MAGNETIC FIELD GEOMETRY AND GAS KINEMATICS IN NGC2024

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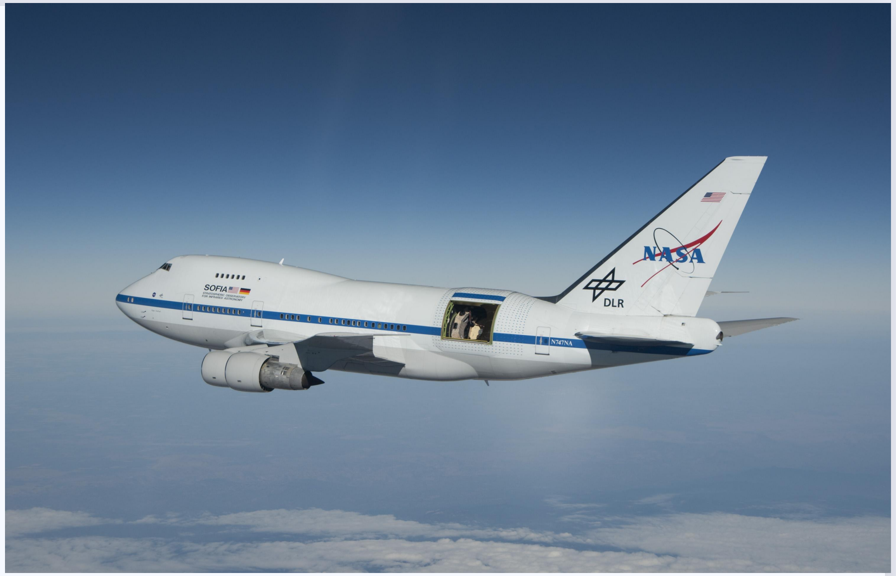
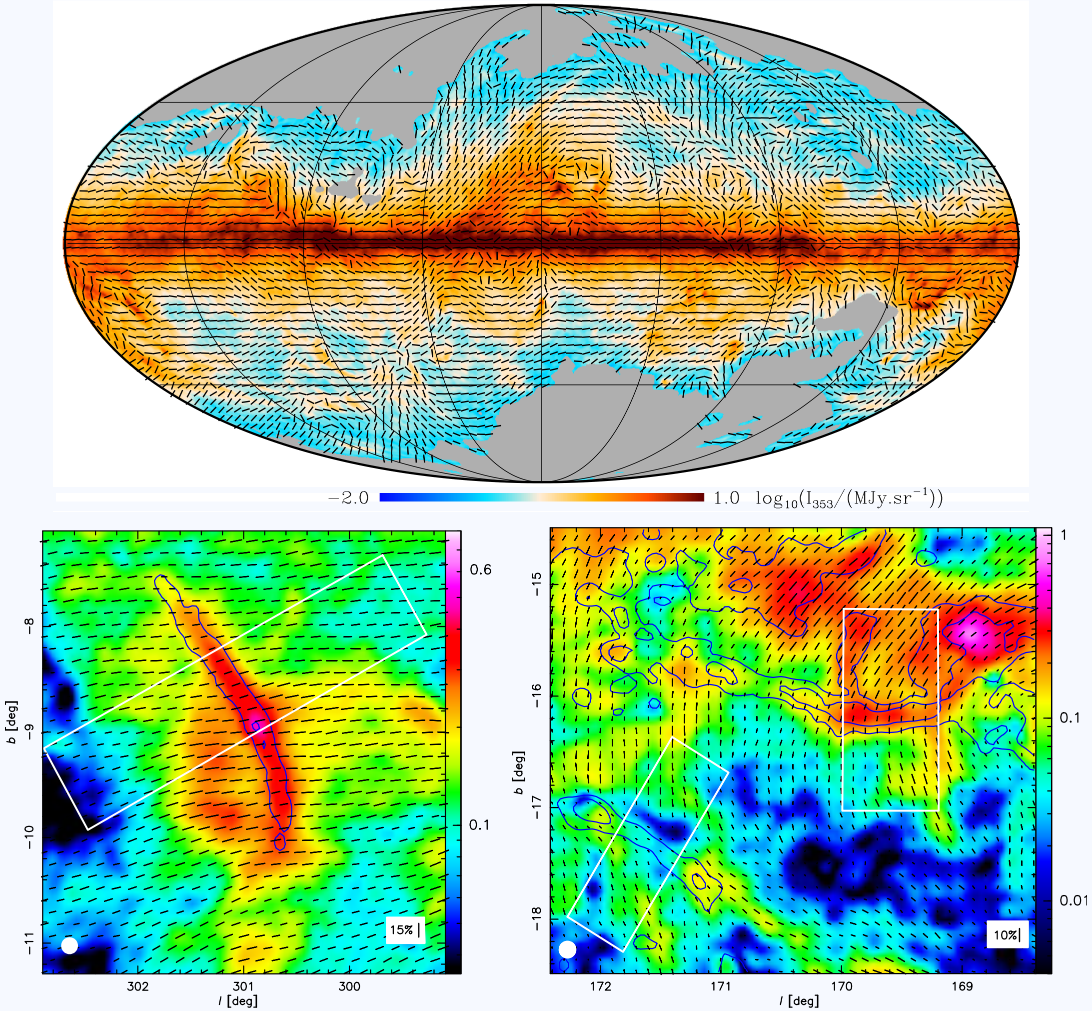


INTRODUCTION



Magnetic fields play a key role in supporting molecular clouds against gravitational collapse.

Planck dust polarization maps revealed a dramatic change in the alignment between the magnetic field and dust and gas in the ISM, from parallel in diffuse regions to perpendicular in dense supercritical filaments and ridges.

Such a transition should be accompanied by a corresponding change in the kinematic properties of the gas.

This can be investigated through a combination of wide-field dust polarimetry and velocity-resolved molecular line imaging at high angular resolution.

