

ACES: Magnetic Fields in Molecular Filaments

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Observations: ACES, FIREPLACE, and BISTRO

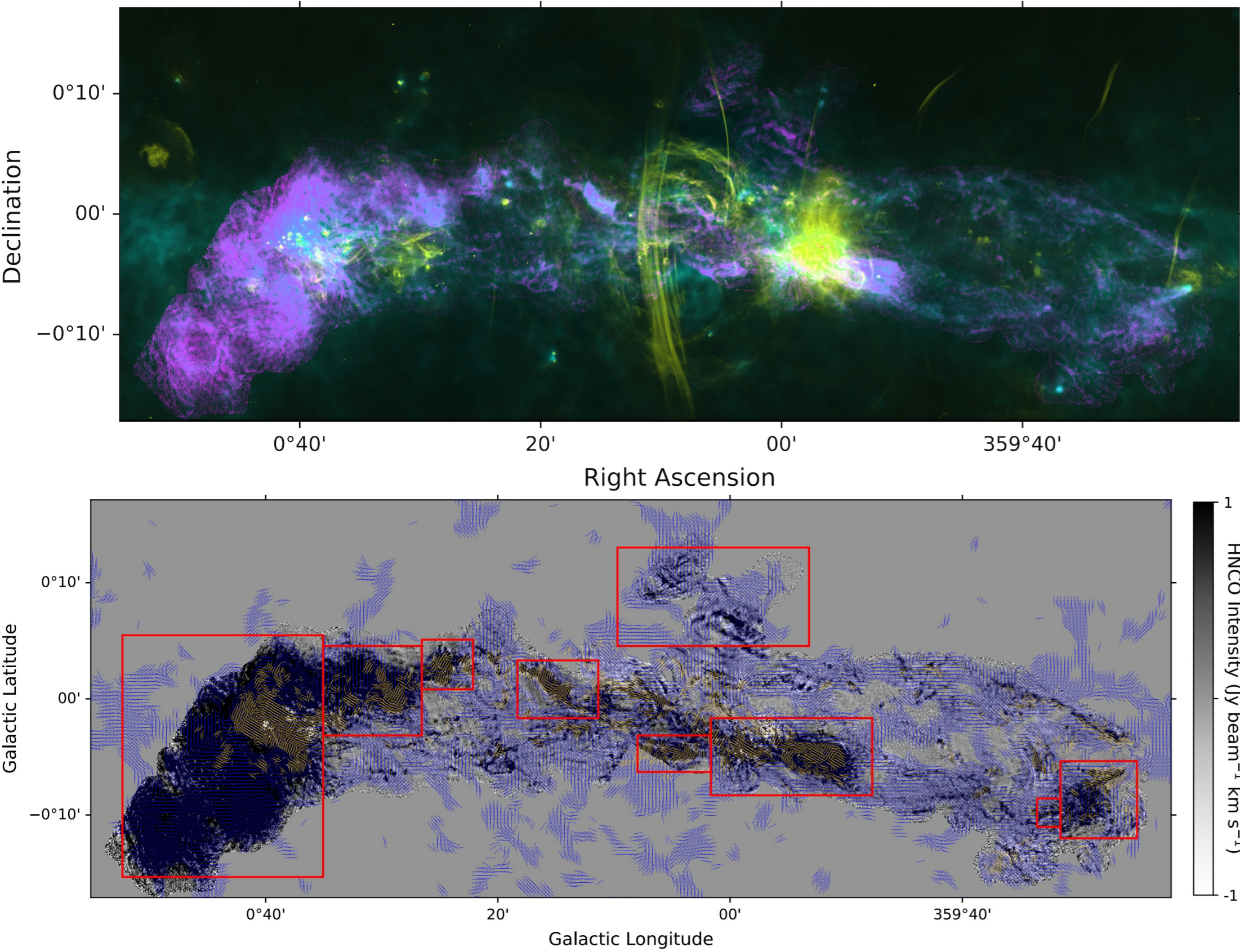


Figure 1: *Top:* 3-color view of the Central Molecular Zone (CMZ) with 20 cm (1.28 GHz) radio emission in yellow (Heywood et al. 2022), 250 μm observed by Herschel in cyan (Molinari et al. 2011), and the 3.4 mm (87.9 GHz) HNC O 4-3 moment 0 distribution from ACES (ALMA Band 3, Lognmore et al. 2026, Walker et al. 2026). *Bottom:* The FIREPLACE (214 μm , Paré et al. 2024) and BISTRO (850 μm , Karoly et al. 2025) magnetic field orientations shown as blue and yellow lines overlaid on ACES HNC O moment 0 (Paré et al. 2026).

