

Galactic HI and the Polarized CMB Foreground

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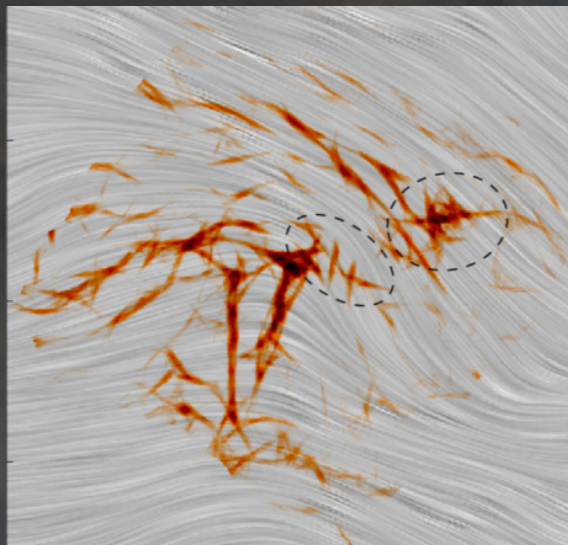


**Do linear HI structures trace
the magnetic field?**

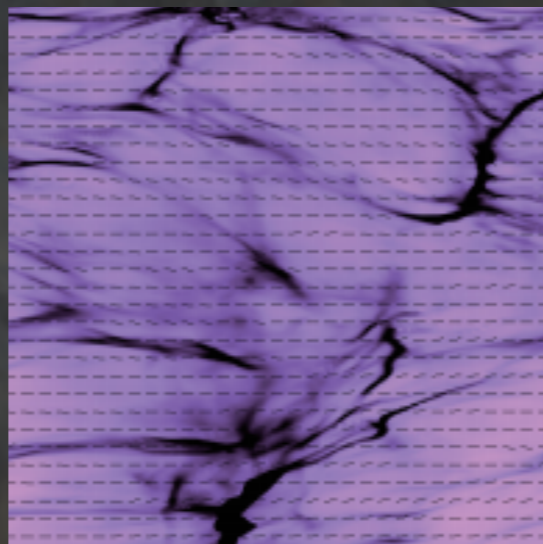
The Rolling Hough Transform

Clark, Peek, & Putman 2014, ApJ 789, 82

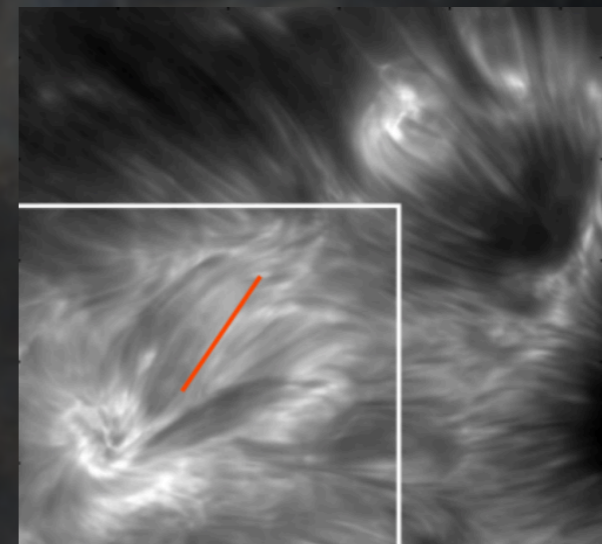
 github.com/seclark/RHT



Malinen+ 2016

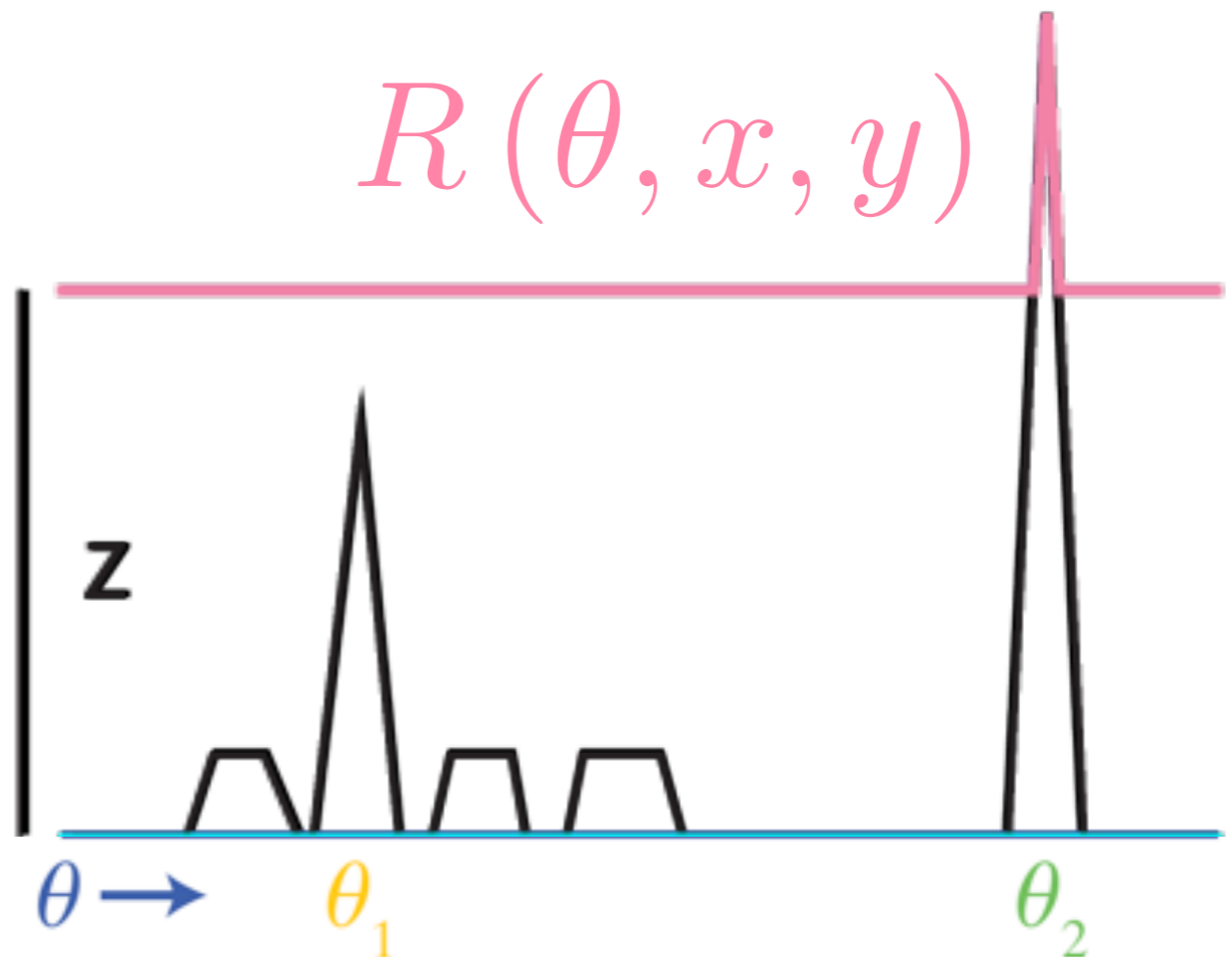
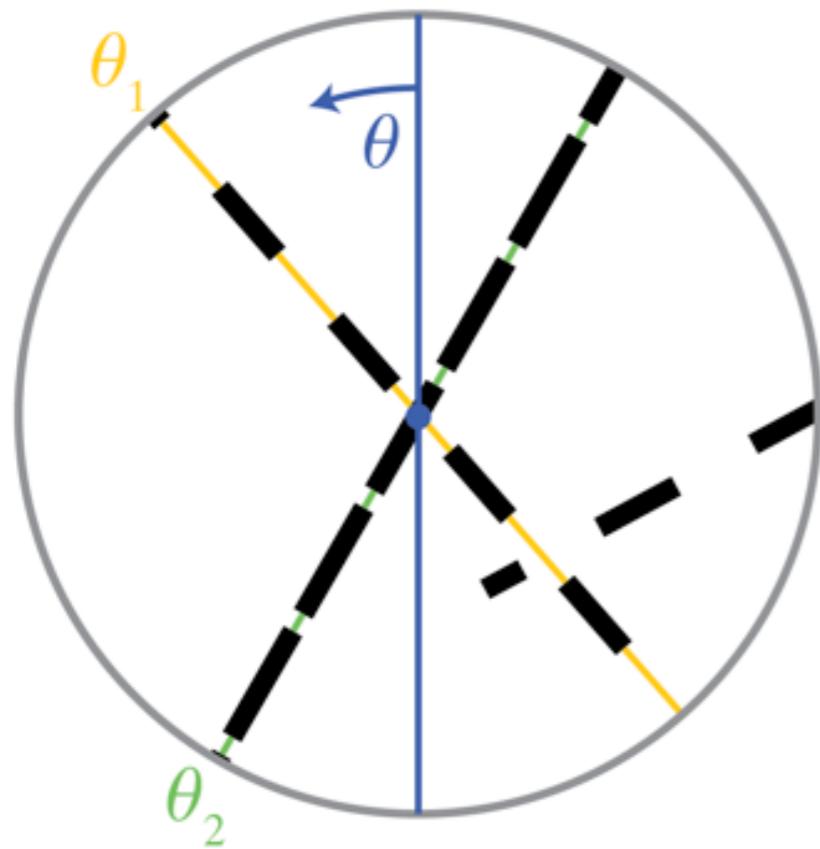