Planck XIX 2015, Planck XXXIII 2016

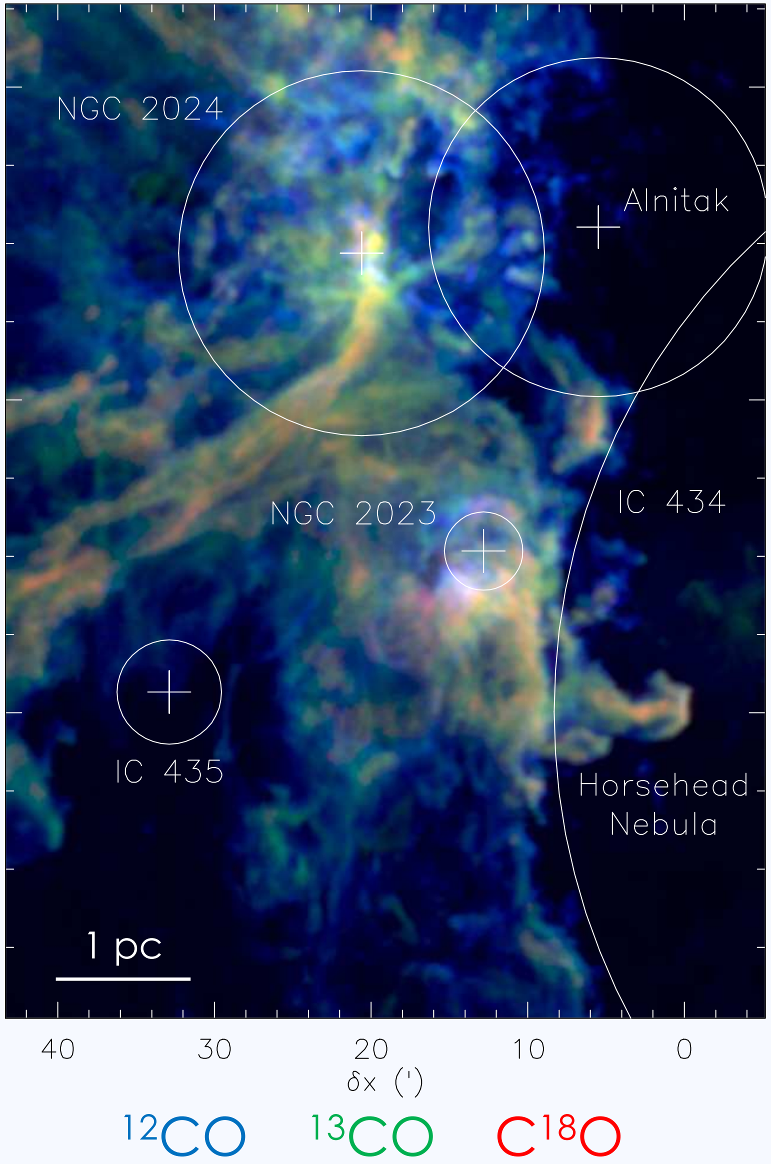
IRAM ORION-B LARGE PROGRAM

The IRAM-30m ORION-B Large Program has imaged a 5 square degree field (~20 pc across) in the Orion B molecular cloud.

Angular resolution of 26'' (10^4 au, or 0.05 pc).

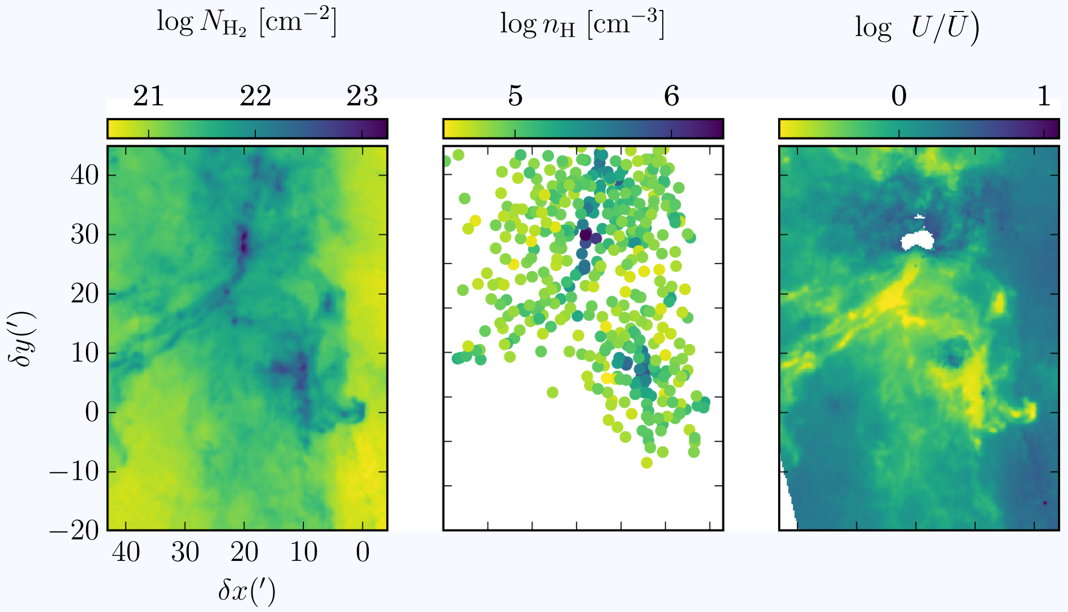
At least 30 molecular lines observed in the 72–116 GHz range with a spectral resolution ~0.6 km s^{-1}.

The species include CO, HCO^+, HCN, and CS, as well as their optically thin isotopologues.

