

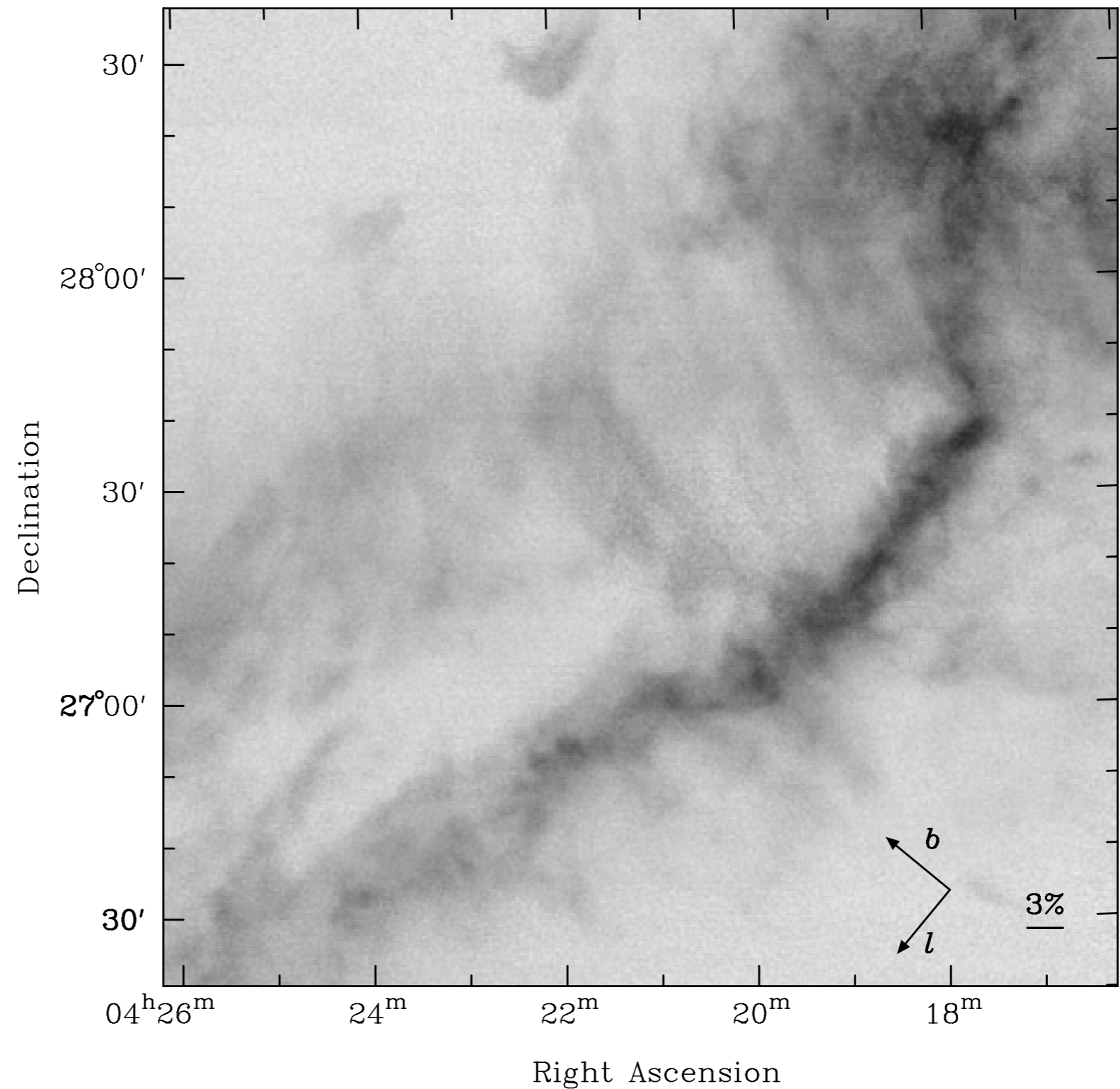
Magnetized Fibers and the Rolling Hough Transform

Susan Clark | NSF Graduate Fellow,
Columbia University

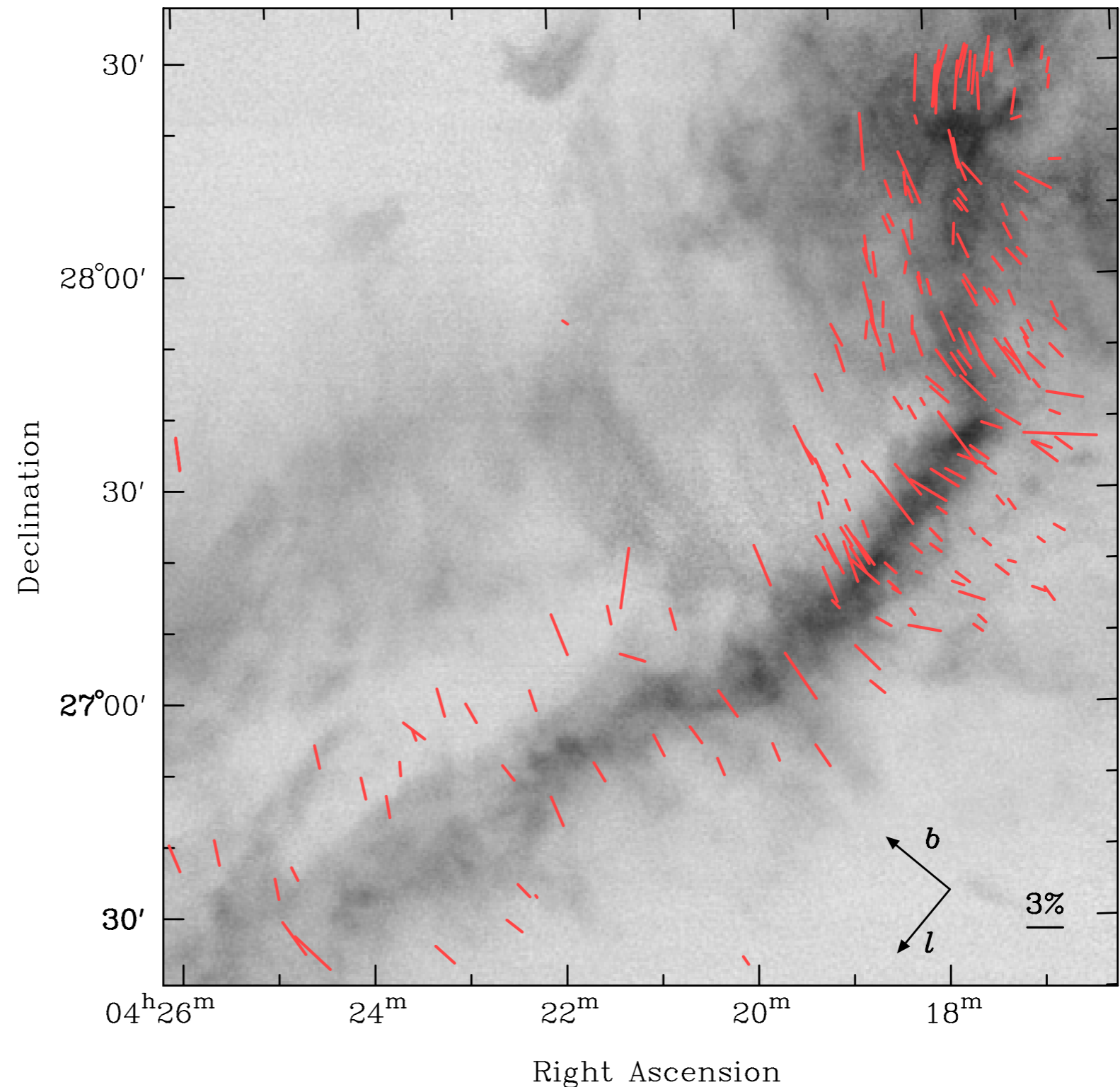
Josh Peek | Hubble Fellow, Columbia University