Inoue & Inutsuka 2016



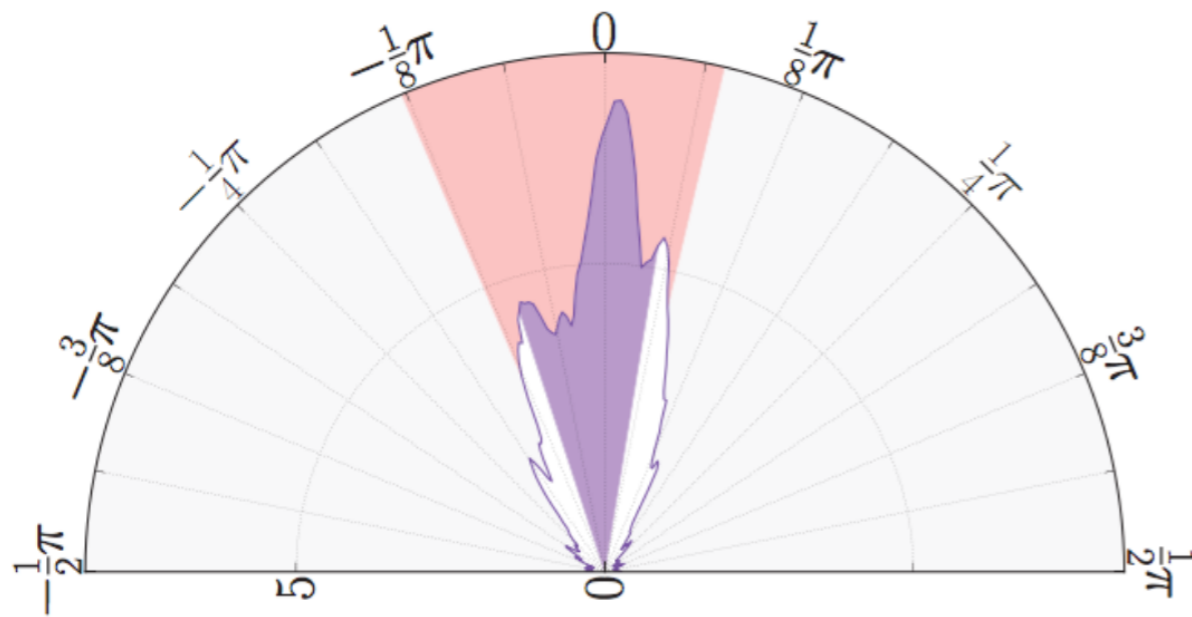
Asensio Ramos+ 2017

Measure intensity as a function of angle.