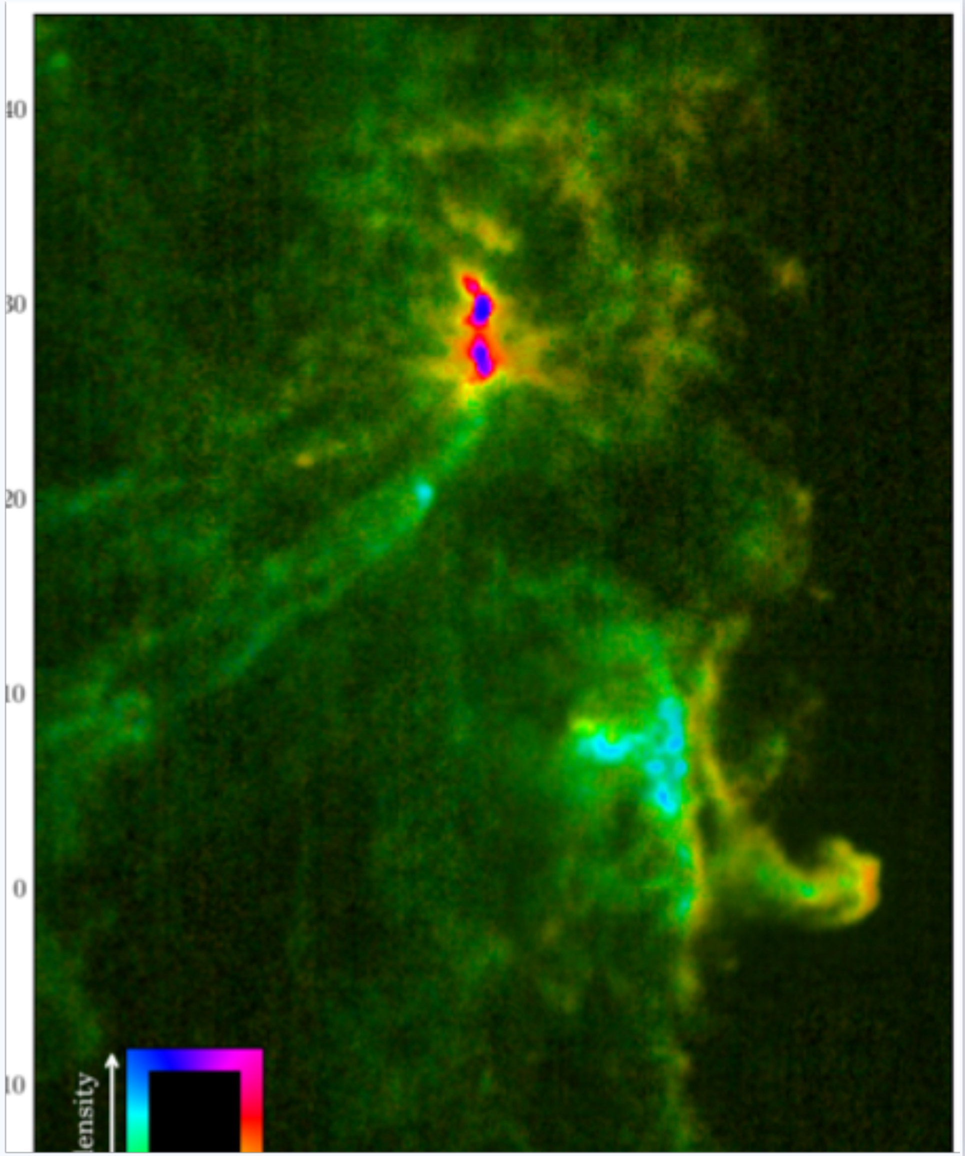


Pety et al. 2017

PCA ANALYSIS

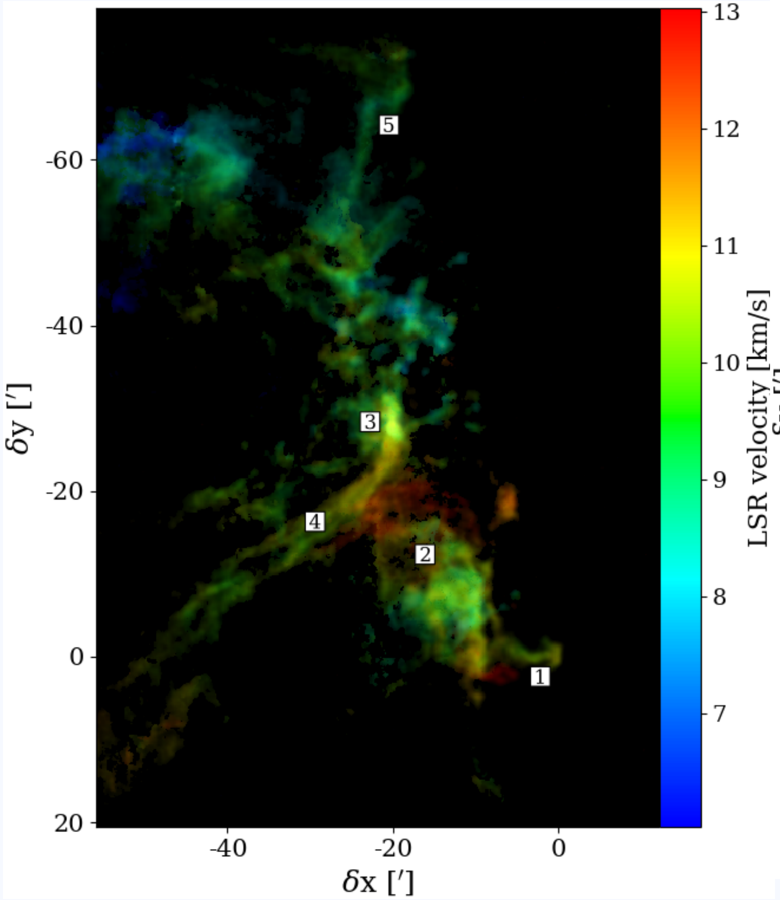


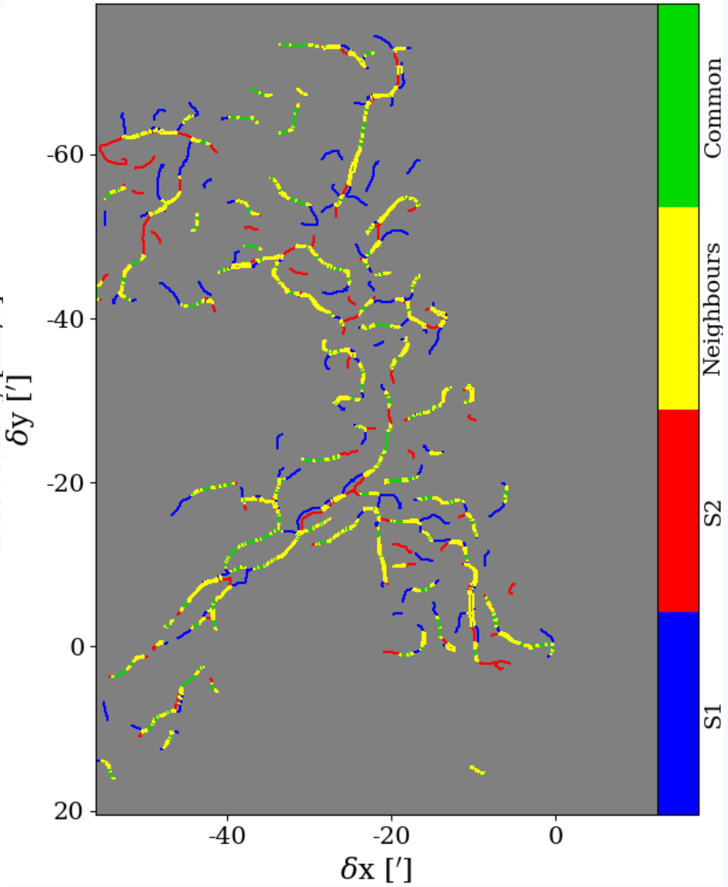
Magenta: dense PDR, yellow: diffuse PDR, green: diffuse non illuminated, blue: dense non illuminated.



Gratier et al. 2017

VELOCITY FIELD AND FILAMENTS





Dynamically young, gravitationally stable network of filaments.

Filament widths 0.12±0.04 pc

Wide range of linear (1–100 $M_\odot$ pc^{-1}) and volume densities (2×10^3–2×10^5 cm^{-3}).

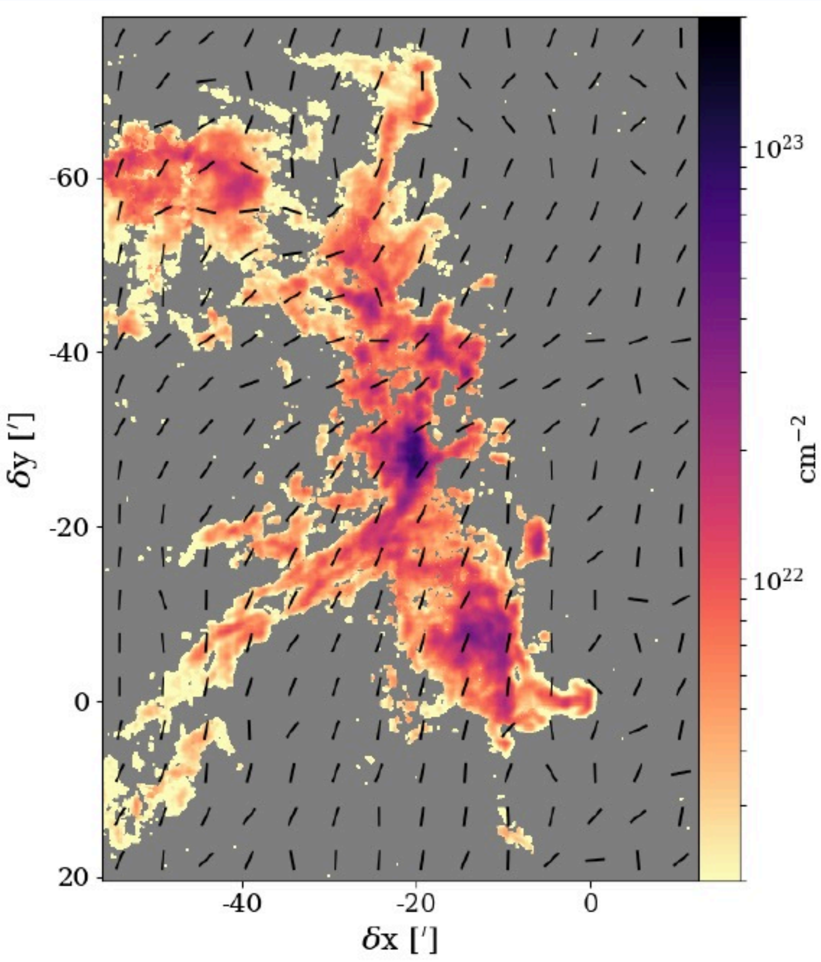
Filament population dominated by low-density, thermally subcritical structures.

Most of the filaments are not collapsing to form stars.

Only 1% of the mass in super-critical star-forming filaments.