Mary Putman | Columbia University

The magnetic field helps explain the morphology and dynamics of the ISM.



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Fibers in the interstellar medium

The Rolling Hough Transform (RHT)

Comparisons with starlight polarization

Investigating a cold cloud

Toward a resolved field strength measure

Fibers in the interstellar medium

The Rolling Hough Transform (RHT)

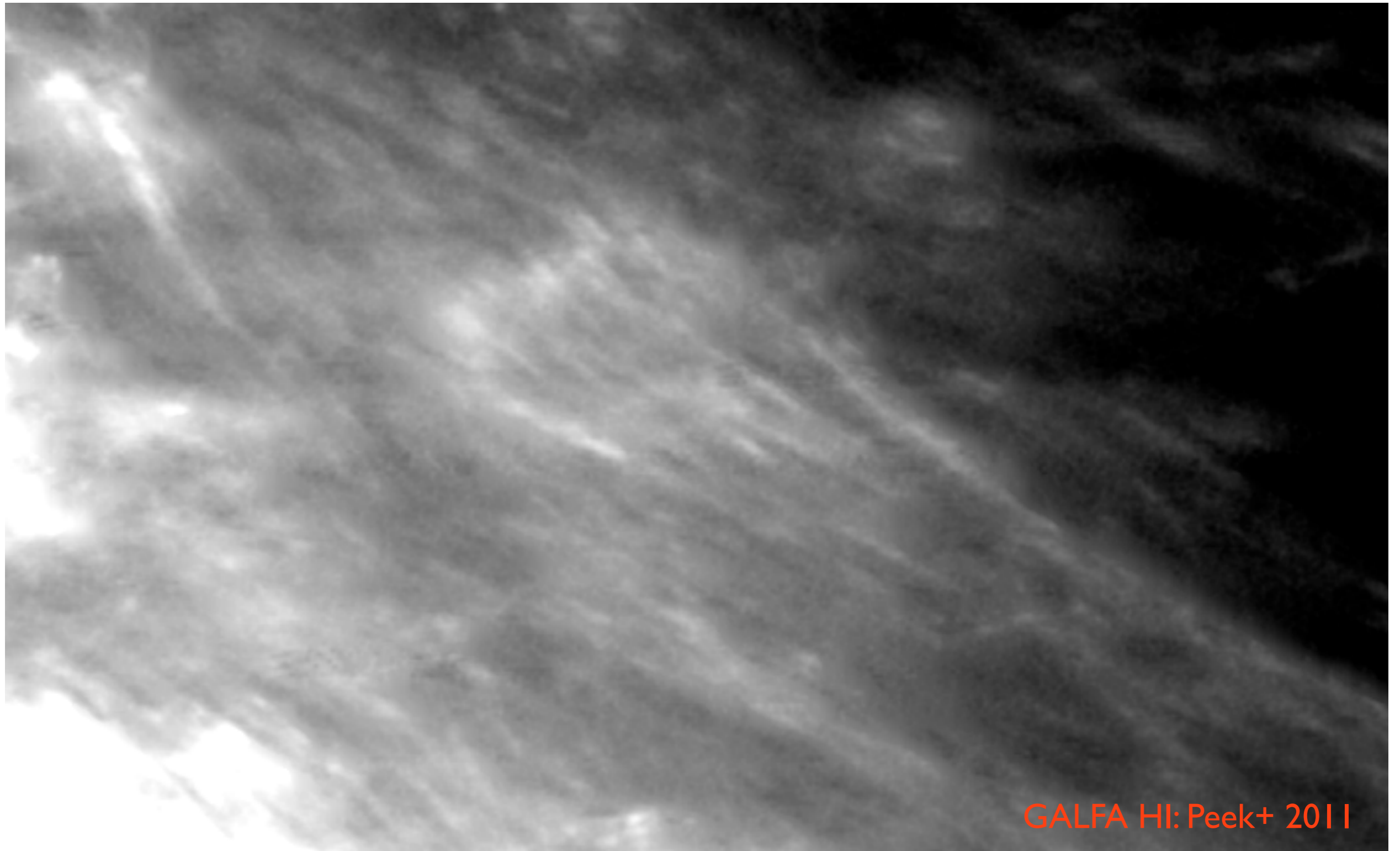
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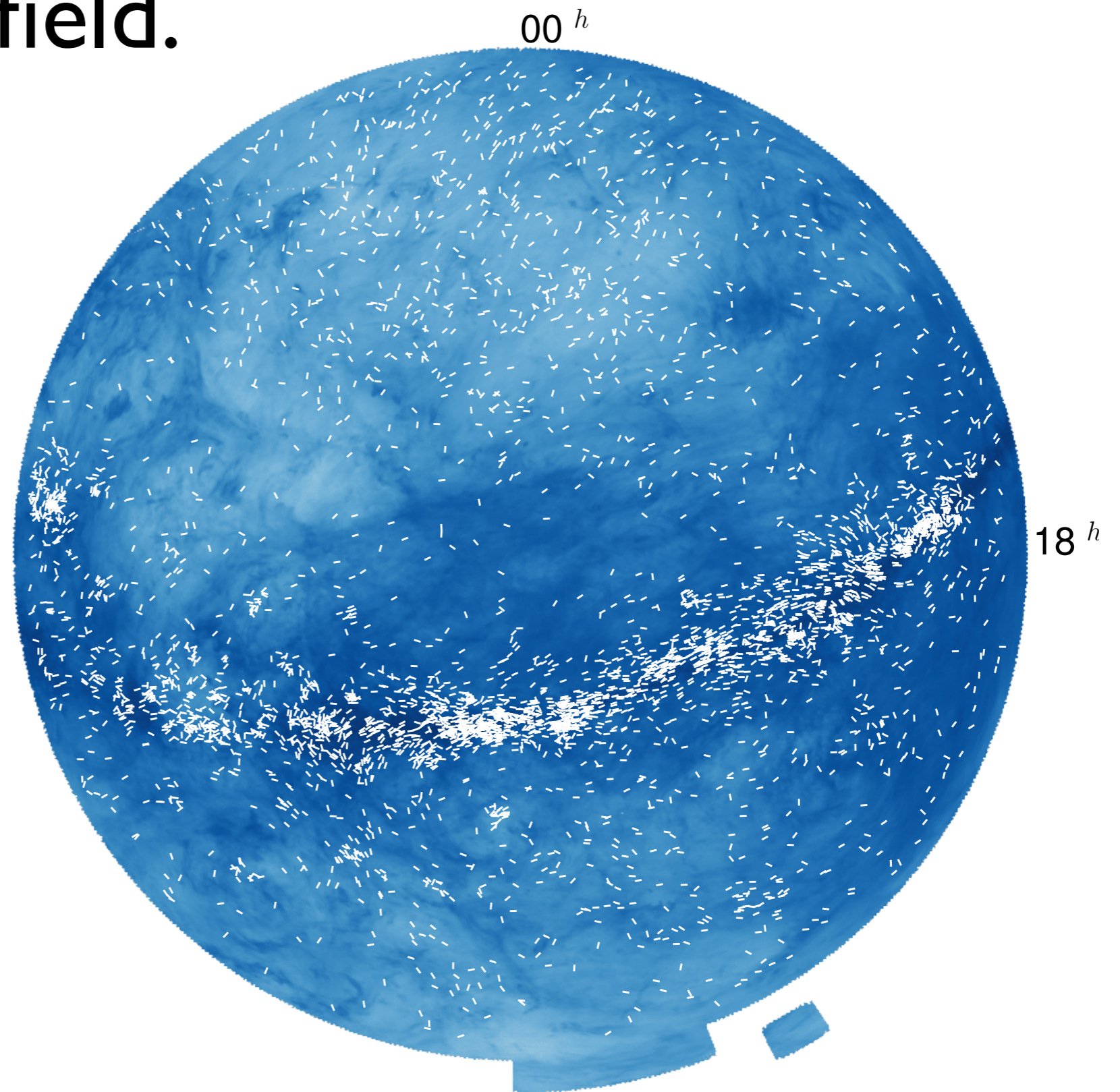
Diffuse HI contains
networks of fibers.