Identified filaments in the ACES moment 0 map using the Rolling Houghs Transform (RHT) method. Focused analysis on the set of large HNC O filaments because they coincide with significant magnetic field measurements obtained from the FIREPLACE and BISTRO surveys and are not connected to CMZ clouds.

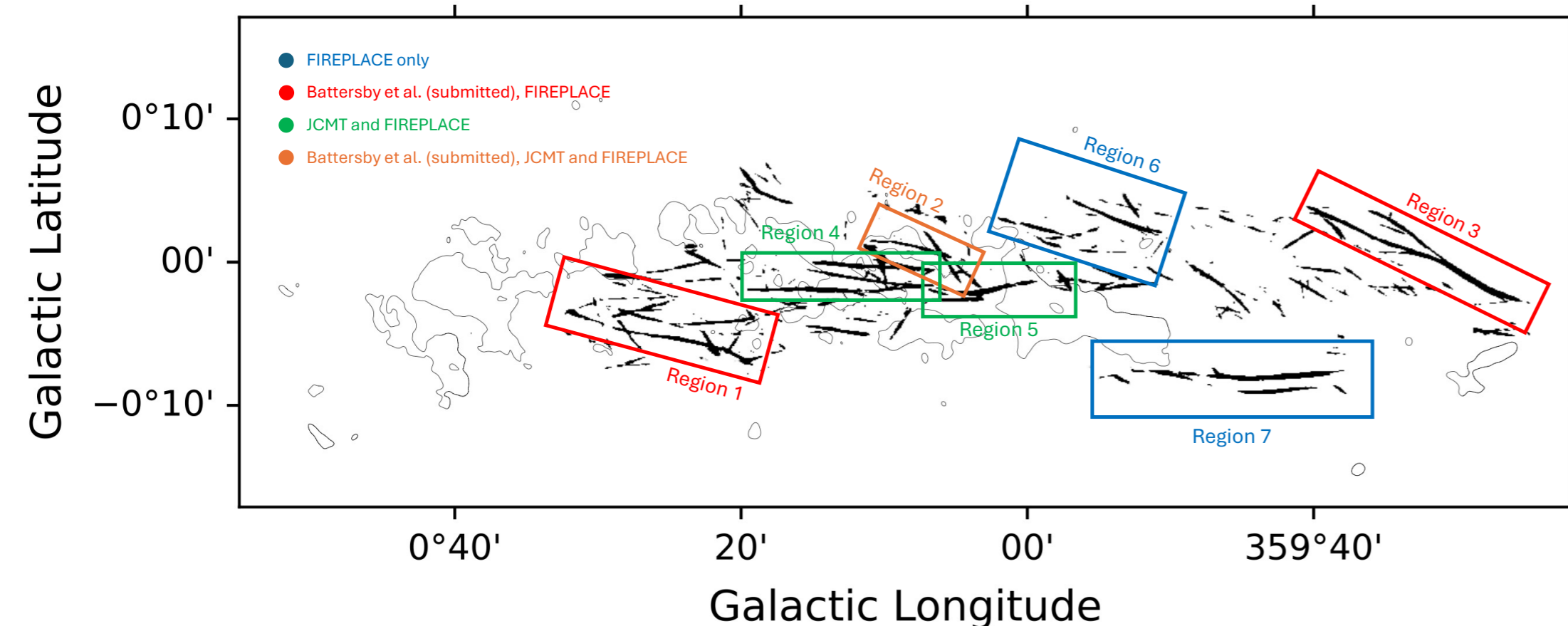


Figure 2: The set of RHT filaments. The longer filaments studied here are marked with boxes indicating whether they coincide with the FIREPLACE magnetic field only or both FIREPLACE and BISTRO. Also indicated is whether these filaments were studied in the ACES paper that first identified these HNC O filaments (Battersby et al. 2026).

