What controls the star formation in Cloud E/F with ACES?

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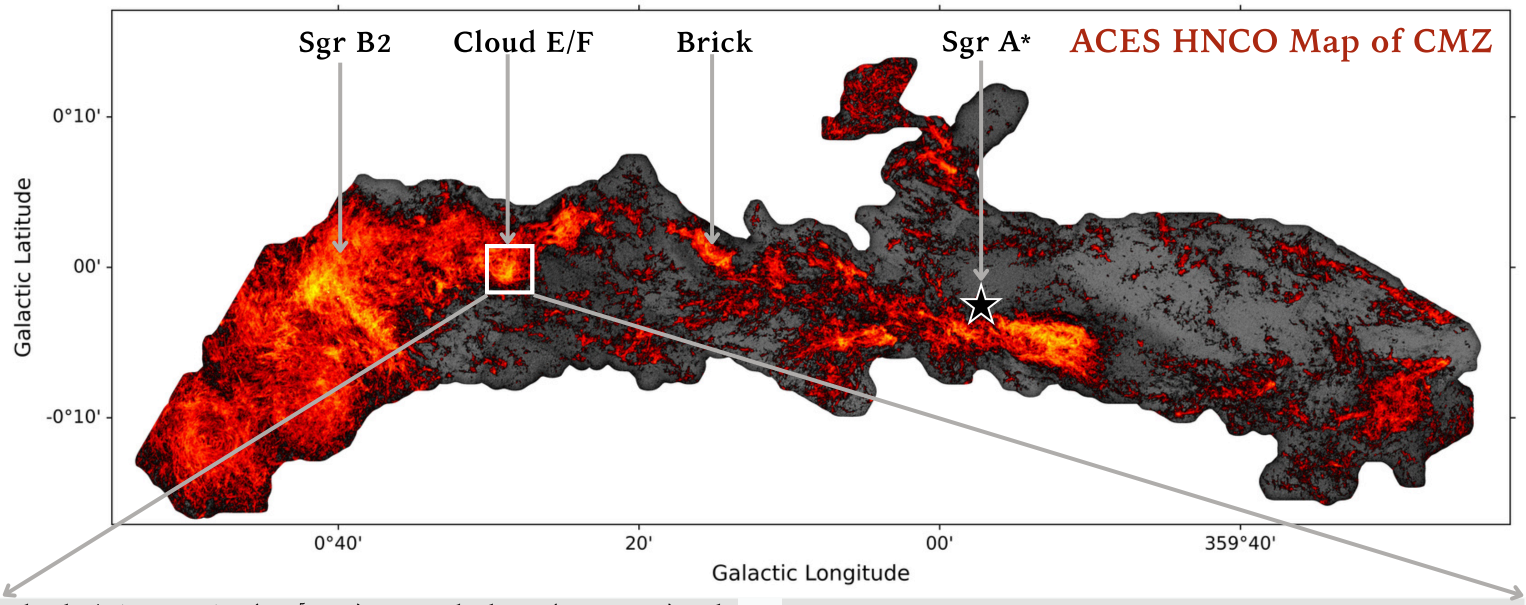
Milky Way's Central Molecular Zone (CMZ)

The **CMZ** - a ring of dense gas in **the innermost 300 pc of the Milky Way**, is characterized by strong magnetic fields, high turbulence, high temperature, high gas density and radiation - an order magnitude higher compared to local molecular clouds in the Galactic disk at the same size scale (Henshaw et al. 2022). **An extreme environment like no other!**

Star Formation in the CMZ

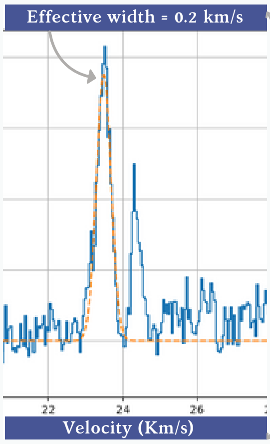
The CMZ violates empirical star formation laws and exhibits an order of magnitude lower star formation rate than expected despite its high gas density (Longmore et al. 2013, Barnes et al. 2017). What controls the star formation there?

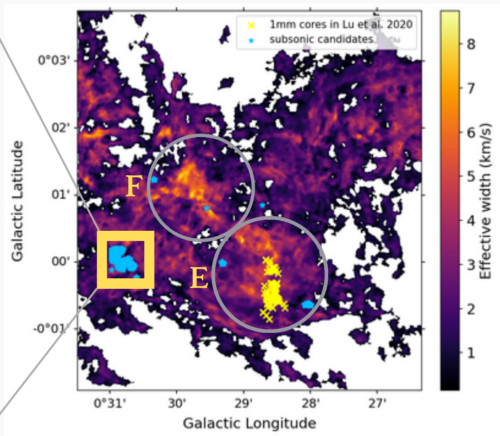


Cloud E/F is a massive (~10^5 M_{sun}), extemely dense (R_{eff}~4.1 pc) and young GMC, situated between Brick and Sgr B2 (Walker et al. 2015, Battersby et al. 2024).
If Cloud E/F were near the Sun, it would make thousands of stars but in reality, it barely makes any.

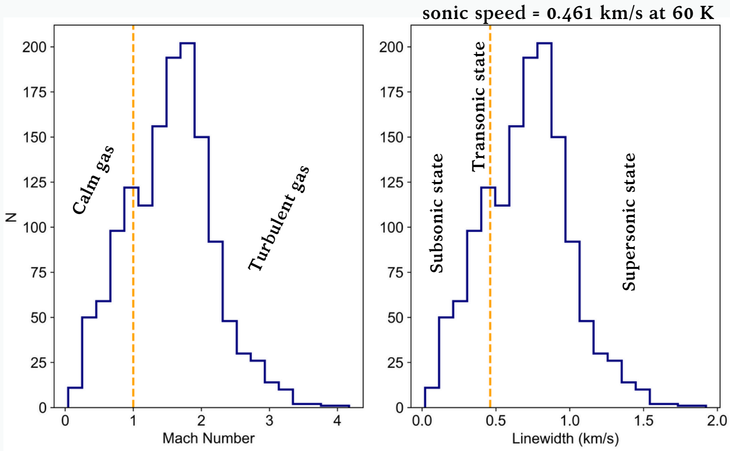
Is it because of high turbulence?
This research investigates 'why' leveraging unprecedented sensitivity and resolution of ALMA Exploration CMZ Survey (ACES).

HNCO Linewidths of Cloud E/F





Turbulence Vs. Coherence

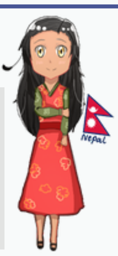


Cloud E/F has broad linewidths, up to 10 km/s —fast, turbulent gas— with few high-mass stars forming. Surprisingly, we also found hundreds of narrow linewidths nearby and within the cloud.

We discovered the narrowest linewidth of 0.2 km/s in subsonic state over 0.1-0.3 pc scales in the extended region of Cloud E/F. This first-of-its-kind discovery hints at a gas transition from coherence to a turbulent supersonic state in the CMZ.

What controls the Star formation in Cloud E/F with ACES?

- The rare subsonic pockets within turbulent gas suggest Cloud E/F is in an early evolutionary stage, preparing for star formation, explaining why star formation is slow and localized.
- The coexistence of both broad and narrow linewidths reveals a complex interplay of turbulent and calm gas, shaping when and where stars can form.
- Star formation on small scales in the CMZ may resemble that in Milky Way disk.



Ongoing Work

- Velocity & velocity dispersion gradient map of Cloud E/F
- Scanning the entire CMZ in search of such narrow linewidths, are they rare?

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