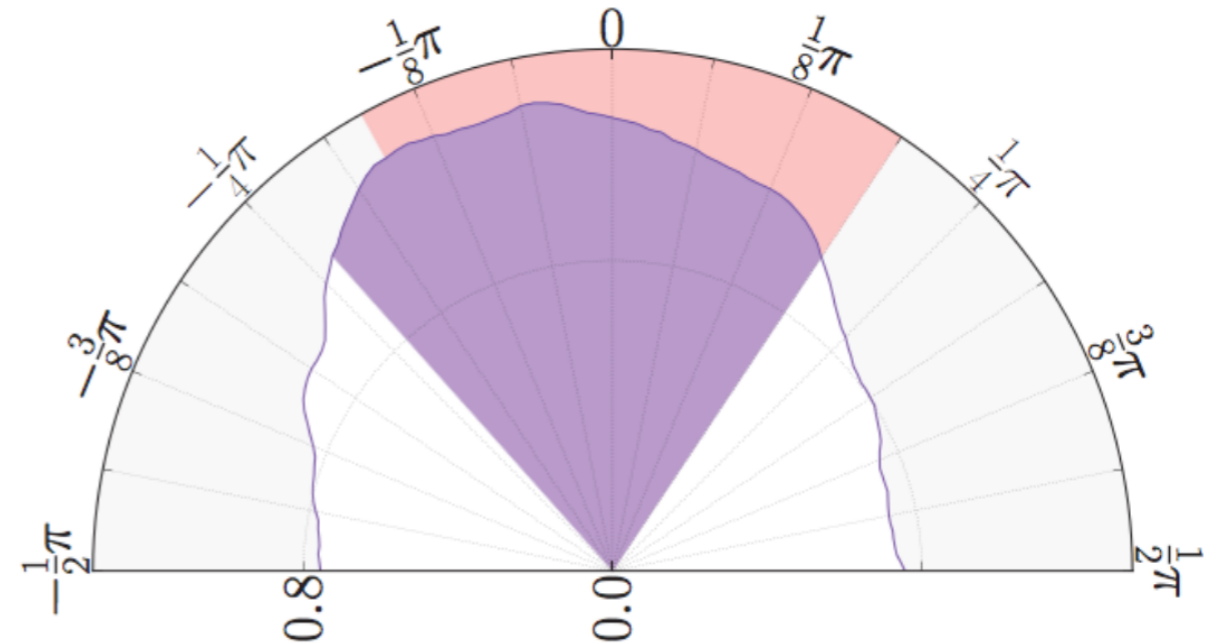


The correlation is tighter with high-resolution HI.

GALFA-HI : 4'



Parkes GASS : 16'



Calculate Stokes parameters
from the HI orientation.

$$Q_{RHT} = \int \cos(2\theta) \cdot R(\theta) d\theta$$

$$U_{RHT} = \int \sin(2\theta) \cdot R(\theta) d\theta$$



Calculate HI and Planck magnetic field orientation.

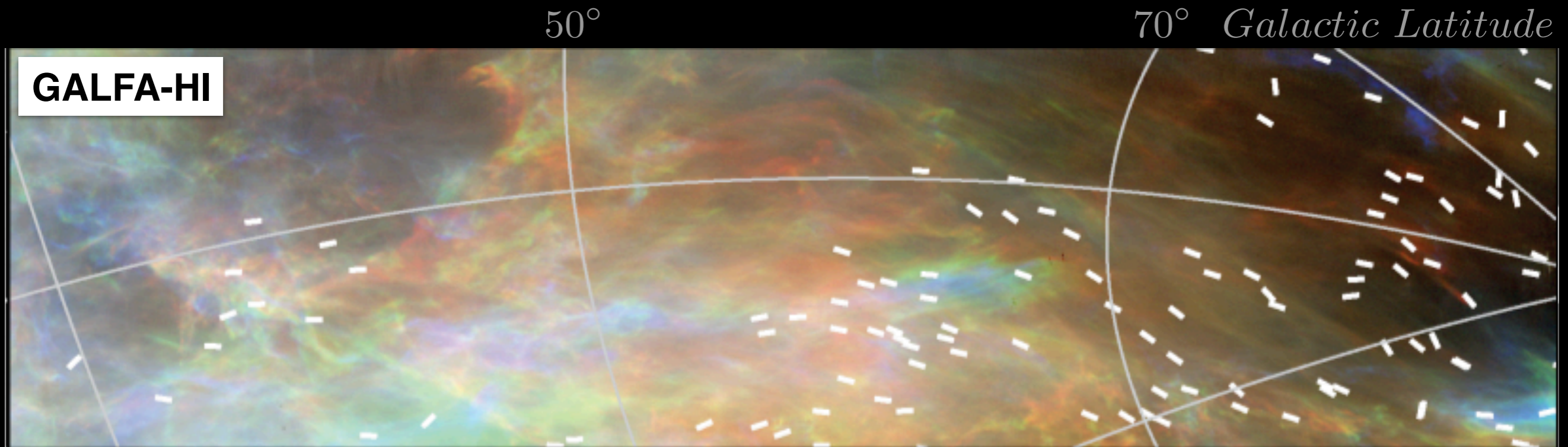
Neutral hydrogen orientation

$$\theta_{RHT} = \frac{1}{2} \arctan \frac{U_{RHT}}{Q_{RHT}}$$

Planck magnetic field orientation

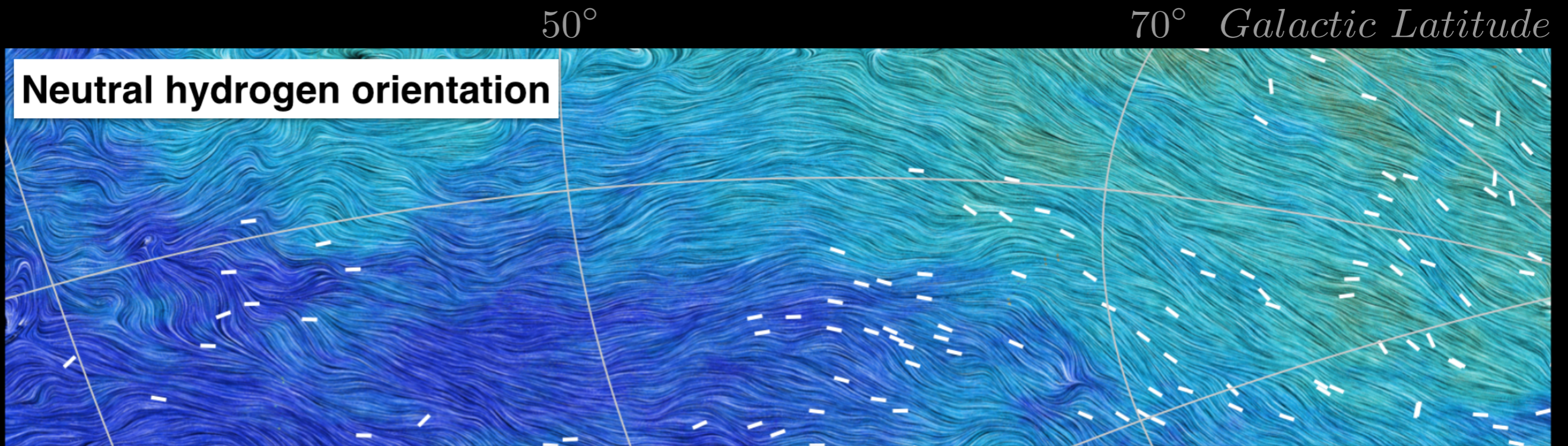
$$\theta_{353} = \psi_{353} + 90^\circ$$

Characterize the orientation of high-latitude GALFA-HI structures.



-3 km/s
0 km/s
+3 km/s

Characterize the orientation of high-latitude GALFA-HI structures.

