JCMT BISTRO Survey: Exploring the Magnetic Fields in the Massive Star-Forming Region Onsala 2

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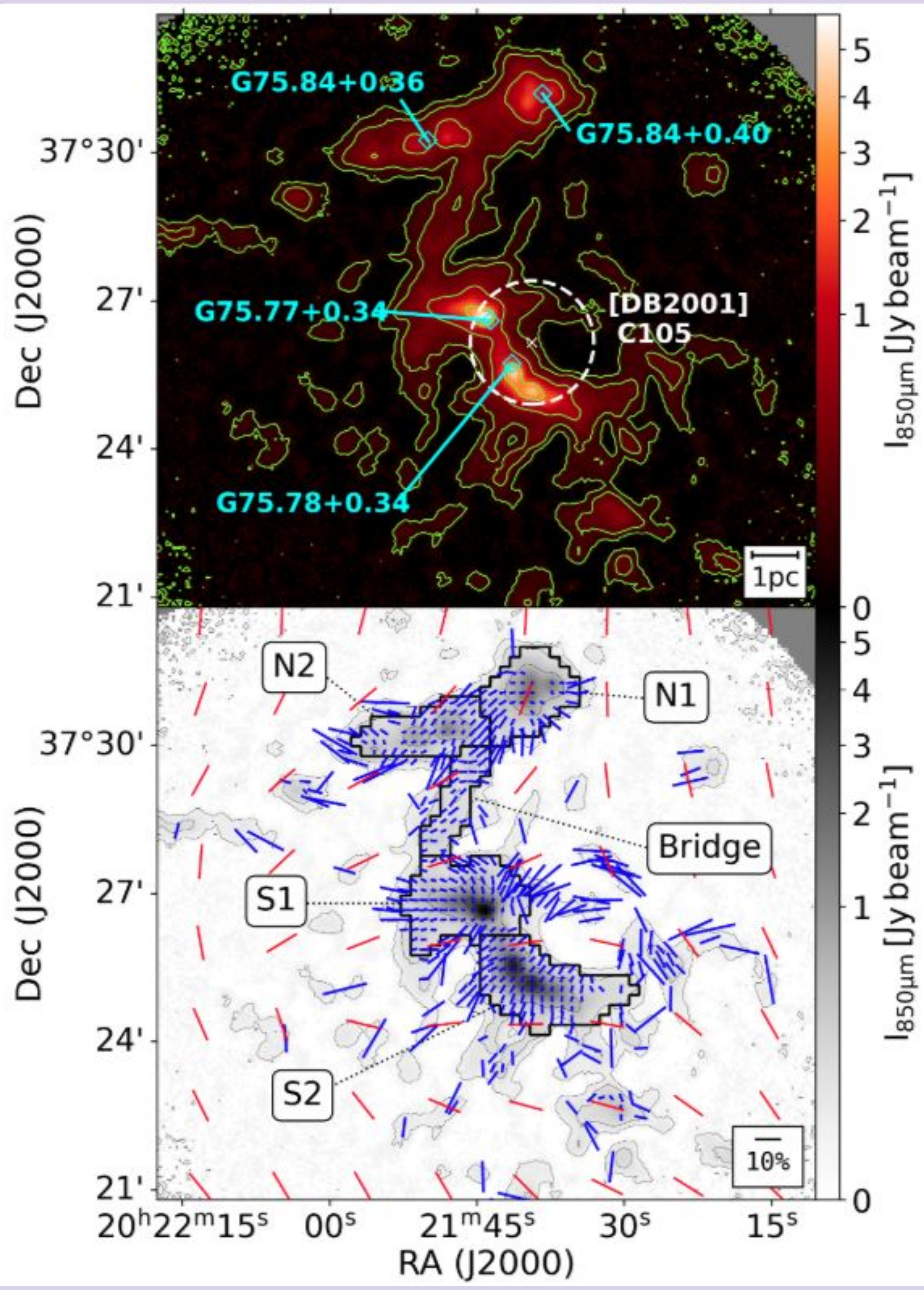


Introduction and Motivation

Star formation is influenced by magnetic fields, turbulence, and gravity. Magnetic field measurements provide a critical constraint on the force balance in massive molecular clouds.

Onsala 2, which is part of the Cygnus X complex, hosts multiple HII regions, making it an ideal testbed for studying magnetic fields and star formation. By comparing small- and large-scale magnetic fields, we find that dense structures are associated with variations in magnetic field morphology.

Observations	
JCMT BISTRO	850μm polarization
JCMT HARP	^{13}CO (3–2), C^{18}O (3–2)
Herschel	70–500μm continuum
Planck	353GHz polarization

Scientific Questions

Q1. What is the dynamical importance of magnetic fields in the massive star-forming region Onsala 2?