3°



GALFA HI: Peek+ 2011

Starlight polarization traces the magnetic field.



Fibers in the interstellar medium

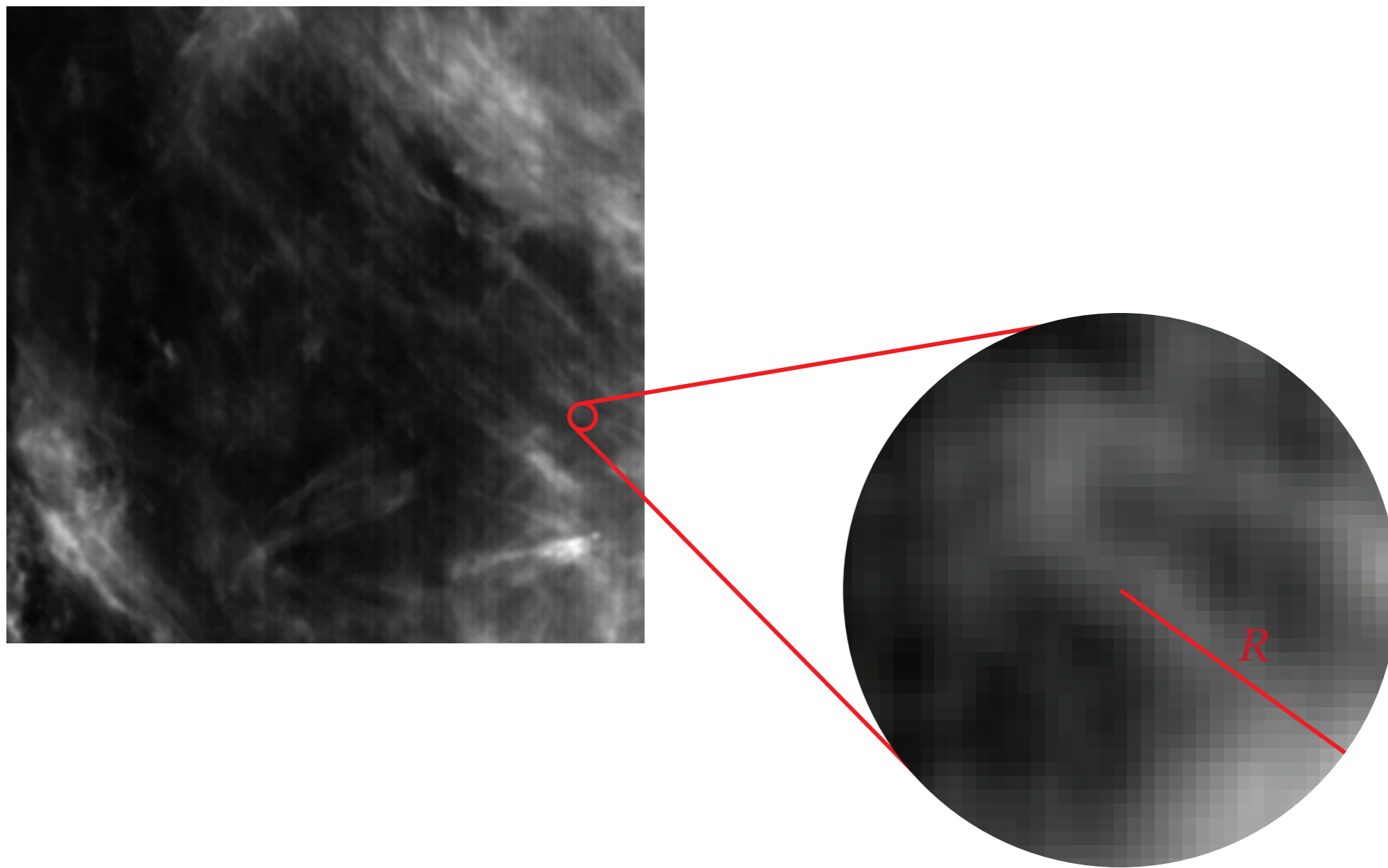
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