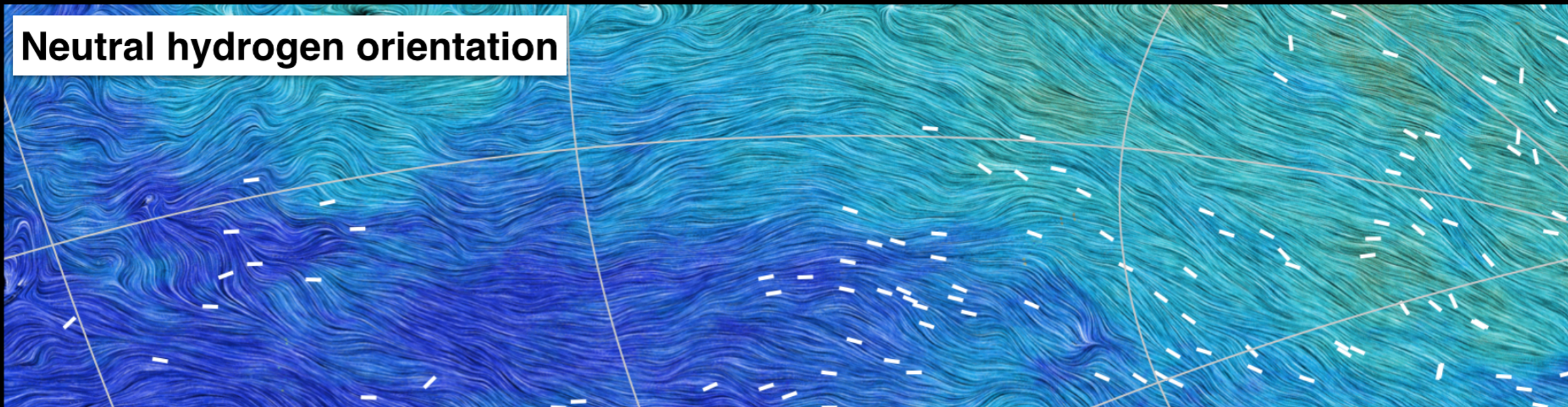


High-latitude GALFA-HI structures are aligned with the Planck magnetic field orientation.

