

Testing Dense Gas Star Formation Relations in the **Outer Milky Way**

Why Outer Milky Way?



Caveats in the definition of **Dense Molecular Gas Tracers**



Image Credit : Evans et al. 2020

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Substantial fraction of the total HCN luminosity arises from lower density regions



Target Details

- 19 Outer Galaxy star forming regions
- R_G range **9.8-17** kpc
- Galactic longitude range $96.28^{\circ} \le l \le 211.98^{\circ}$
- All the targets are diverse in nature (physical sizes, cloud mass, density, number of massive stars) and different metallicities.



Fig 1: The variation of oxygen abundances with respect to R_{G}

Dense Gas Tracers

- $A_v > 8 mag$
- mm continuum emission
- HCN (J=1 \rightarrow 0) and HCO⁺ (J =1 \rightarrow 0)

Observations Taeduk Radio Astronomy Observatory, KASI. Simultaneous observation of HCN (J=1-0) &

- 13.7m single dish radio telescope at **
- ** HCO+ (J=1-0)
- RMS sensitivity 0.1 K at velocity resolution ** of 0.2 km/s





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Do the Tracers Agree ?



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NOT FOR ALL CLOUDS!!!

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 \succ The difference in \mathbf{f}_{L} is large between HCN and HCO⁺ for most of the clouds.

 \succ Strong trend of increasing of f_1 arising from higher column density region with total line luminosity.

Future Plans Comparison with Inner Galaxy

- clouds.
- formation.

REFERENCES

[1] Arellano-Córdova et al. 2020

[2] Wang et al. 2018

[3] Mendez-Delgado et al. 2020

[4] Bailer-Jones et al. 2018



Explore the metallicity effect on the relation between dense gas and star

Sh2-252 & Sh2-266 are included in our JWST proposal which has been submitted for the cycle 1 run. Deep NIR observations and follow up point source analysis are planned with DOT, Subaru and LBT telescopes.

[5] Marsh et al. 2017

- [6] Ripple et al. 2013
 - [7] Evans et al. 2020
- [9] Kauffmann et al. 2017 (10) Pety et al. 2017

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