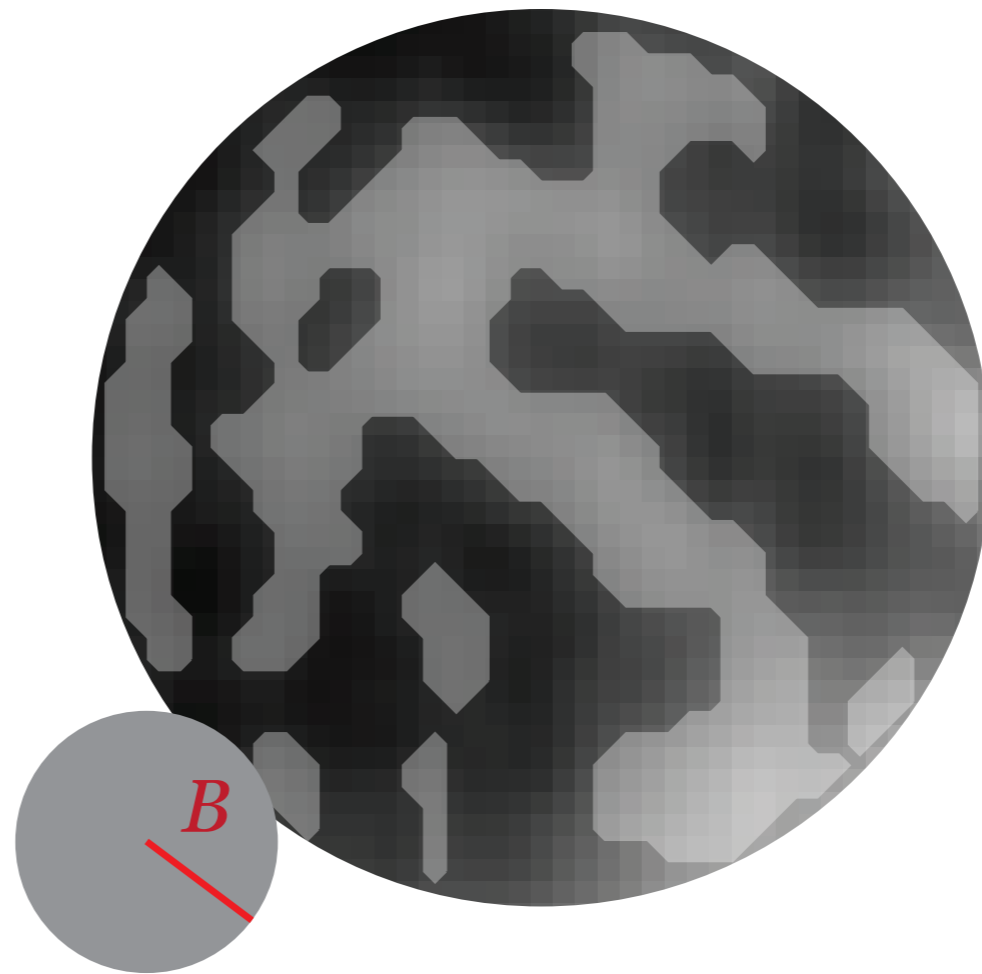
Investigating a cold cloud

Toward a resolved field strength measure

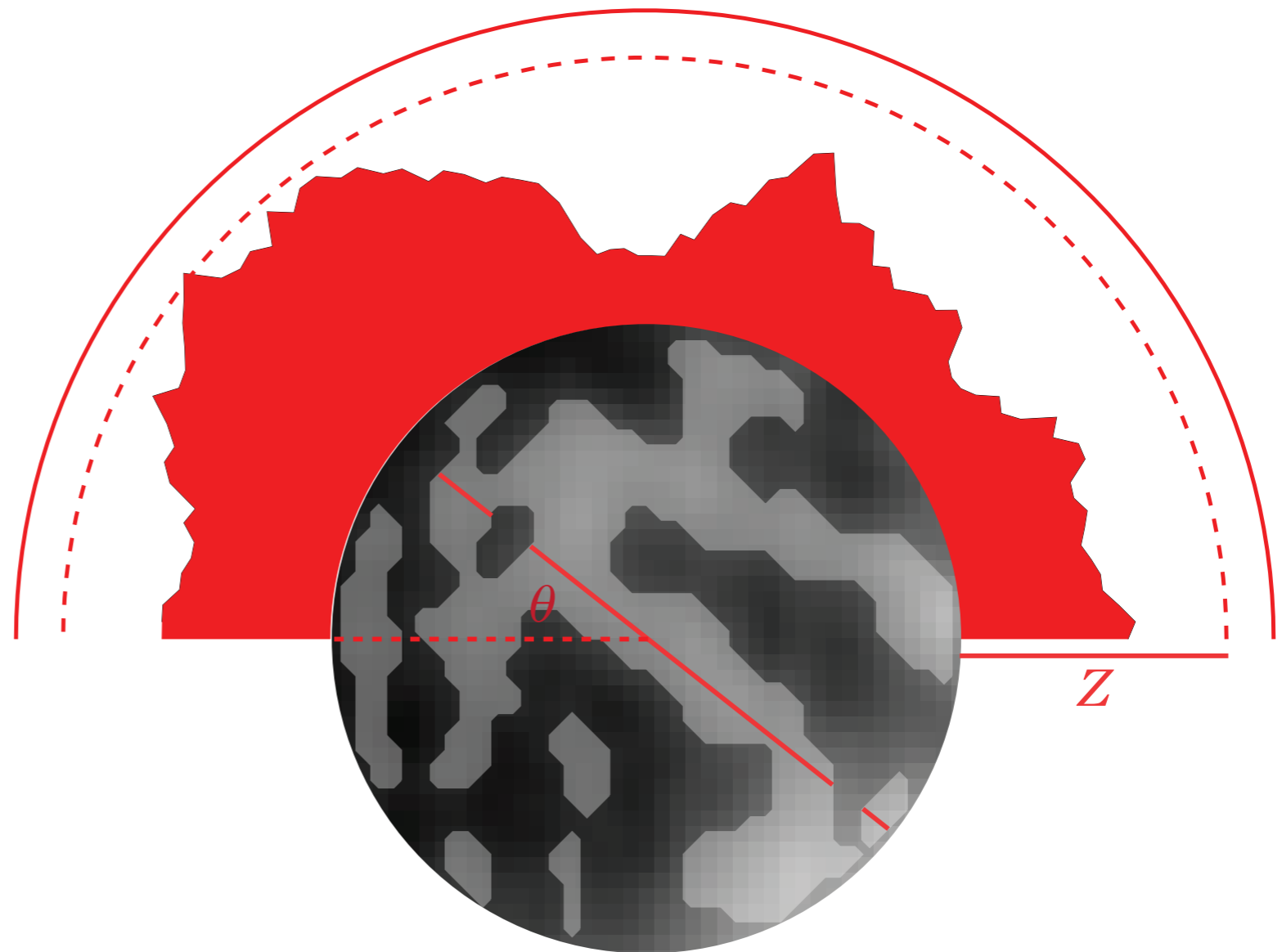
Select a region.