Observations: B-field and ACES HNC O Filaments

Magnetic field alignment was studied using the Histogram of Relative Orientation (HRO) and Alignment Measure (AM) methods. The magnetic field is generally (but not universally) parallel to the HNC O filaments.

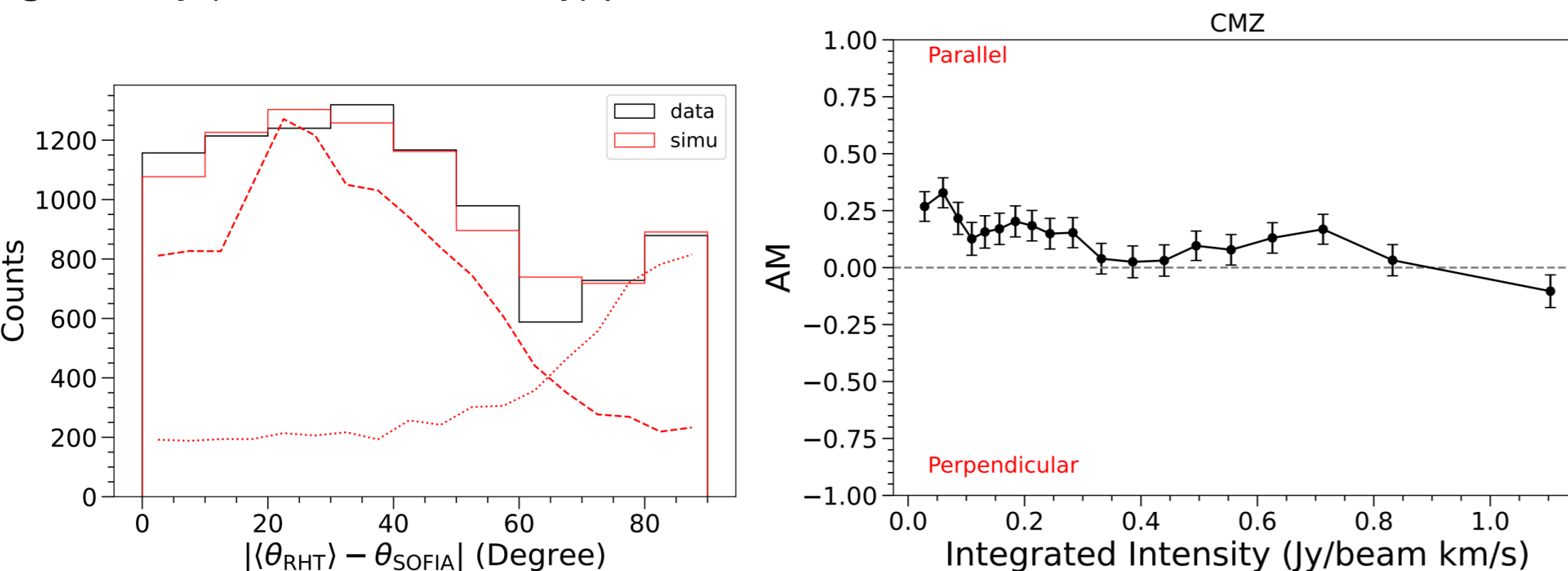


Figure 3: Orientation of the FIREPLACE magnetic field. *Left:* the HRO results indicating the angle between the HNC O filament orientation and the FIREPLACE magnetic field orientation. Angles are generally <40 degrees, indicating a preferential parallel alignment in the magnetic field. *Right:* The AM results for the set of large HNC O filaments marked in Figure 2. Positive AM values indicate a parallel magnetic field alignment whereas negative values indicate perpendicular alignment. The AM reveals a parallel magnetic field except at the highest HNC O moment 0 intensity regime (Paré et al. 2026).

