Identifying star-forming cores in ^{13}CO emission maps
- Star formation efficiency in molecular clumps-

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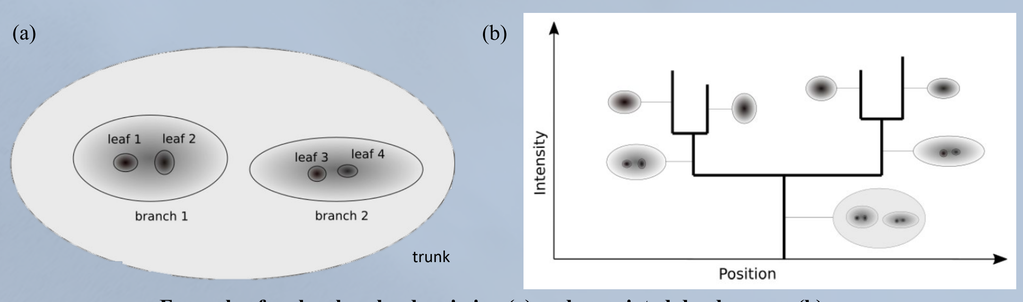
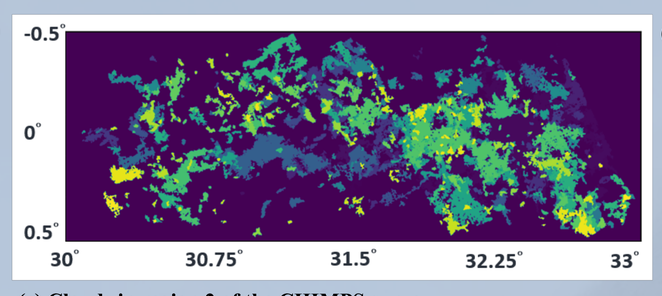
Introduction

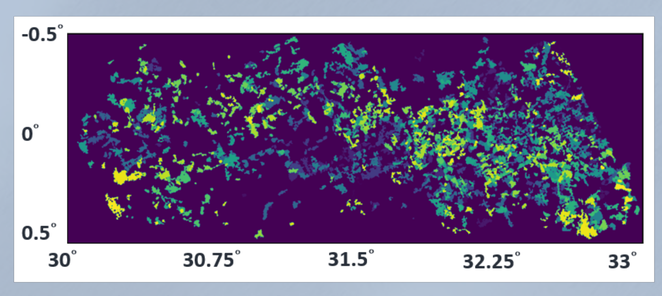
Multi-tracer surveys have revealed the hierarchical nature of molecular clouds, showing how high-density, small-scale features are always nested within more rarefied, larger envelopes. The densest regions in a cloud are compact cores, the seeds of star formation. With an algorithm based on graph and clustering theory (SCIMES), individual gaseous structures are identified in the ^{13}CO emission maps of the CO Heterodyne Inner Milky Way Plane Survey (CHIMPS) emission maps. In this project, we aim to find the densest regions within CHIMPS molecular clouds. These regions are encoded within the leaf. We estimate the star formation efficiency (SFE) of each leaf by matching it with infra-red luminosities measured independently in the Herschel infrared Galactic Plane Survey (Hi-Gal). We then make use of the physical properties of the leaves (e.g. density, size, mass) to search for a connection between the leaves' characteristics and their SFE.



Example of molecular cloud emission (a) and associated dendrogram (b). Darker color indicated higher intensity of emission.



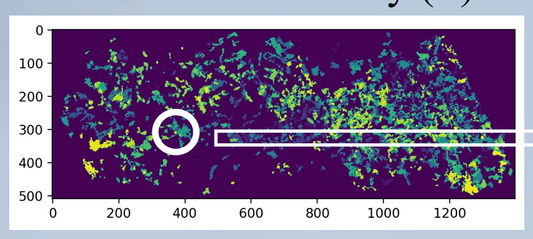
(c) Clouds in region 2 of the CHIMPS survey. Different color represents different cloud.

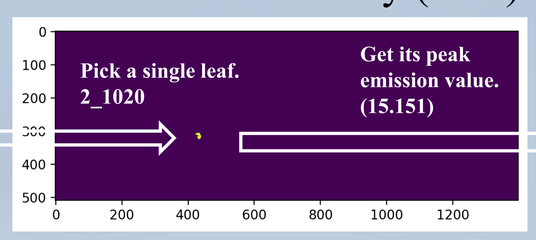


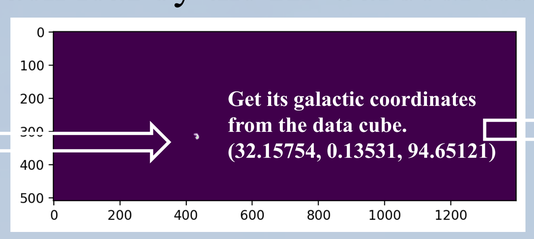
(d) Leaves inherit distances from the clouds that contains them.