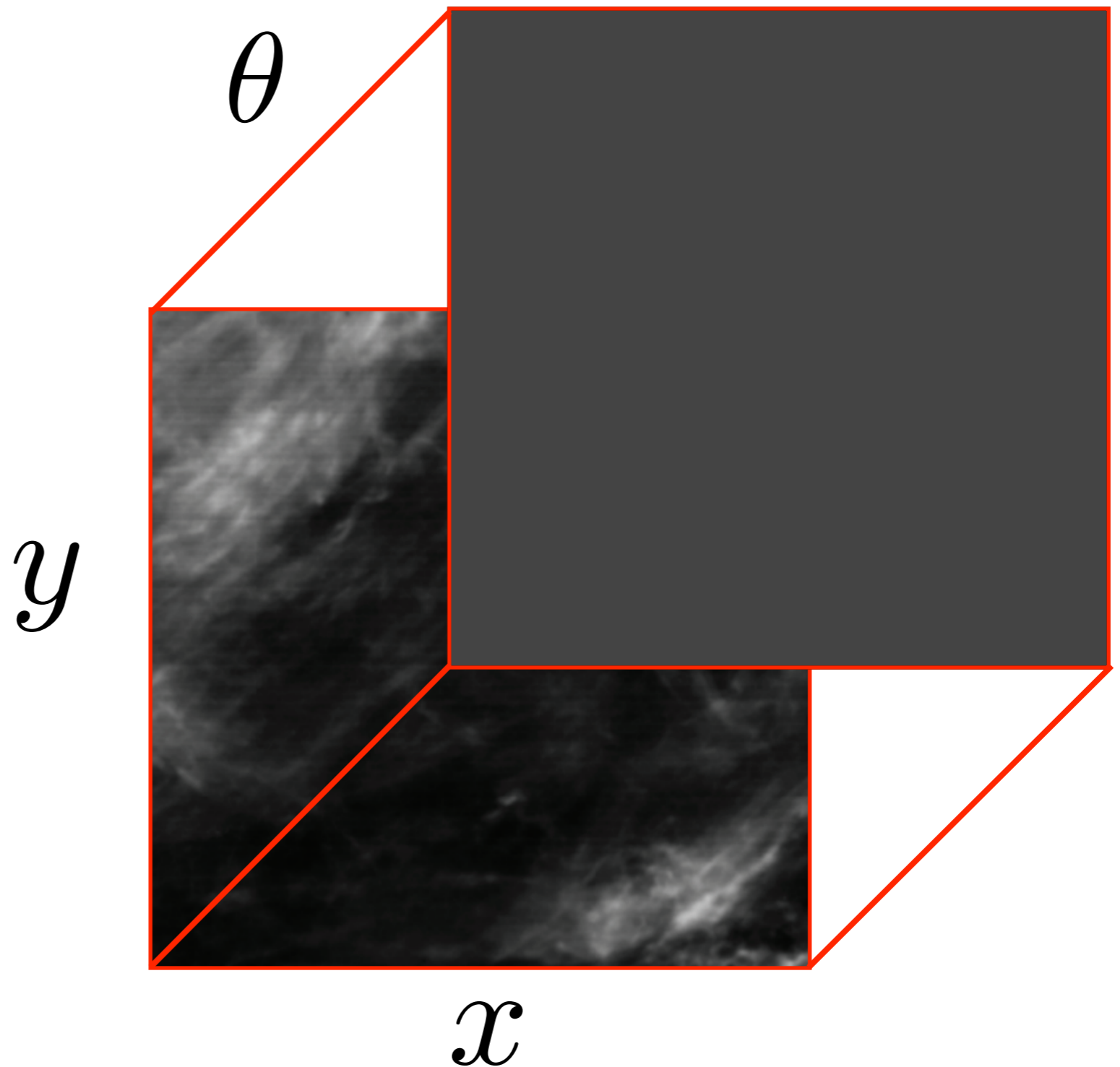
Smooth and unsharp
mask the data.