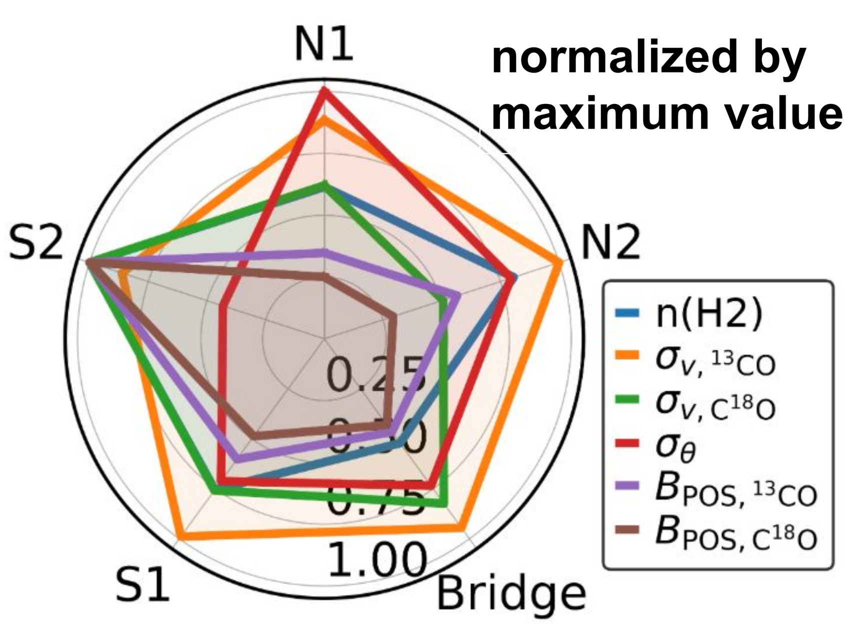
Q2. How do star formation activity and magnetic fields interact in the massive star-forming region Onsala 2?

Magnetic Field Strength and Energy Budgets

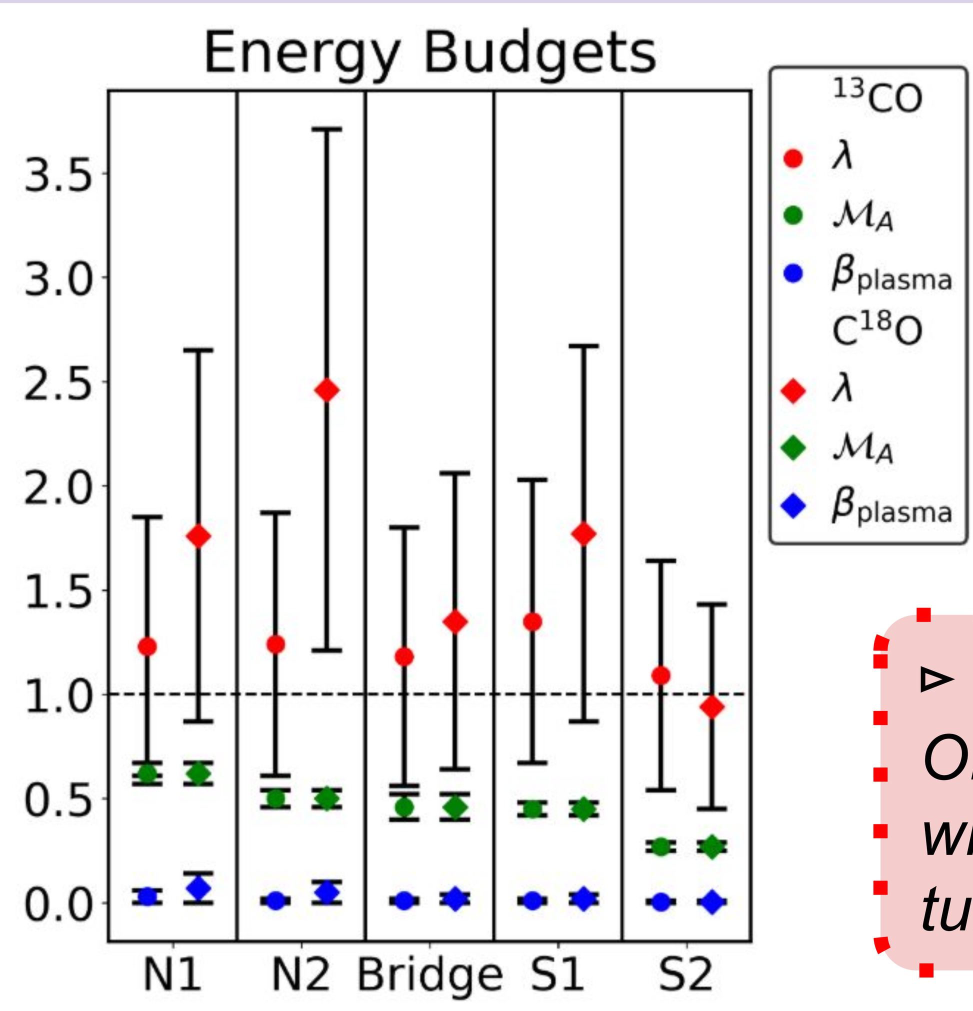
$$B_{POS} = Q' \sqrt{4\pi\rho}\ \frac{\sigma_\nu}{\sigma_\theta}$$