Orkisz et al. 2019

MOTIVATION FOR SOFIA OBSERVATIONS



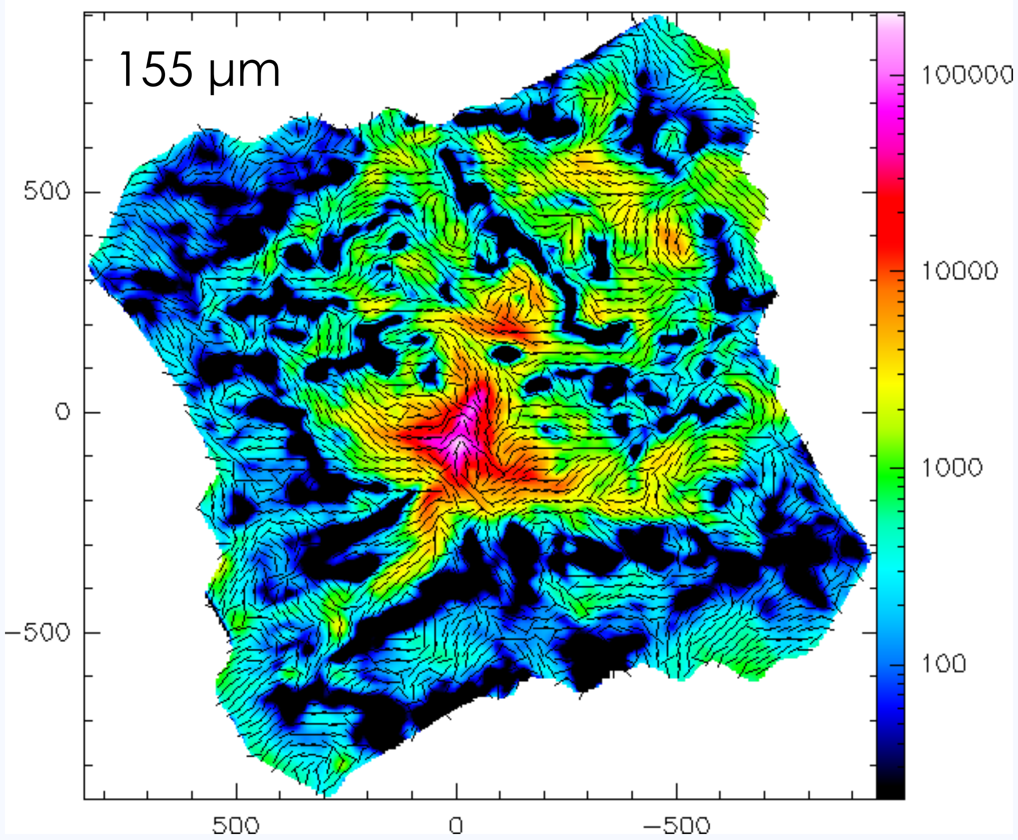
Unprecedented characterization of the physical structure, chemistry, and dynamics of a typical star-forming GMC with a favorable geometry.

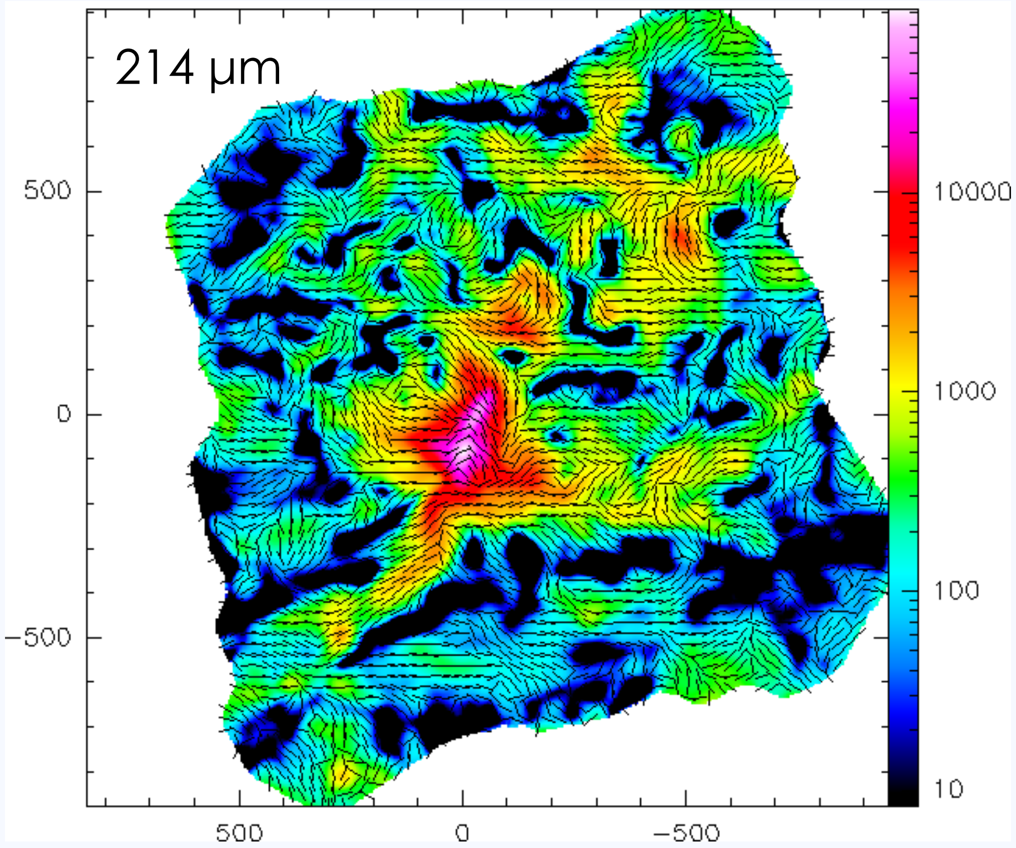
Lack of knowledge of the magnetic field on scales comparable to the characteristic size of dense ridges (~0.1 pc, 50″).

Our goal is to correlate changes in the magnetic field geometry with corresponding changes in the kinematic properties of the gas.