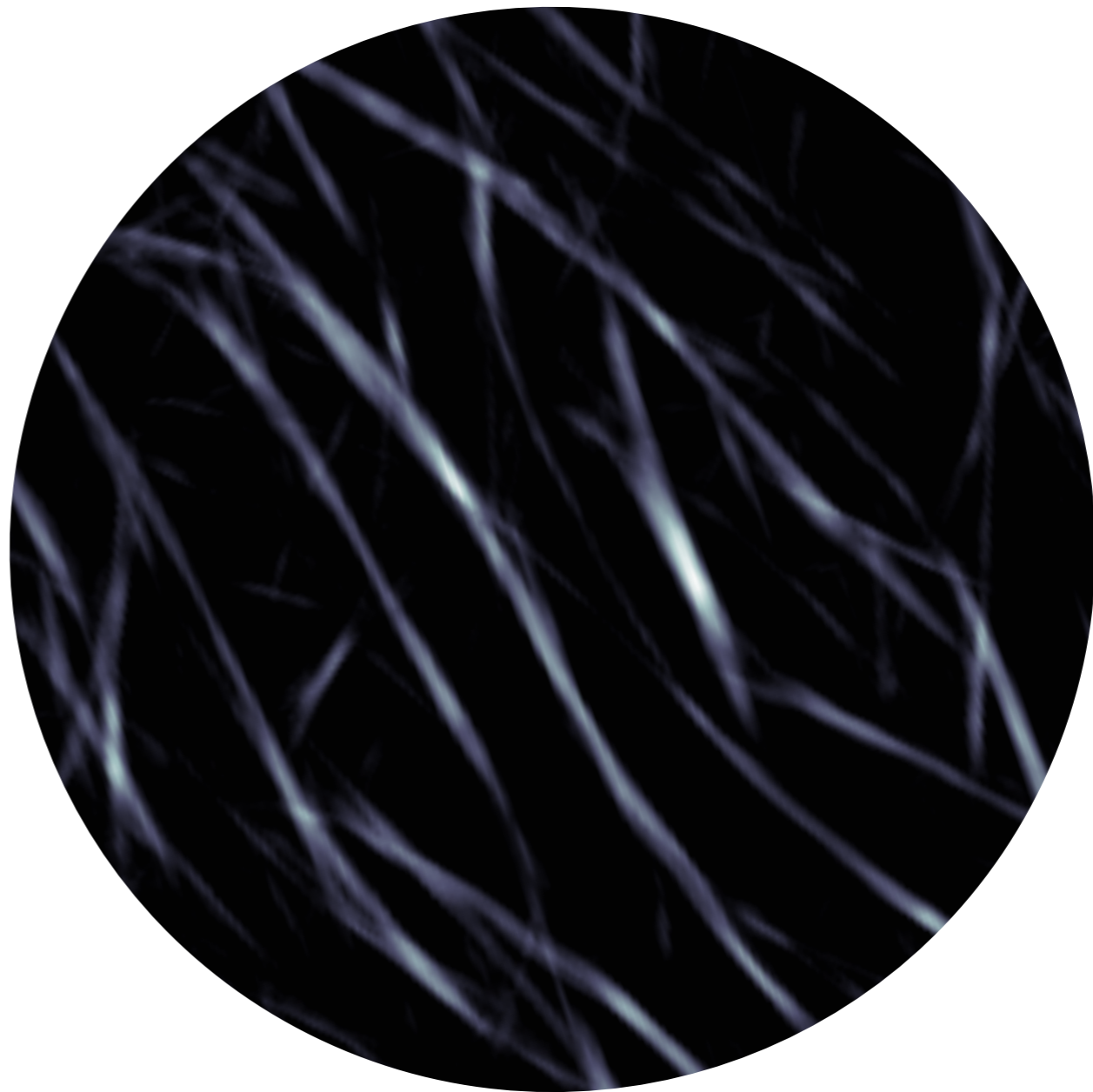
Find power
as a function of angle.