References:

Battersby, C. et al. 2026, arXiv, arXiv:2602.20262; Coudé, S. et al. 2026, ApJS, 282, 2; Heywood, I. et al. 2022, ApJ, 925, 165; Karoly, J. et al. 2025, ApJL, 982, L22; Longmore, S. et al. 2026, arXiv, arXiv:2602.20340; Molinari, S. et al. 2011, ApJL, 735, L33; Paré, D. M. et al. 2024, ApJ, 969, 150; Paré, D. M. et al. 2026, ApJ, 1000, 37; Tress, R. G. et al. 2024, A&A, 691, A303; Walker, D. L. et al. 2026, arXiv, arXiv:2602.20276;

Simulations: MHD Model

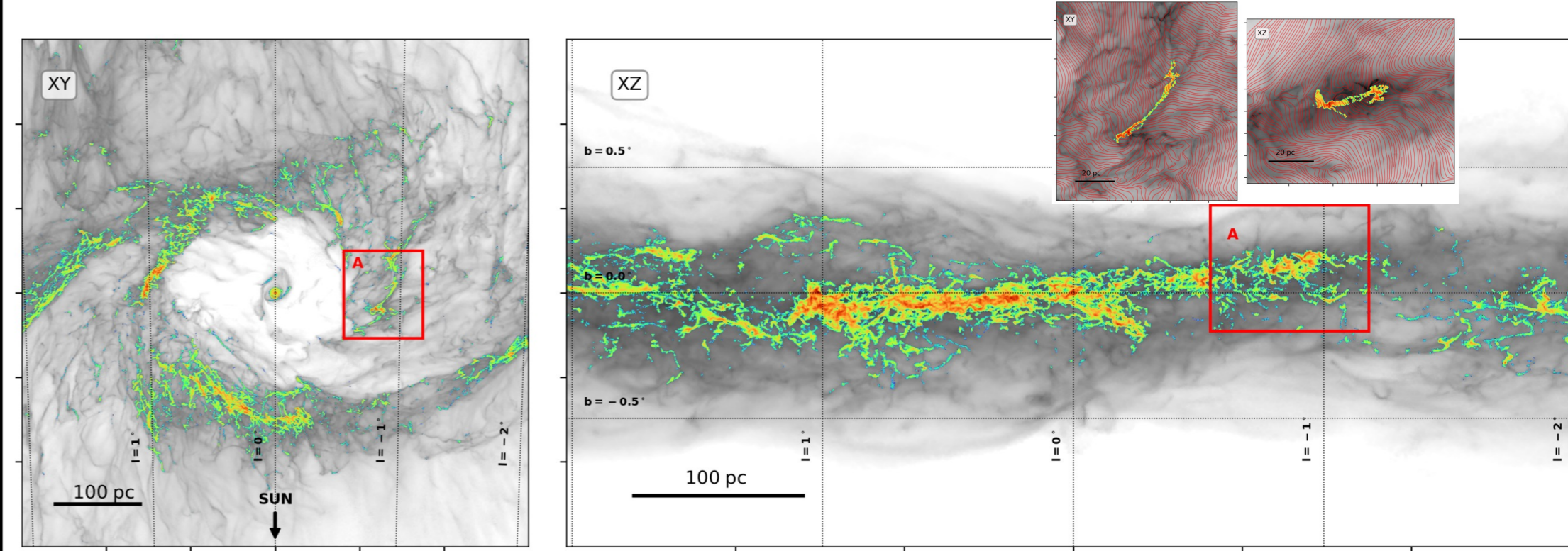


Figure 4: A face-on and edge-on view of the H_2 column densities obtained from the MHD model. Total H_2 gas is shown in grayscale and the dense ($n > 10^3$) molecular gas is shown in colorscale. Inset panels show an example filament shown face-on and edge-on. The location of this filament in the full simulation is shown with red boxes.

The model was generated using the moving-mesh code AREPO covering the central few kpc of the Galaxy following the modeling of Tress et al. (2024). ISM evolution of entire barred region is modeled under the effect of an externally imposed barred background potential with magnetic fields but not self-gravity.