$C^{18}O$ + Planck polarization vectors *Orkisz et al. 2019*

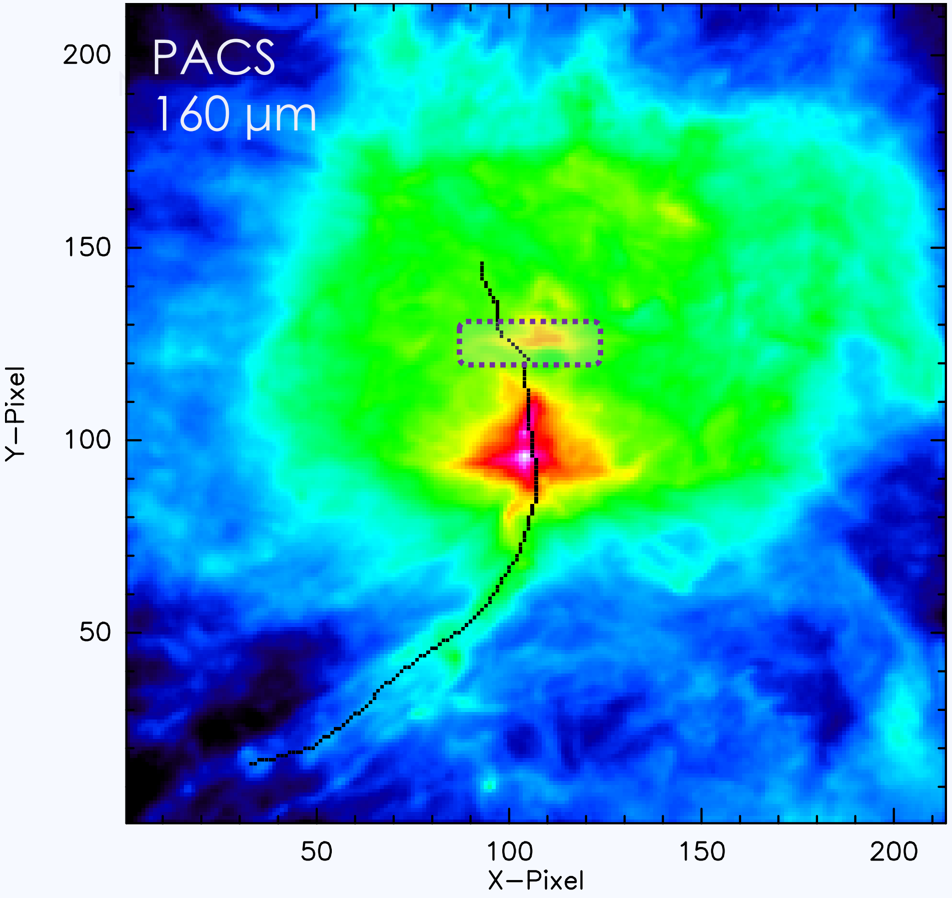
SOFIA OBSERVATIONS

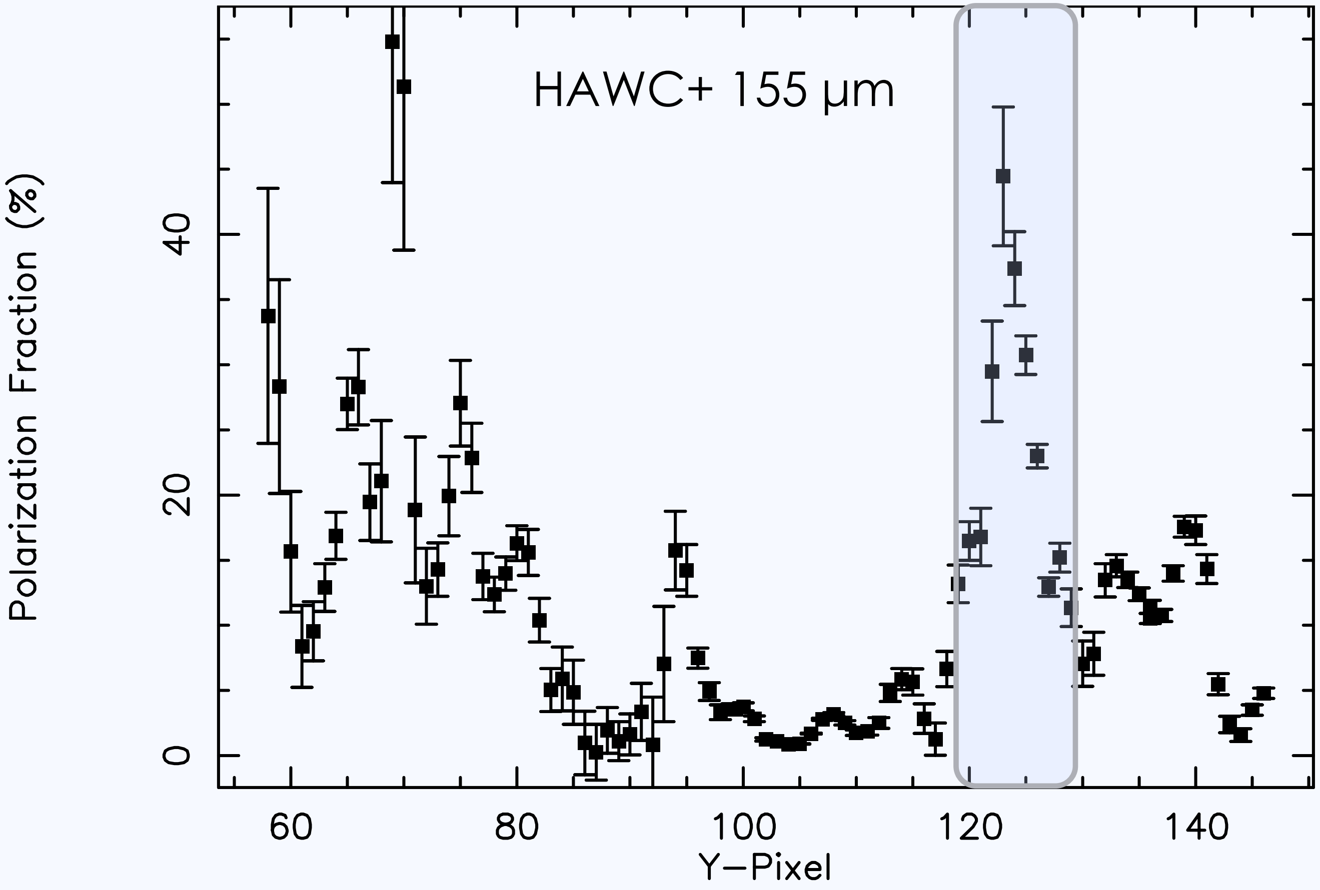




Challenging observations, ~20×20′ region, but excellent data quality.