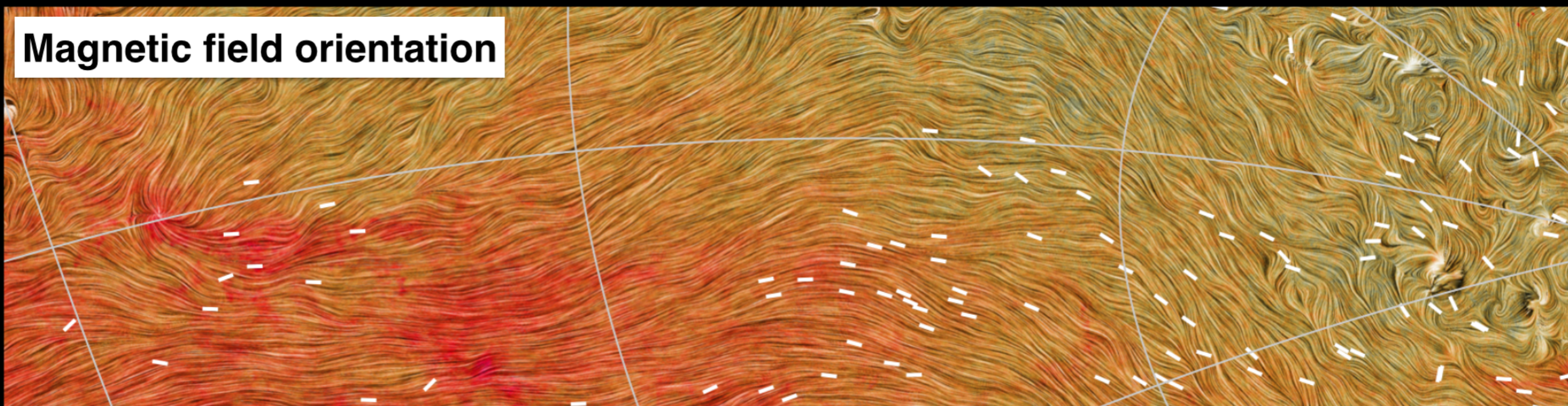
50°

70° *Galactic Latitude*

Neutral hydrogen orientation



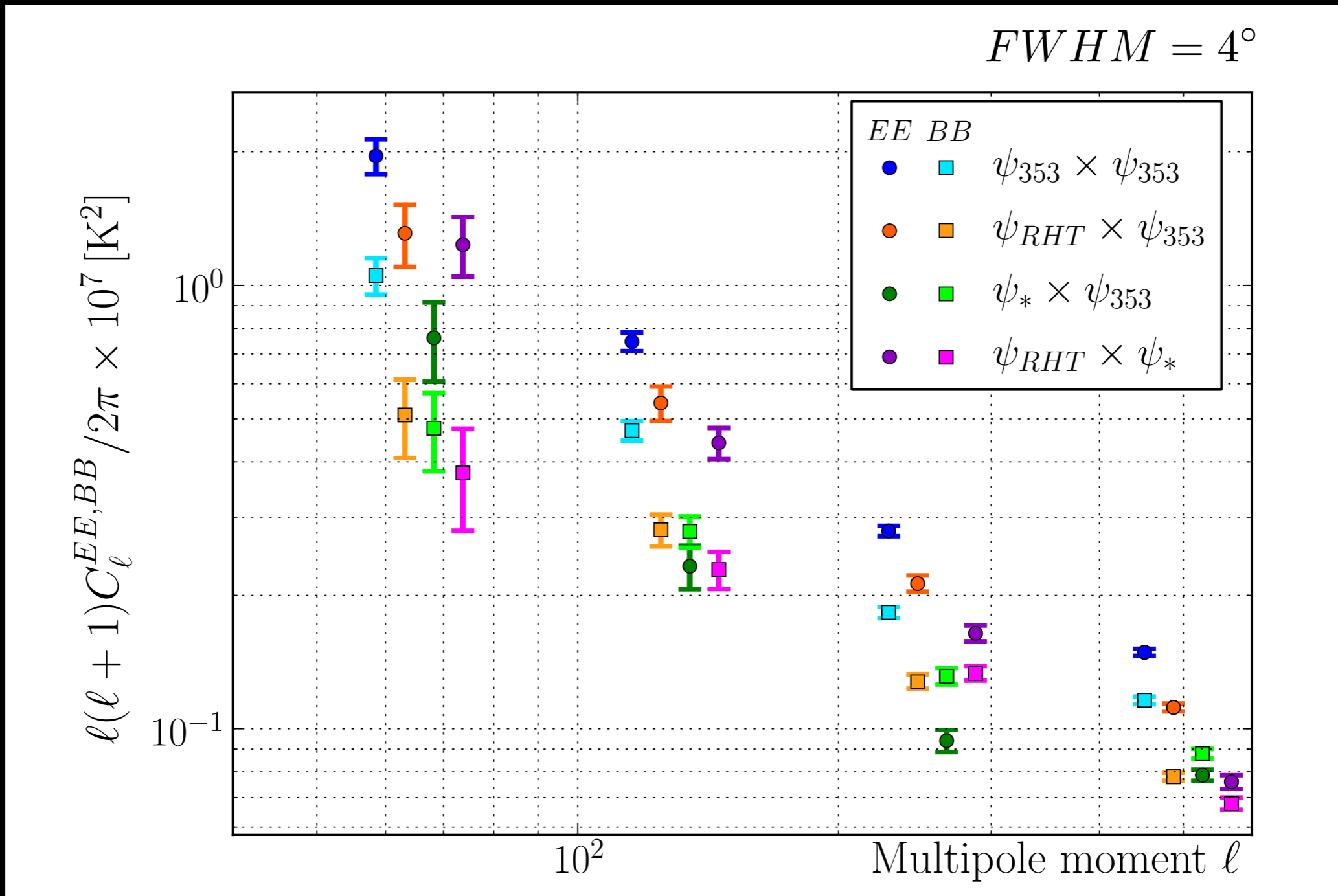
Magnetic field orientation



Starlight polarization: Heiles 2000

Clark, Hill+ 2015, PRL

We detect strong cross-correlations between RHT, 353 GHz, and starlight polarization angles.



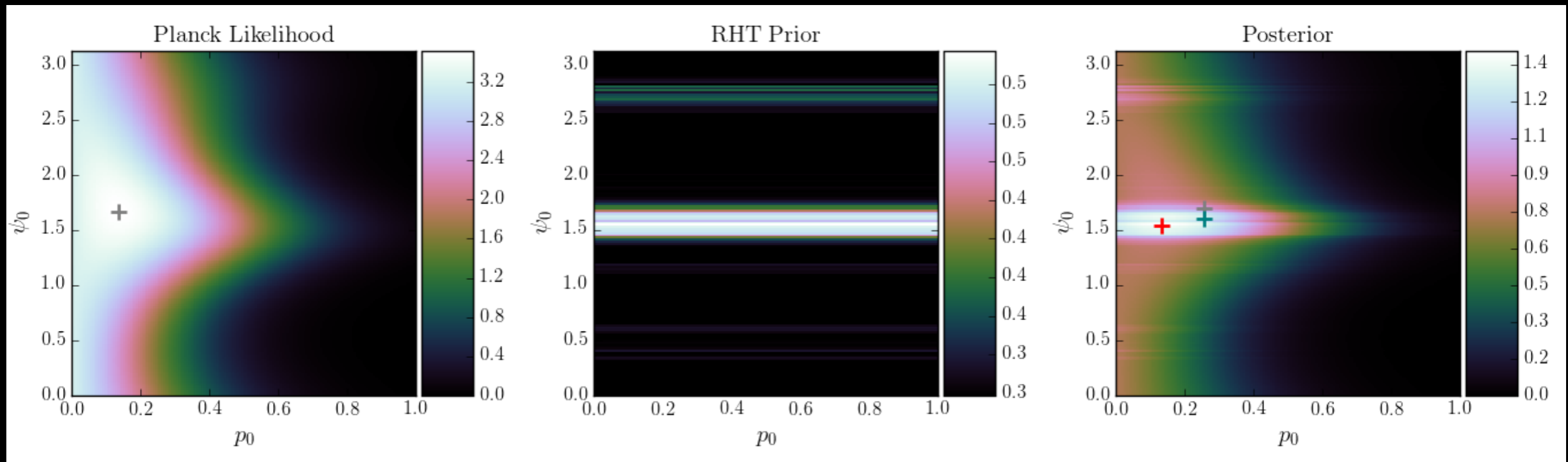
We use HI data to better constrain the plane-of-sky magnetic field orientation.

Planck likelihood

RHT HI prior

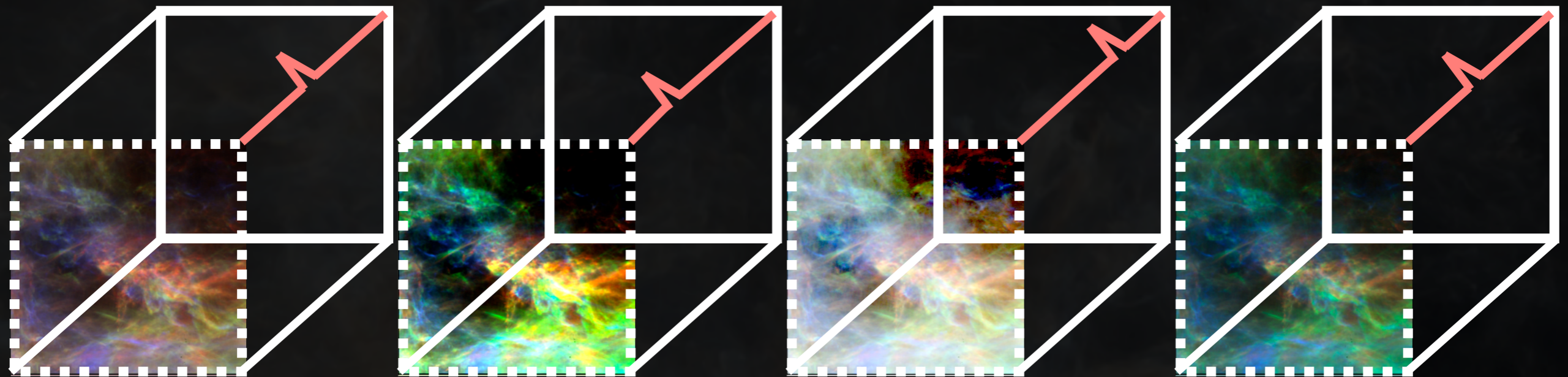
Posterior

θ_0



p_0

What can we learn about the magnetized ISM from the velocity structure of HI linearity?



V_1

V_2

V_3

V_4

fourth dimension: velocity

Can we learn about the LOS magnetic field?

Polarized dust emission region

higher fractional polarization



lower fractional polarization



Distance

Can we learn about the LOS magnetic field?