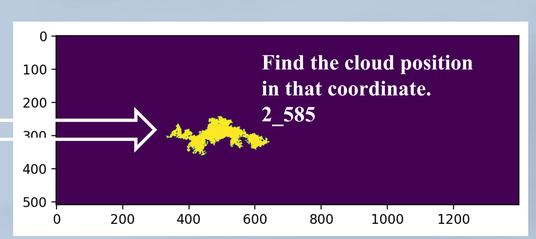
Method

1. Link each leaf to the SCIMES clouds that contains it, by matching the coordinates of the leaf's peak emission. The leaf inherits the distance of the cloud.
2. Link Hi-GAL to CHIMPS leaves by their Galactic coordinates.
3. Estimate luminosity (L) and star formation efficiency (L/M) of each leaf by the Hi-Gal sources it contains.

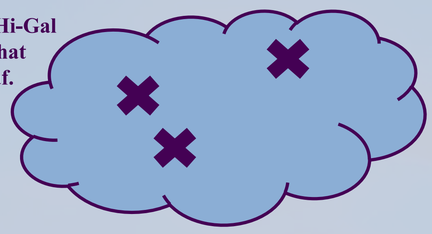








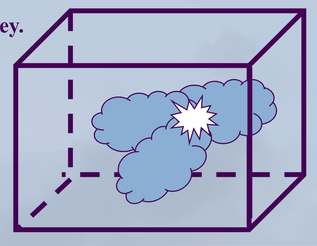
Finding Hi-Gal sources that is in a leaf.



Hi-GAL catalogue contains only PP information.

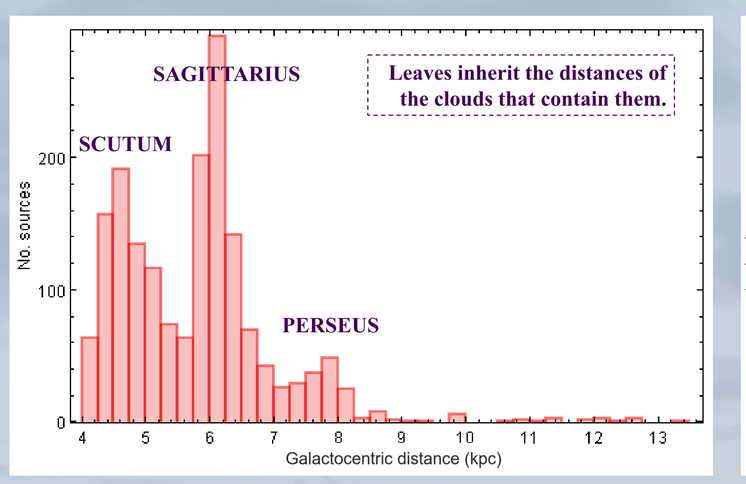
(32.84604, 0.07093)

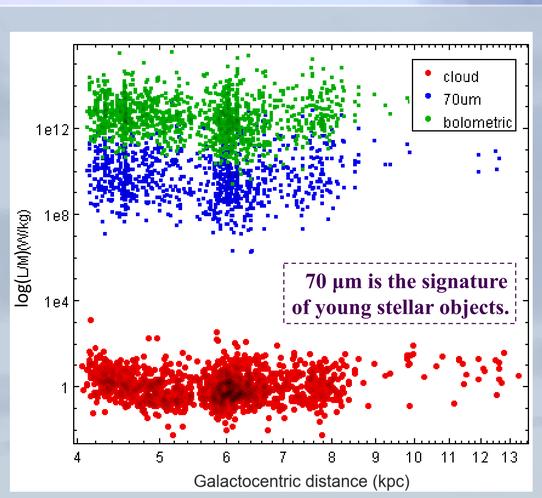
CHIMPS is a 3D survey.

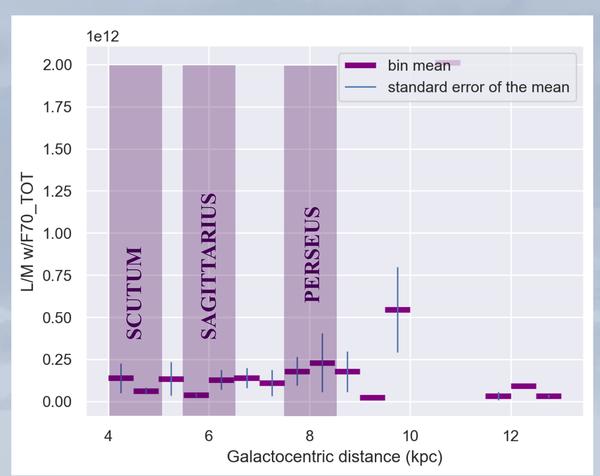


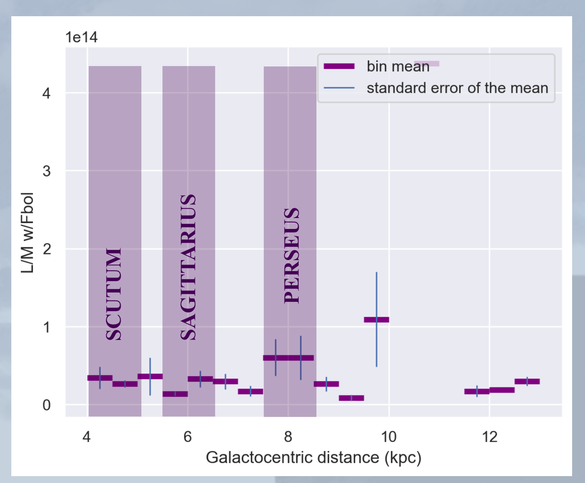
There may be not only one leaf at the position, but actually the leaves are at different velocity channels. We choose the leaf with the greatest brightness temperature.