MAIN NGC2024 FILAMENT

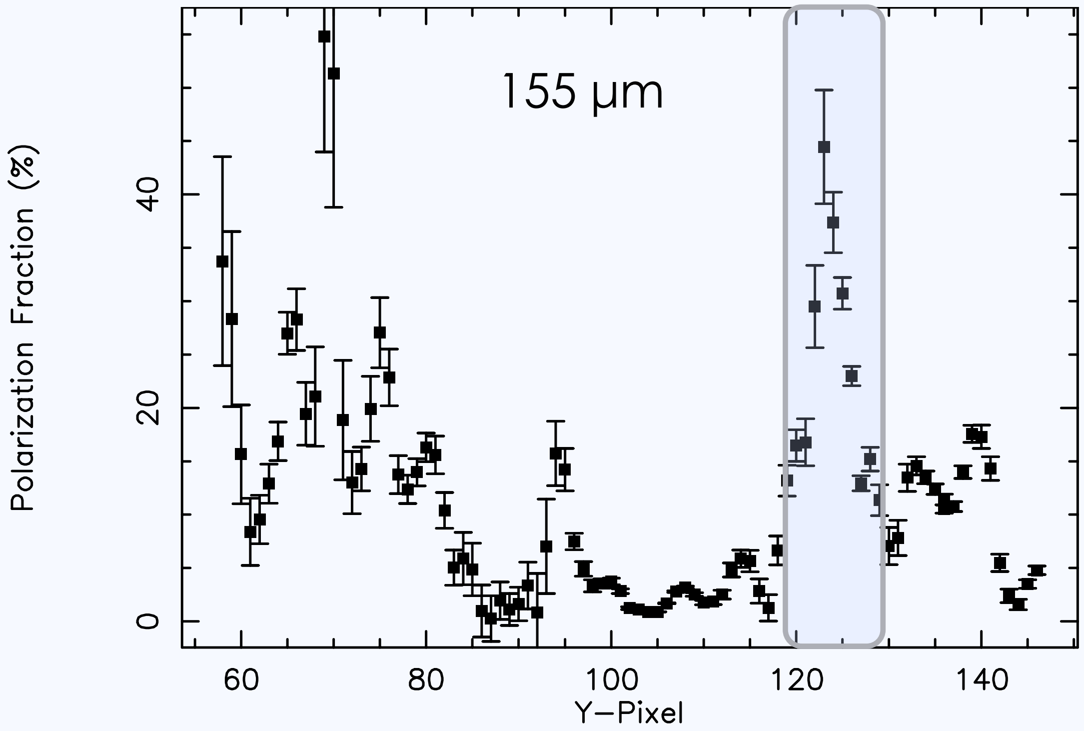


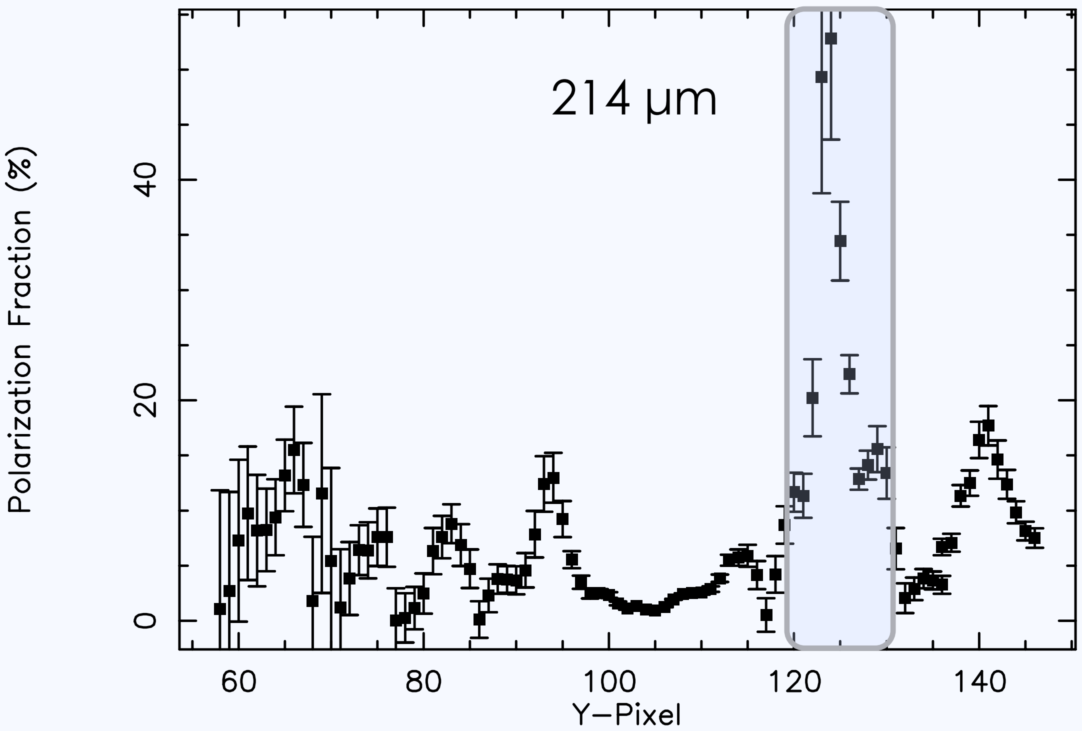


Large change in the polarization fraction in the north part of the filament.

High Polarization Fraction (HPF) region.

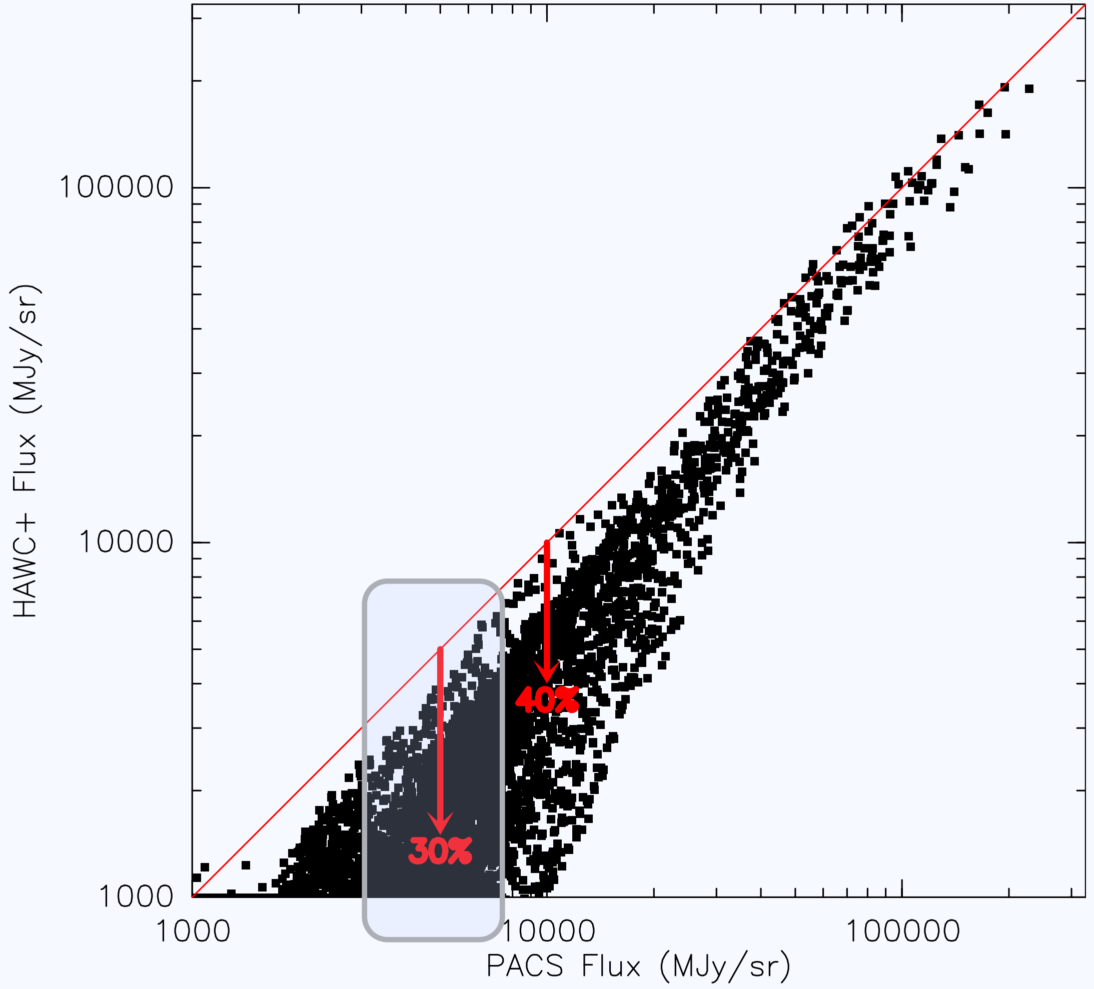
COMPARE 155 AND 214-MICRON HAWC+ DATA





Same pattern seen at 155 and 214 µm – independent observations.
But the very high polarization fraction does not seem reasonable!