HI velocity channel

higher fractional polarization

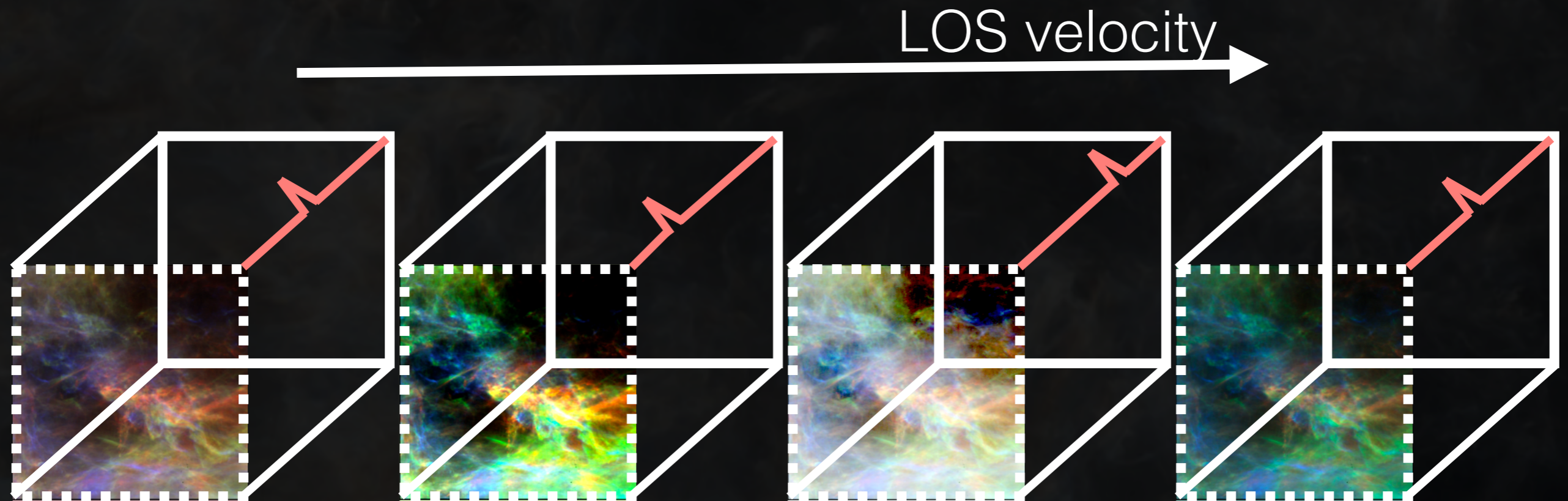


lower fractional polarization



LOS velocity

Can we learn about the LOS magnetic field?



1

$$Q_v = I_v \cos(2\theta_{RHT})$$
$$U_v = I_v \sin(2\theta_{RHT})$$

2

$$Q_{HI} = \int Q_v dv$$

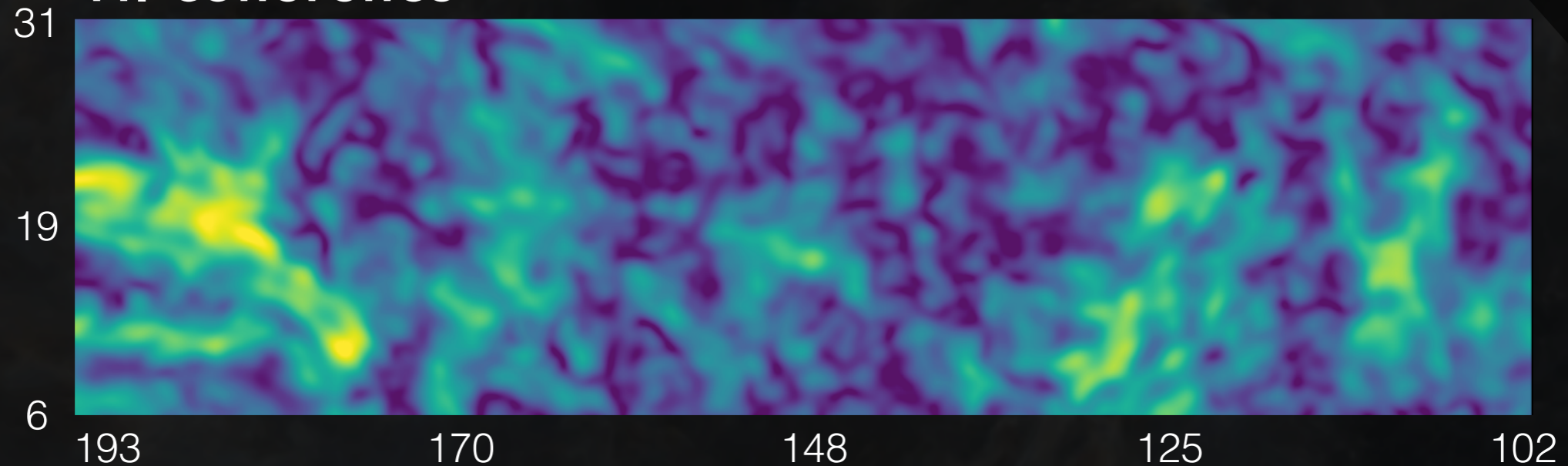
3

$$p_{HI} = \frac{\sqrt{Q_{HI}^2 + U_{HI}^2}}{I_{HI}}$$

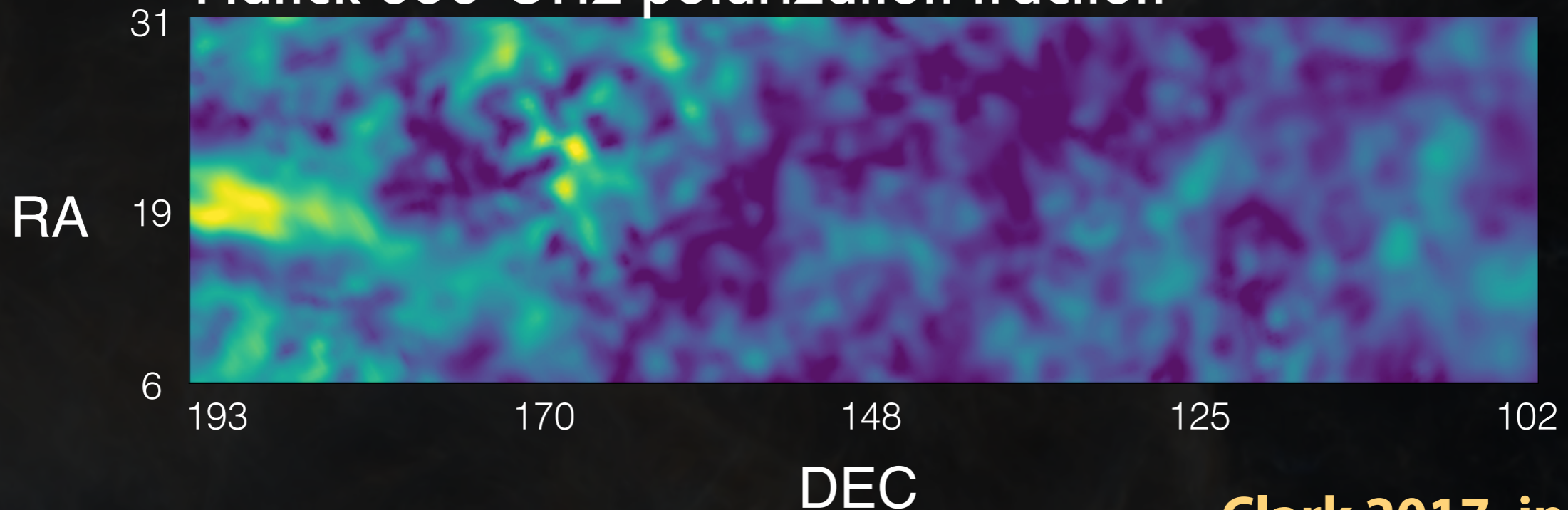
The dispersion of HI orientation traces LOS depolarization.