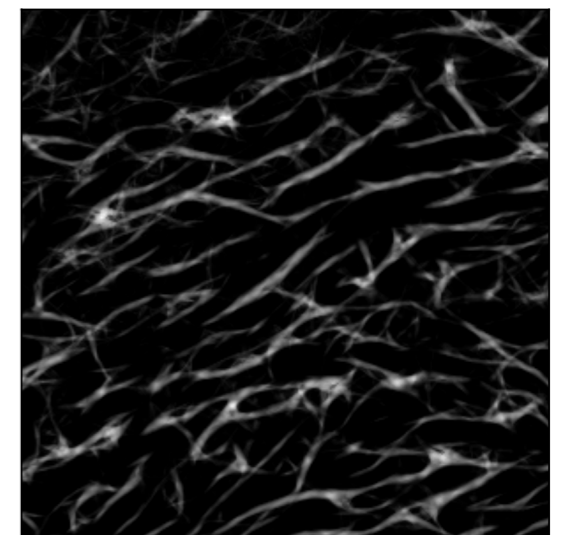
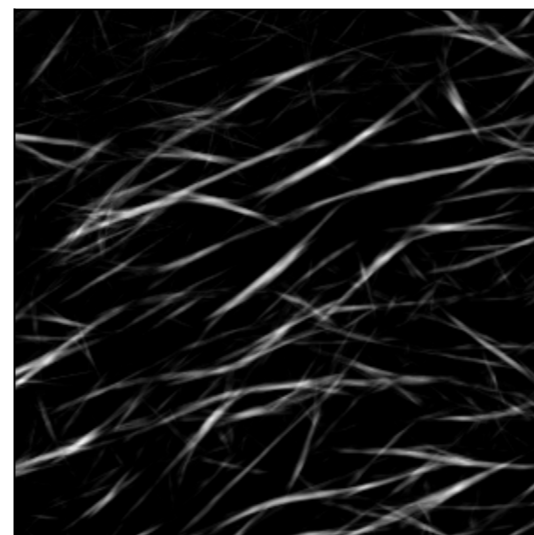
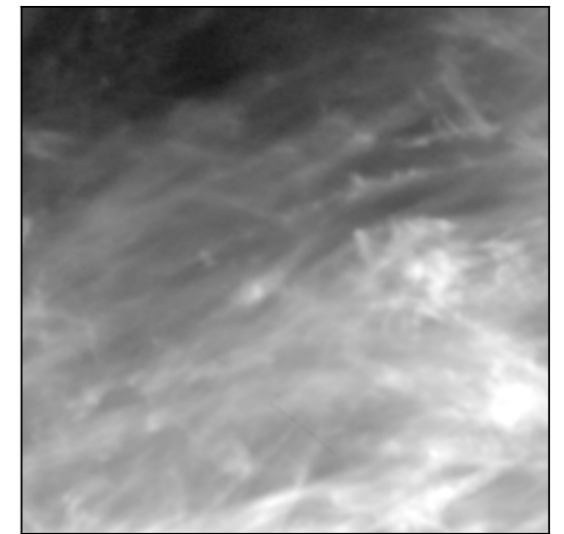
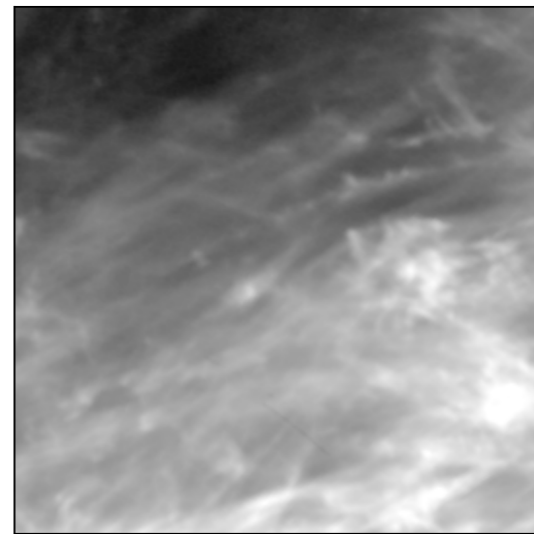
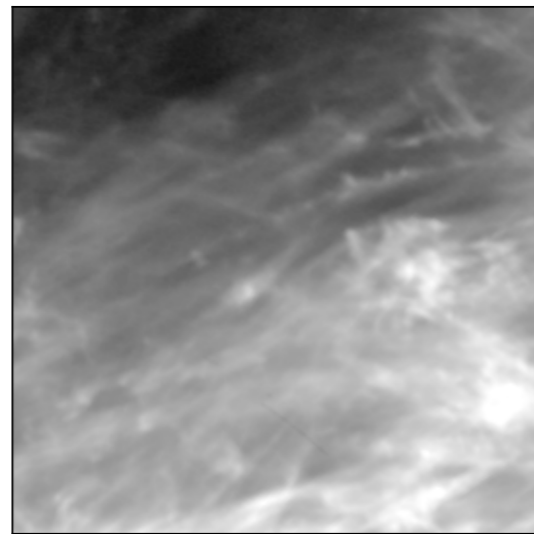
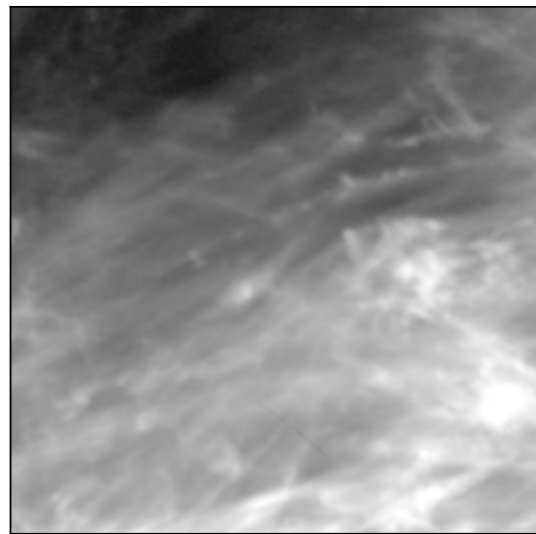
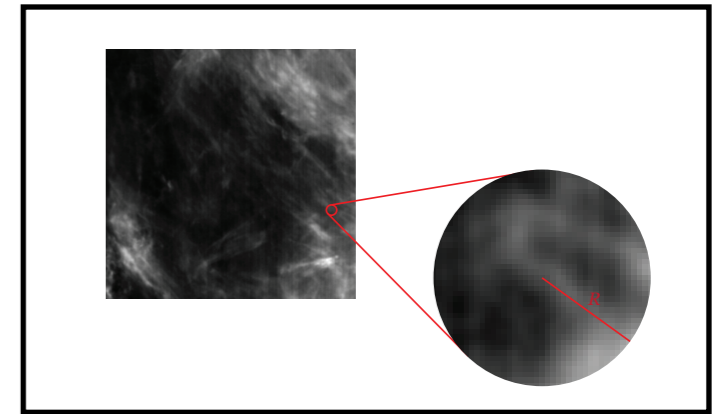
Store power as a function of angle
for every pixel.



Integrate over θ
to backproject.



Rolling window diameter sets minimum fiber length.