FILTERING OF EXTENDED DUST EMISSION

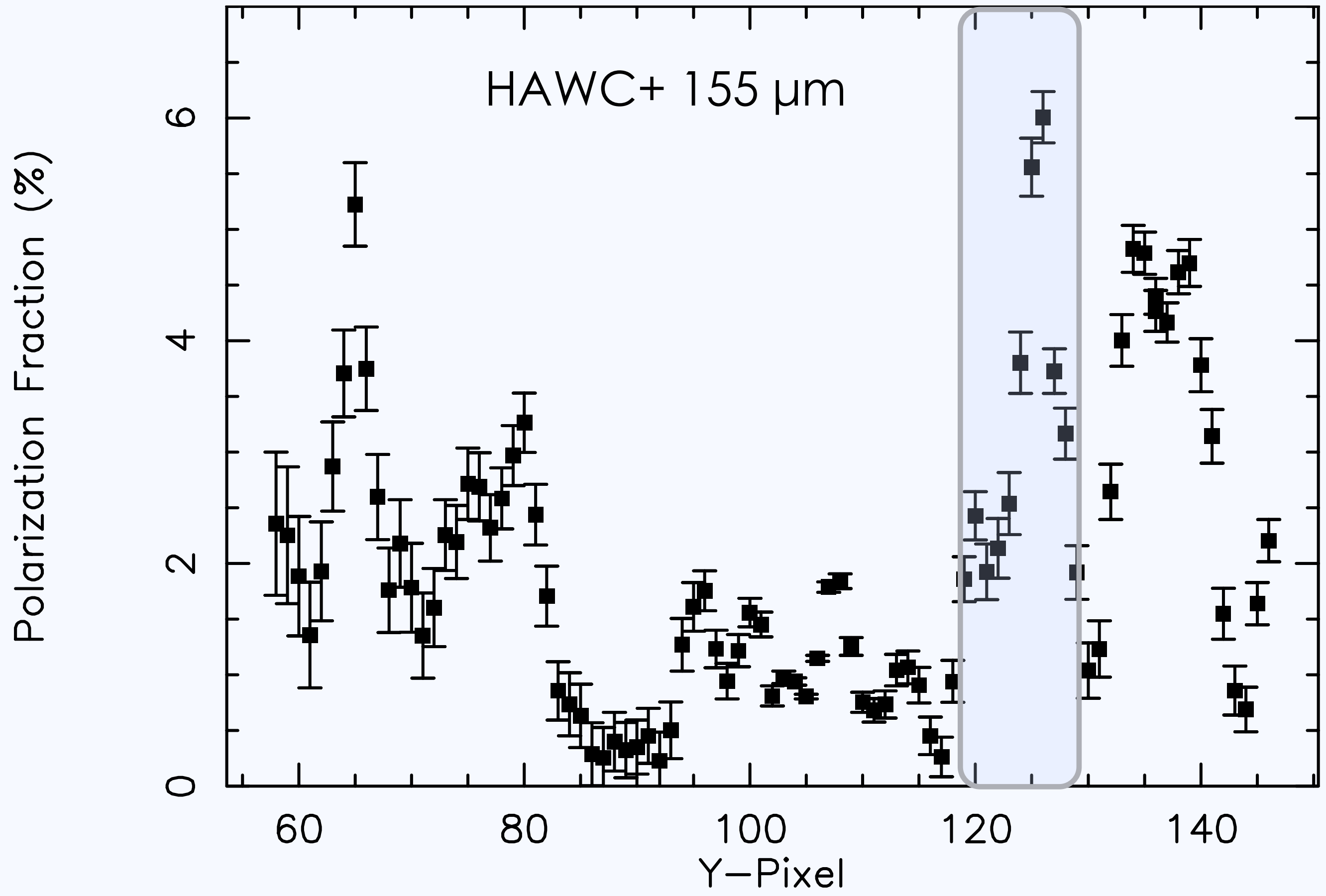


Good agreement between PACS and HAWC+ fluxes near the peak of the emission.

Significant filtering in the HAWC+ images at low flux levels.

Can we correct for this effect by using total PACS flux and polarized HAWC+ flux to re-compute the polarization fraction?

CORRECTED POLARIZATION FRACTION



Zeroth order correction: use HAWC+ polarized flux and PACS total flux (should be done earlier in the pipeline).

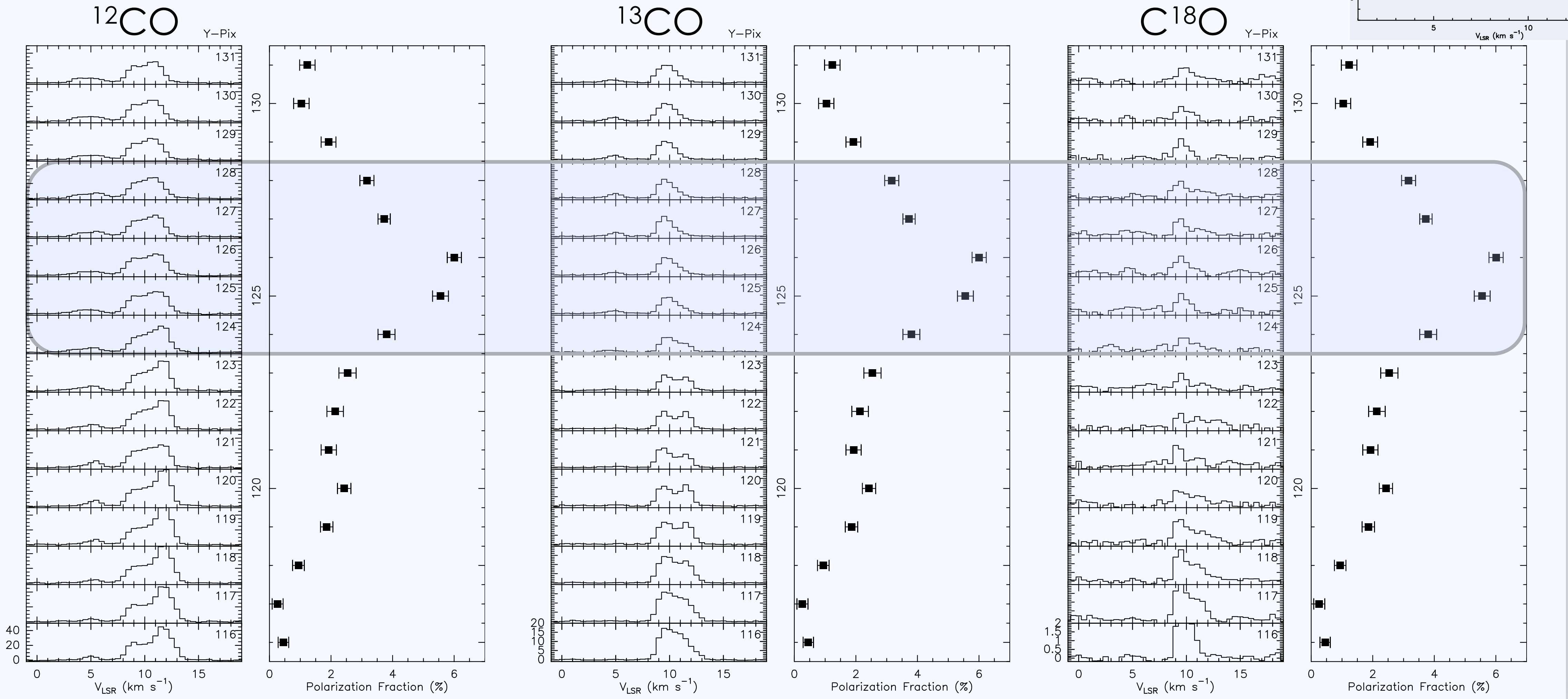
A peak in the polarization fraction at the same location.

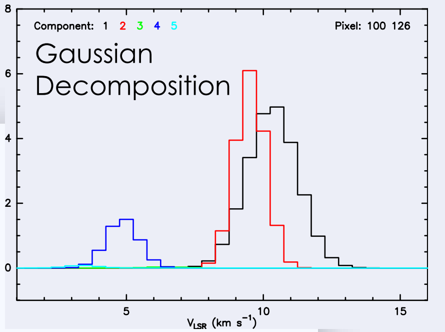
Maximum polarization fraction ~6% only.

Much more consistent with observations of other star-forming regions.