preliminary

HI coherence



Planck 353 GHz polarization fraction

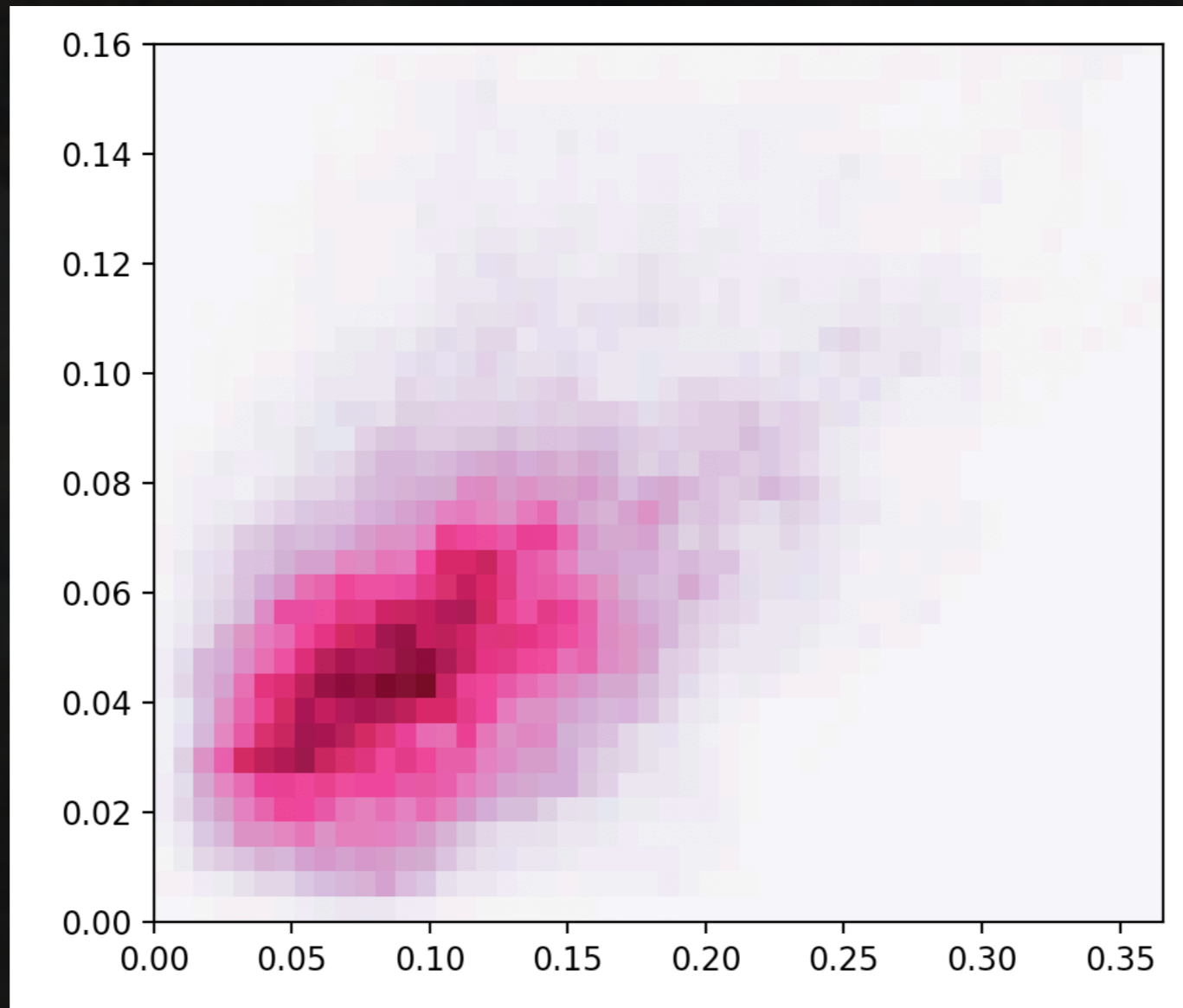


Clark 2017, in prep

The dispersion of HI orientation traces LOS depolarization.