(Davis 1951; Chandrasekhar & Fermi 1953)

- **ρ** : mass density
- **σ_v**: non-thermal velocity dispersion
- **σ_θ**: angular dispersion



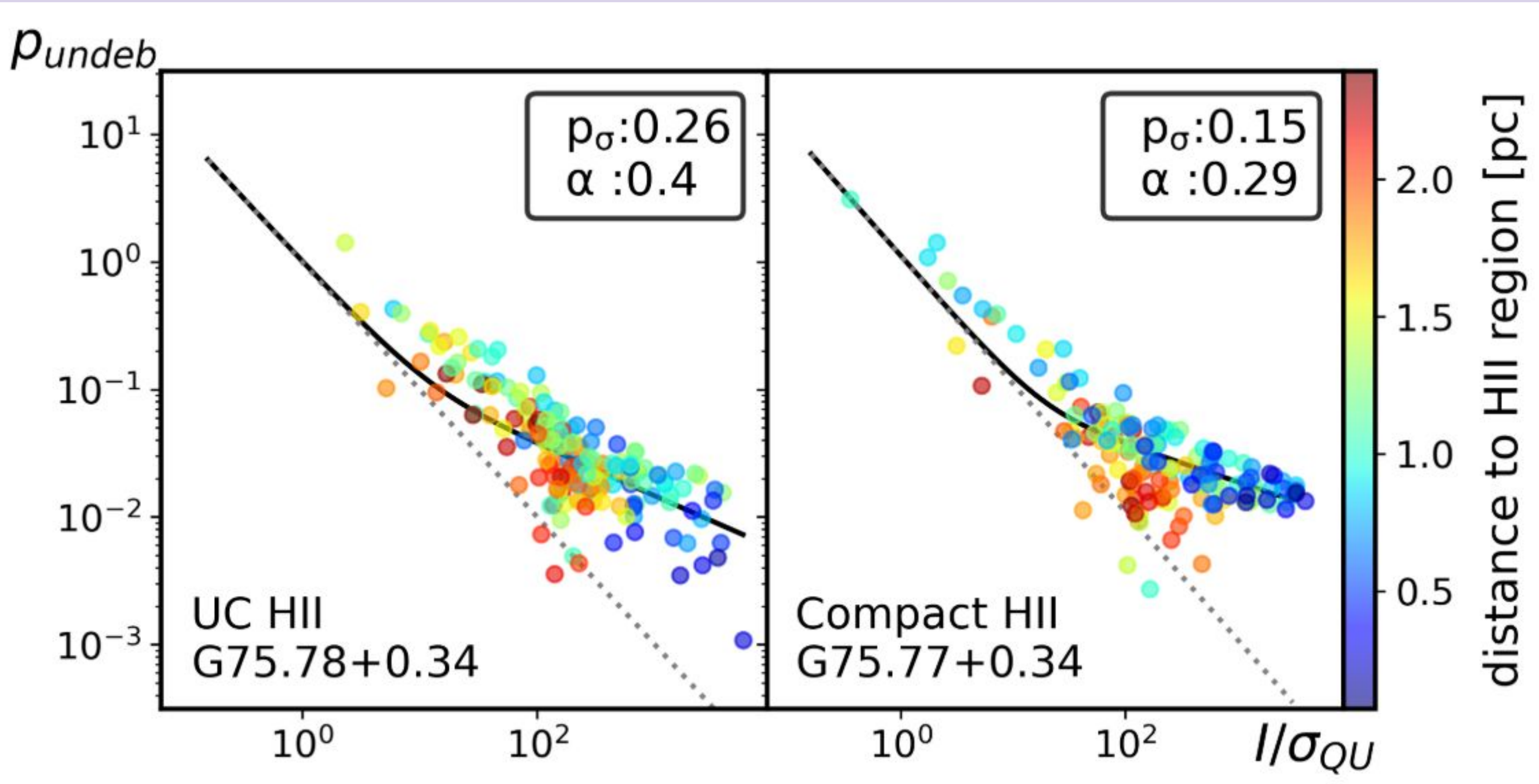
[μG]	$B_{POS,13CO}$	$B_{POS,C18O}$
N1	42.2	29.6
N2	68.7	34.7
Bridge	56.6	51.0
S1	73.2	57.7
S2	121.5	118.4



