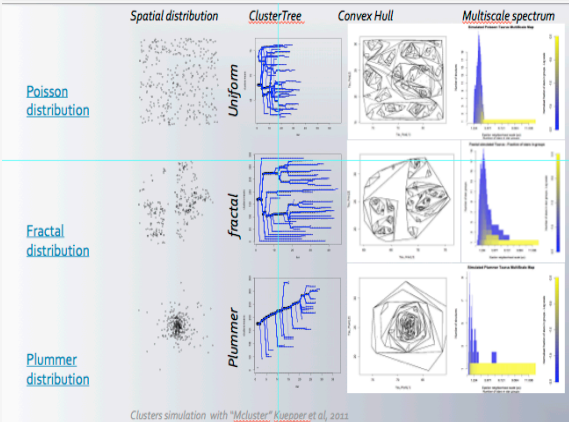
MS analysis of young Taurus complex

So far, hierarchical structure of star formation in star groups and galaxies has been obtained when first smoothing the distribution of stars by a kernel to produce a continuous map from which a dendrogram is obtained (Gouliermis +2010, 2017, 2018) as done for the continuous gas map (Rosolowski+2008)

Our multiscale method is an alternate way using the full information contained in the discrete distribution.



MS-dbscan on simulated clusters



We apply our method on simulated clusters produced using Mcluster program (Kuepper et al, 2011). Our method allows to identify the type and structure of clusters from the properties of their ClusterTree and multiscale spectrum.

Structures detection reliability

Based on nearest neighbor statistics, we have implemented a method to identify the substructures obtained at one level with a high level of confidence (>99%) above random expectation (Joncour +2018). We currently implement it to the MS analysis. These substructures are then used to perform astrophysical studies to derive constraints on star formation process.

Conclusion This work offers a complete framework to detect and characterize the multiscale substructures above random expectations of young stars in star forming regions that allow to derive in turn new constraints on star formation and dynamical evolution processes.