preliminary

Polarization fraction

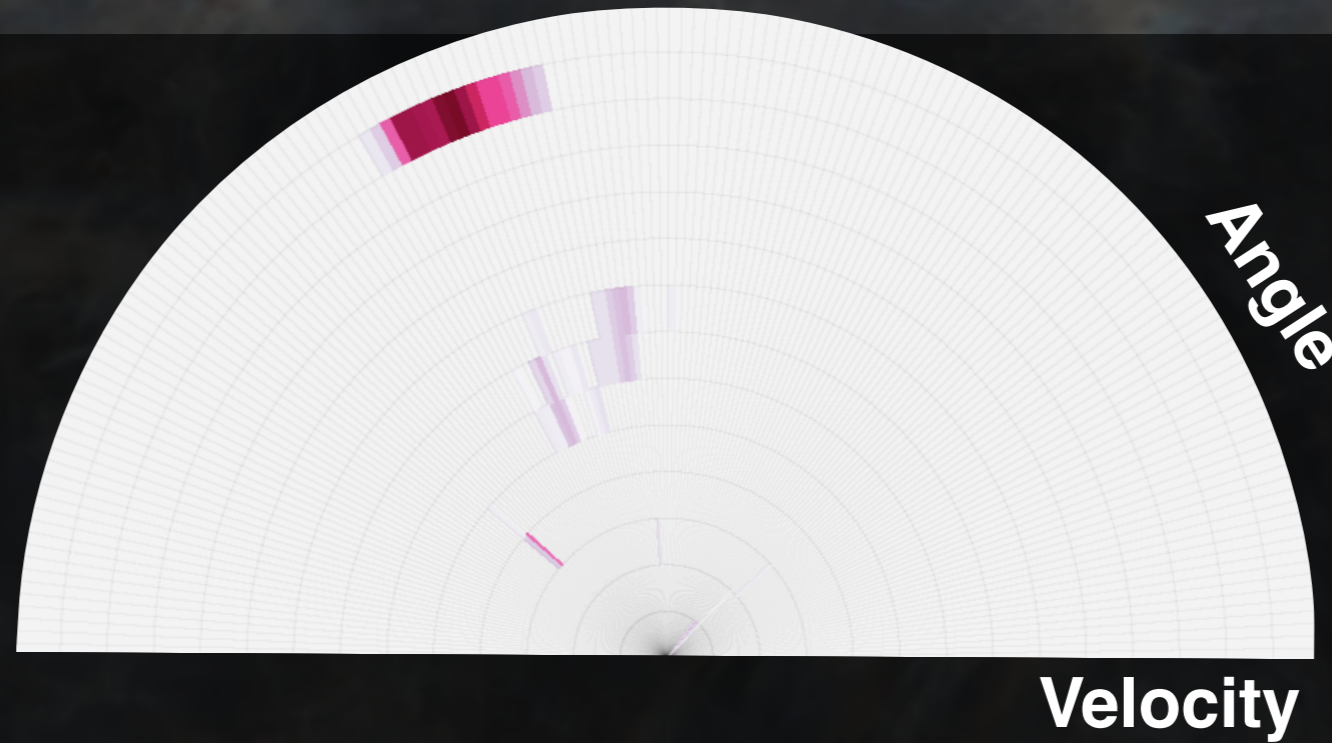


HI coherence

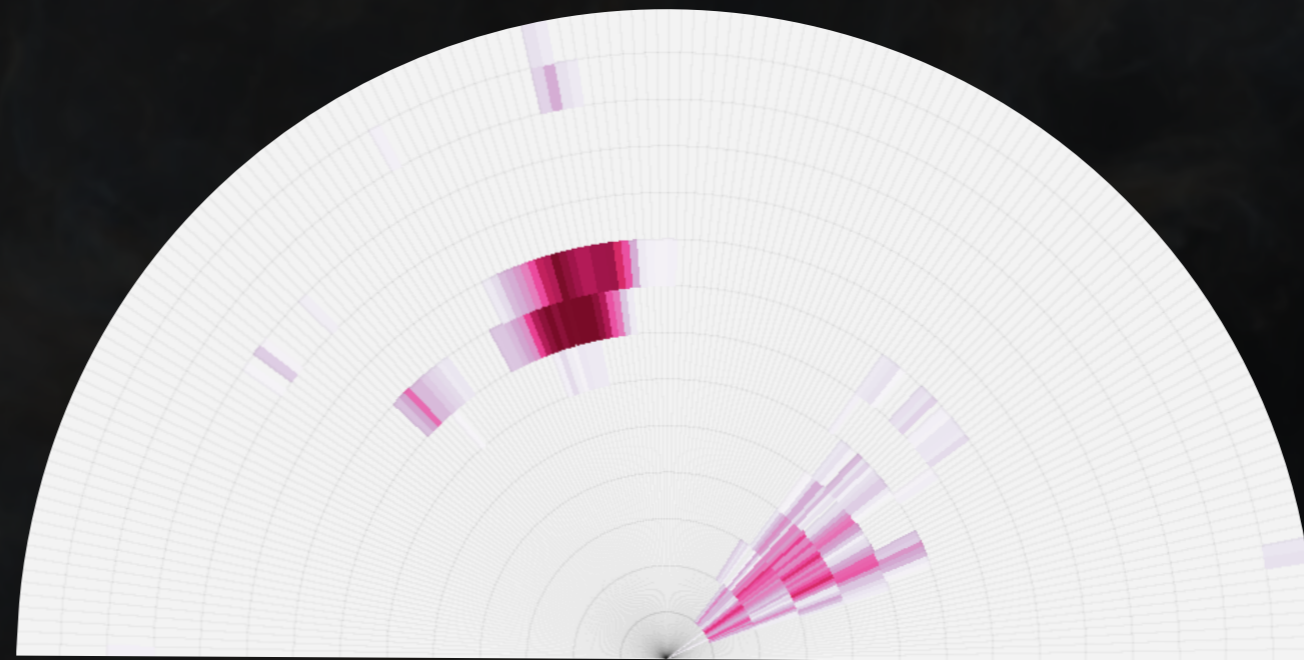
The dispersion of HI orientation traces
LOS depolarization.

preliminary

higher fractional
polarization



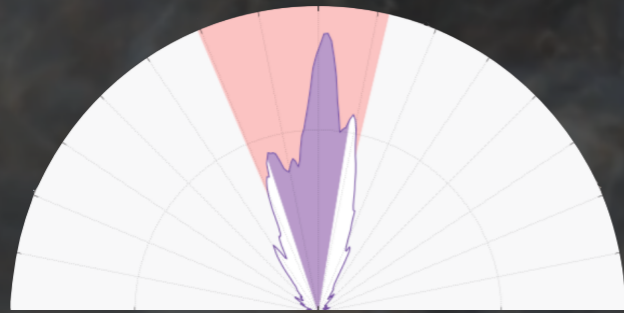
lower fractional
polarization



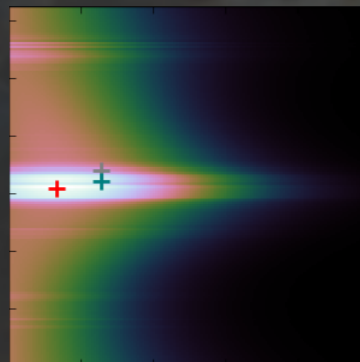
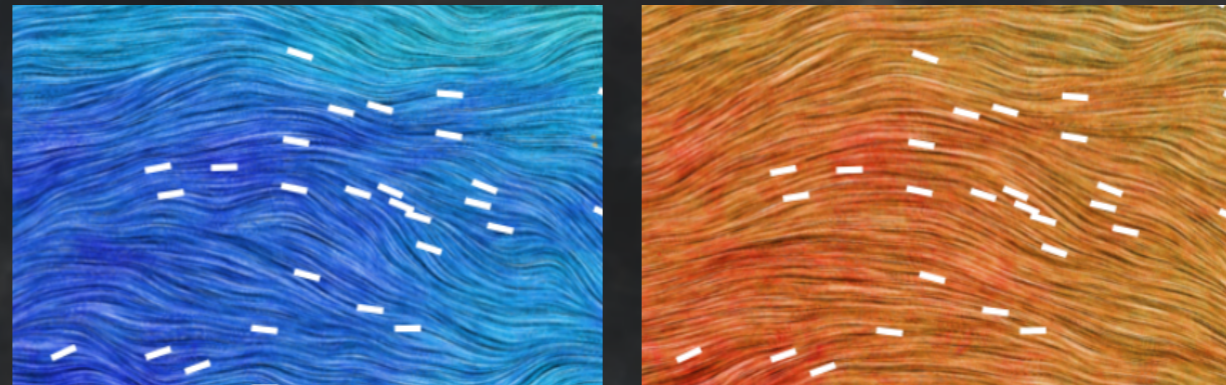
Clark 2017, in prep

Neutral hydrogen in the diffuse ISM is aligned with the interstellar magnetic field.

Clark+ 2014, ApJ



Clark+ 2015, PRL



We are using HI orientation to produce higher-fidelity maps of the plane-of-sky magnetic field. Clark, Hill+, in prep

The velocity structure of HI morphology probes line-of-sight magnetic field tangling. Clark 2017, in prep

DR2 of GALFA-HI will soon be public!
Peek+ 2017, accepted