Simulations: Synthetic Data Set

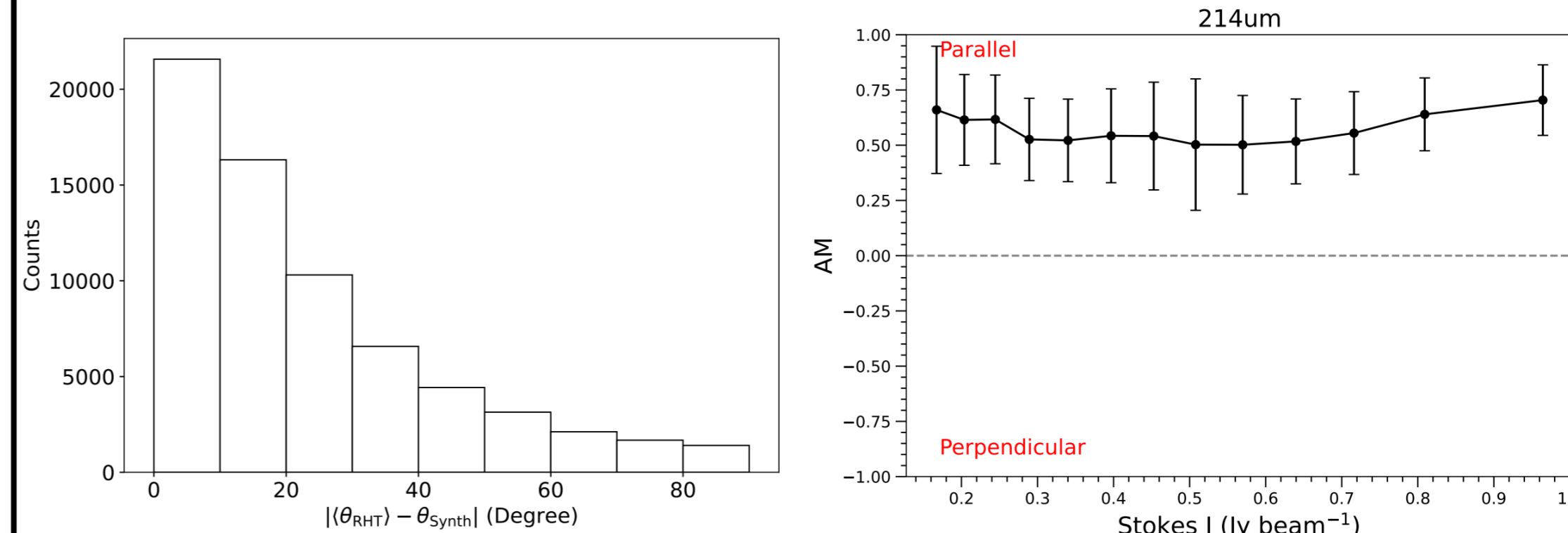


Figure 5: The alignment of the POLARIS-generated magnetic field with the set of synthetic filaments. A parallel magnetic field alignment is observed in this synthetic data set that corresponds to a high magnetic field strength of a few 100 μG .

A synthetic data set is created from the central 350 pc region of the Galaxy of the MHD model using the POLARIS radiative transfer software. The POLARIS data set was generated assuming a strong magnetic field (a few 100 μG). The RHT method is then applied to identify synthetic filaments with the HRO and AM methods then run to determine the alignment of the synthetic magnetic field with these filaments.

Discussion and Conclusion: What Does it All Mean?

The magnetic field is generally parallel, though there is a bimodal distribution in the FIREPLACE data set (Figure 3) which does not appear when comparing to the BISTRO magnetic field. The parallel filaments are found to be dominated by mechanisms like subsonic turbulence and shear which are possible mechanisms that inhibit cloud collapse.

- Parallel magnetic field orientations are also observed in the synthetic data sets that were made with a high magnetic field strength, indicating that parallel magnetic fields could be supporting against gravity, preventing cloud collapse.
- Changing orientations in different filaments indicate the changing role of turbulence where it could be variously assisting or inhibiting cloud collapse. Such changes could help explain the range of SFRs seen in individual clouds of the CMZ.
- The filaments studied here are similar to Galactic disk molecular filaments known as the “bones” (Coudé et al. 2026). The range of magnetic field alignments in our filaments contrasts with the generally perpendicular orientation seen in the bones. The morphological similarity of our filaments leads us to adopt the term “ribs” for these Galactic Center structures.

The “Paper Sprint” Organization

This work was mainly conducted during an intense, two week collaborative research and writing process involving astronomers in a large range of timezones (based on Battersby et al. 2026). During this two week period researchers devoted 50% or more of their research time towards data analysis and paper writing for this project. This two-week period was organized like so:

- Researchers were split into focus groups depending on expertise, such as observations and modeling.
- Each group had a leading directing the work of the group and teams would meet daily to discuss progress and next steps.
- All groups would meet together every other day to track overall progress
- First week was devoted to data analysis and interpretation, second week for paper writing and editing.