Mass-to-Flux Ratio, λ
λ > 1 (gravity-dominated)
Alfven Mach Number, M_A
M_A > 1 (turbulence-dominated)
Plasma Beta, β_{plasma}
β_{plasma} > 1 (thermal energy dominated)

▹ *Key Results (Q1)*

ON2 clumps are gravity-dominated, while magnetic energy exceeds turbulent and thermal components.



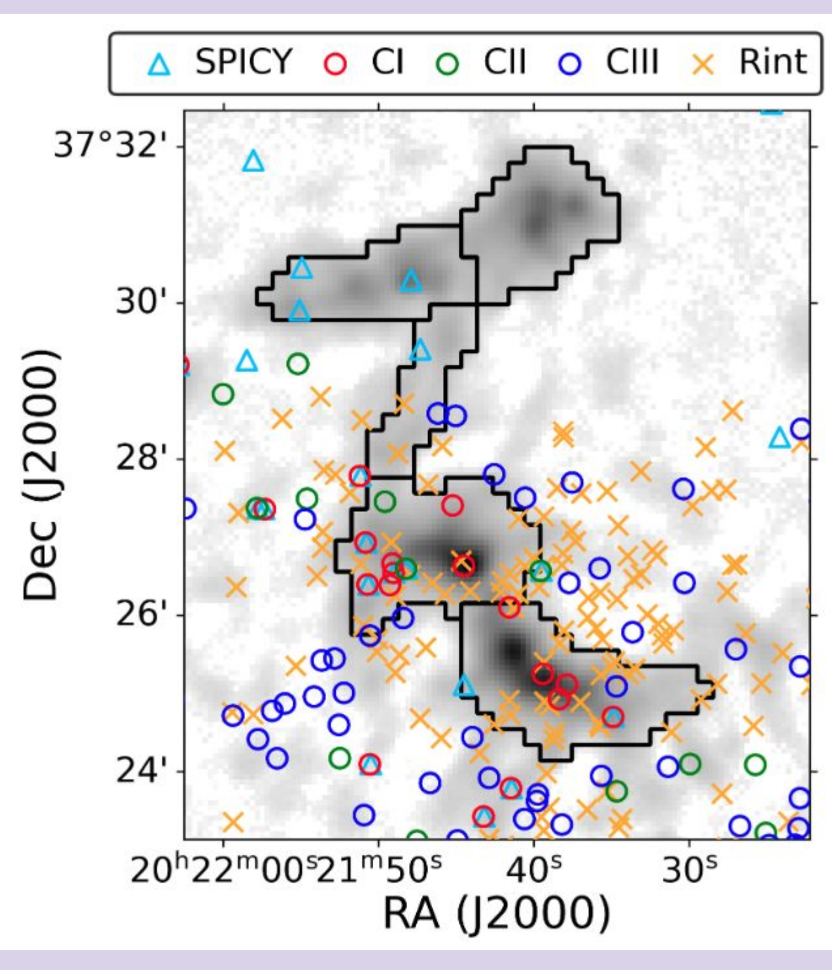
Grain Alignment Efficiency

Magnetic field morphology is traced by dust polarization arising from aligned dust grains. Following Pattle et al. (2019), the dust grain alignment efficiency is quantified using a Ricean-mean model, fitted to the dependence of the un-debiased polarization fraction on the intensity signal-to-noise ratio.

α→0 indicates a better grain alignment efficiency.

▹ *Key Results (Q2)*

Grain alignment efficiency increases toward HII regions, affecting polarization diagnostics, especially in S1 and S2.



Star Formation Rate and Efficiency

YSO (S1/S2) from SPICY and Fuente et al. 2021			SFR [$M_\odot$ Myr^{-1}]	SFE [%]
Class 0/I	Class II	Class III		
13/19	2/0	0/1	13.5/19.2	1.1/1.1

▹ *Key Results (Q2)*

Current SFR and SFE estimates do not show clear evidence for magnetic regulation, as incompleteness in embedded YSOs may bias the inferred star formation activity.

- Stellar feedback can modify grain alignment efficiency, changing the quality of magnetic field diagnostics.
- Current SFR/SFE estimates are insufficient to demonstrate magnetic regulation of star formation.
- Therefore, the interaction between star formation and magnetic fields can be probed observationally, but is not yet causally established.