Orkisz et al. 2019

COMPARISON WITH MOLECULAR SPECTRA

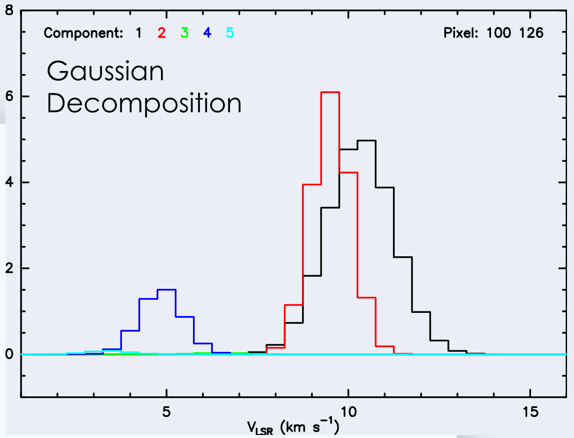




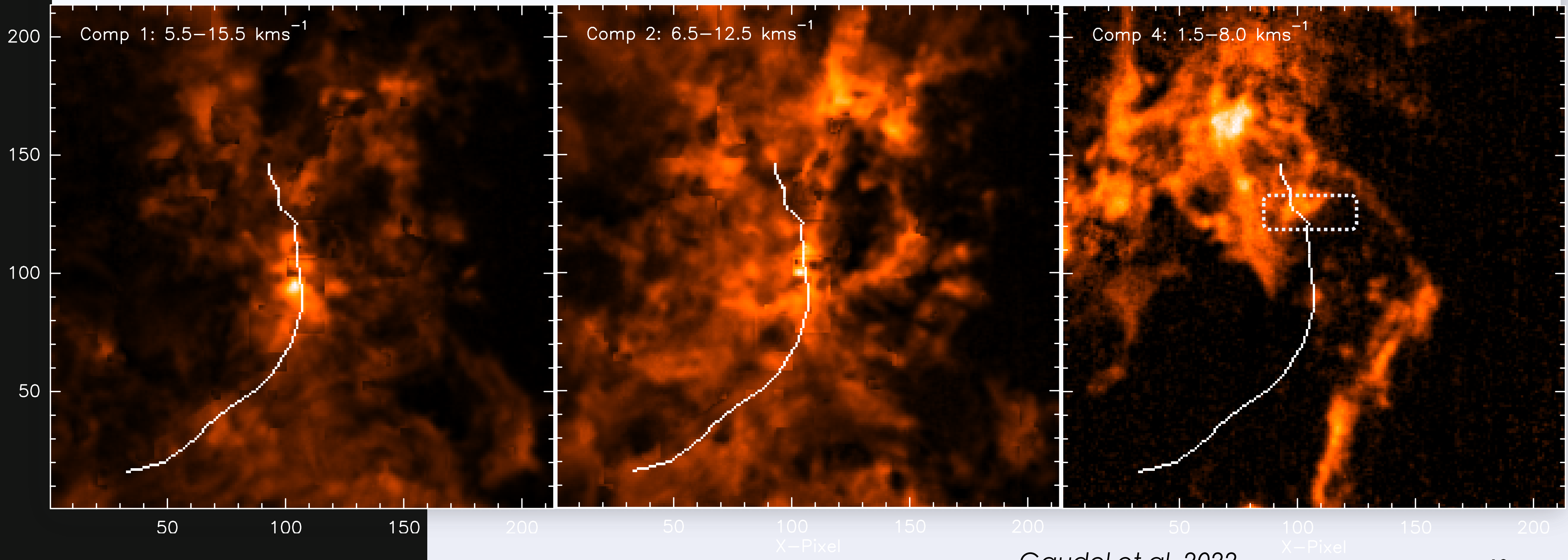
Changes in the molecular line shapes—three velocity components can be identified in the spectra in the vicinity of the HPF region

^{13}CO VELOCITY FIELD

Multiple velocity components with distinctly different morphologies.
The 5 kms^{-1} component spatially coincident with the HPF region.

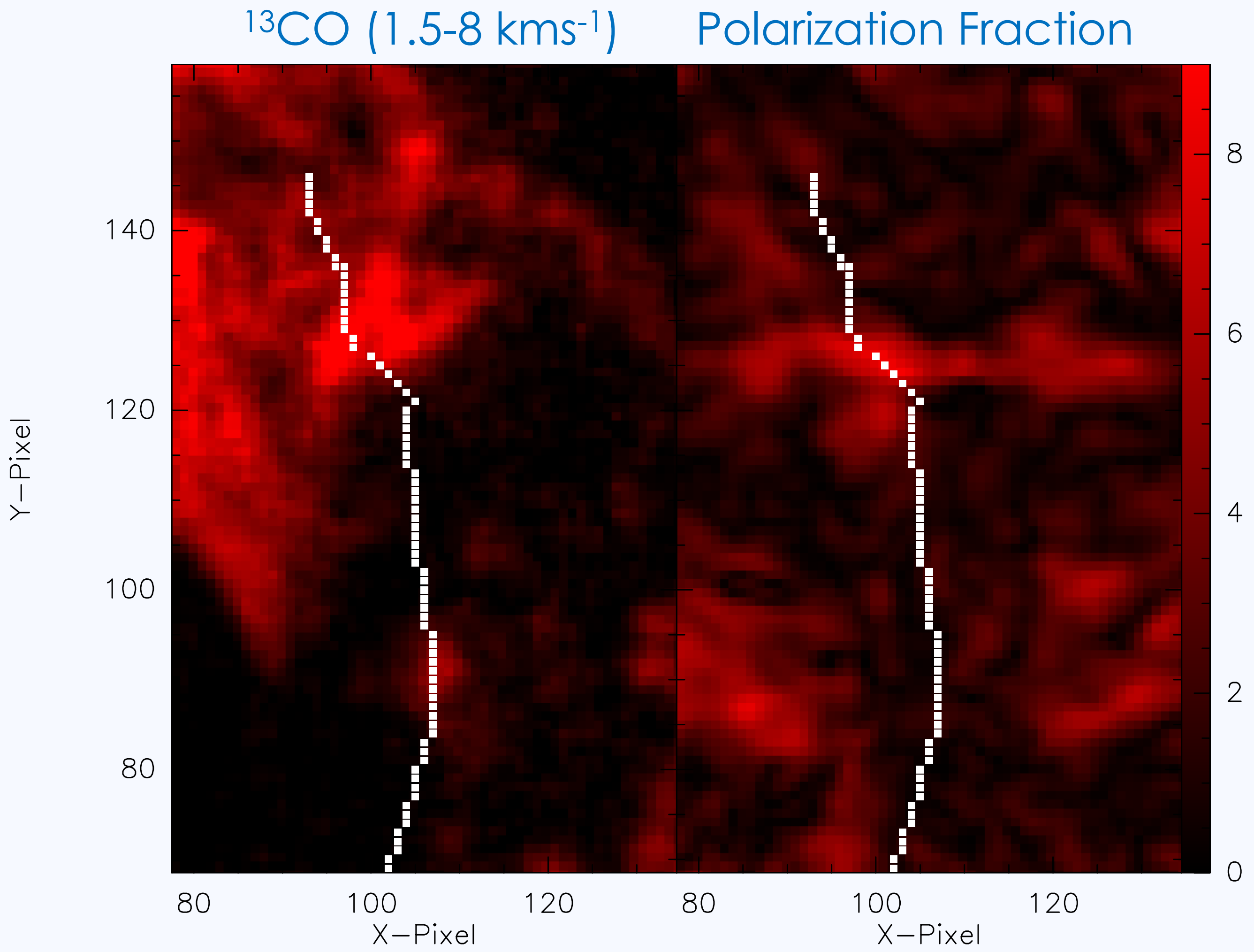


10.25 kms^{-1} 9.5 kms^{-1} 5.0 kms^{-1}



Gaudel et al. 2022

SUMMARY



Evidence for a correlation between changes in the polarization fraction and the kinematic properties of the gas *in one particular region.*

Developing techniques for the analysis of the full map.

PACS/SPIRE images should be used by the HAWC+ pipeline as an input model to help correct for the extended emission filtered out by HAWC+.

Molecular line observations provide kinematic information for separating spatially overlapping cloud components along the line of sight.

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