Results

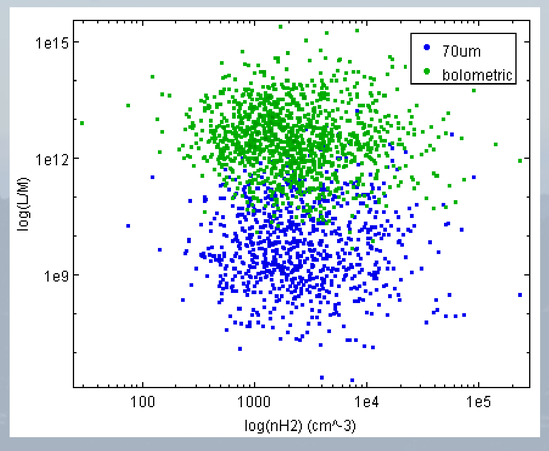


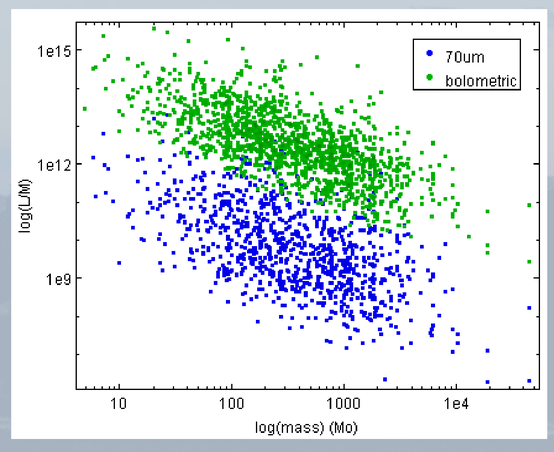


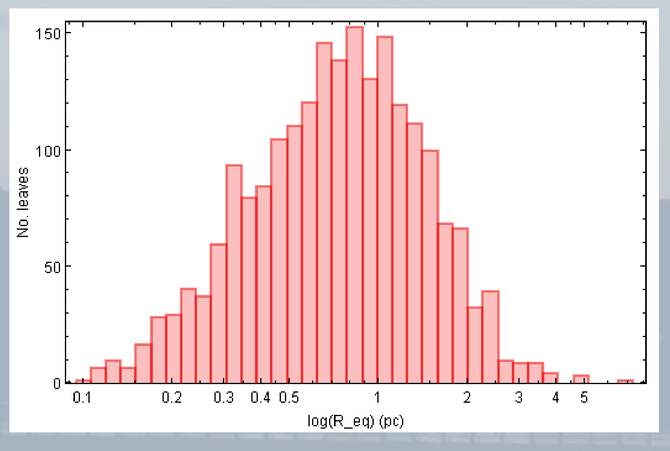


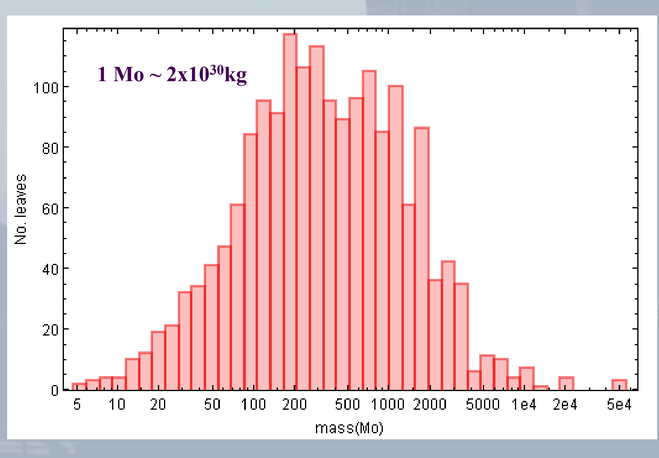


⇒ Star formation efficiency (measured by L/M) is not influenced by the spiral arms!









⇒ Bigger leaves have higher SFE, and more massive leaves have lower SFE. The sites of star formation are very localized within leaves (compact cores), thus the luminosity increases by smaller amounts than the mass with increasing Req.

References

∗Brunt, 2014, MNRAS ∗Colombo, 2015, MNRAS ∗Rigby, 2016, MNRAS
∗Elia, 2017, MNRAS ∗Rani, 2022, MNRAS

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