Fibers in the interstellar medium

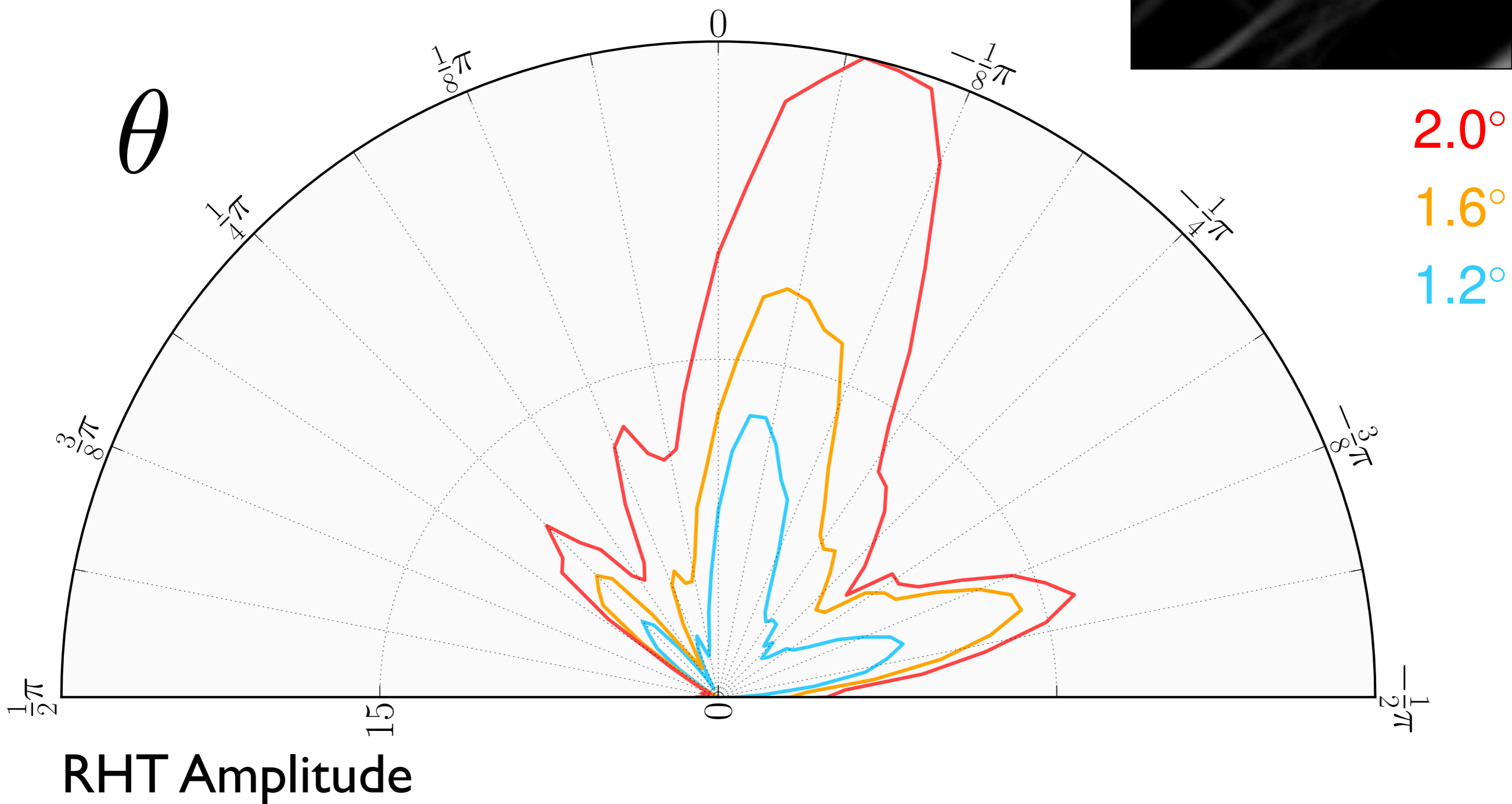
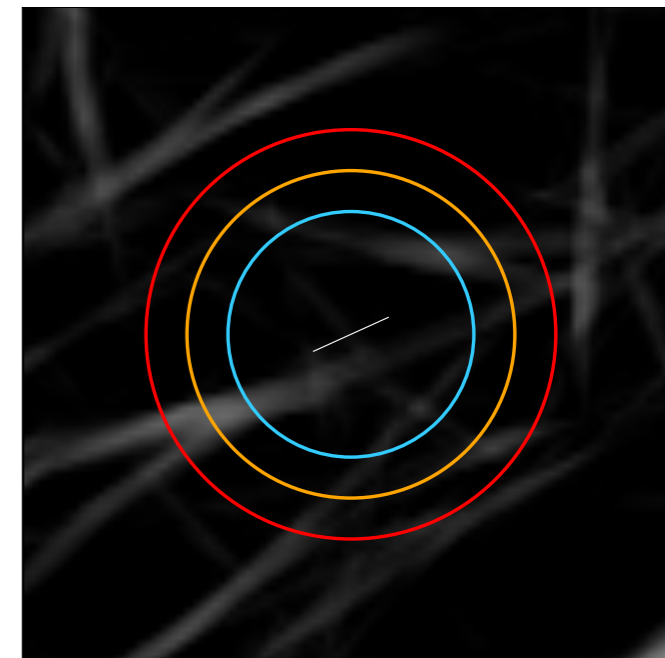
The Rolling Hough Transform (RHT)

Comparisons with starlight polarization

Investigating a cold cloud

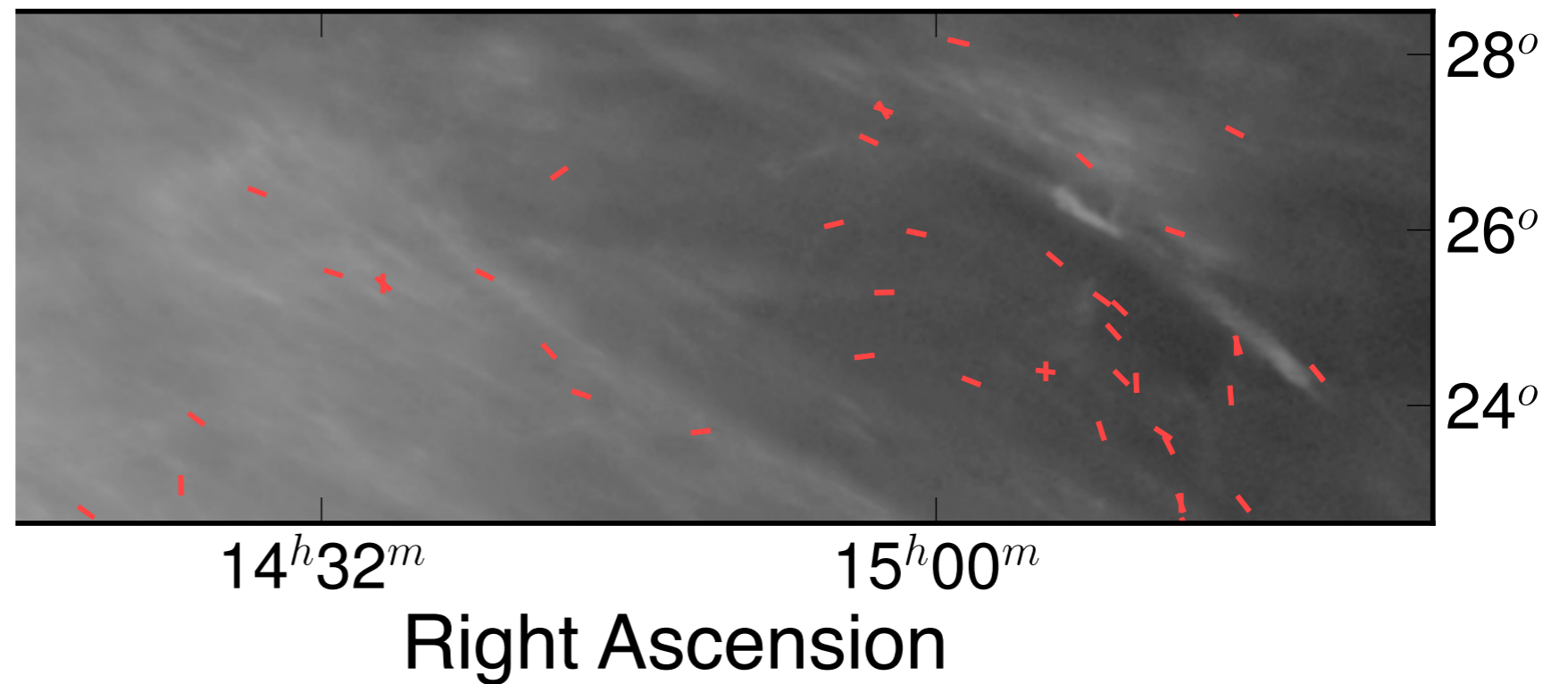
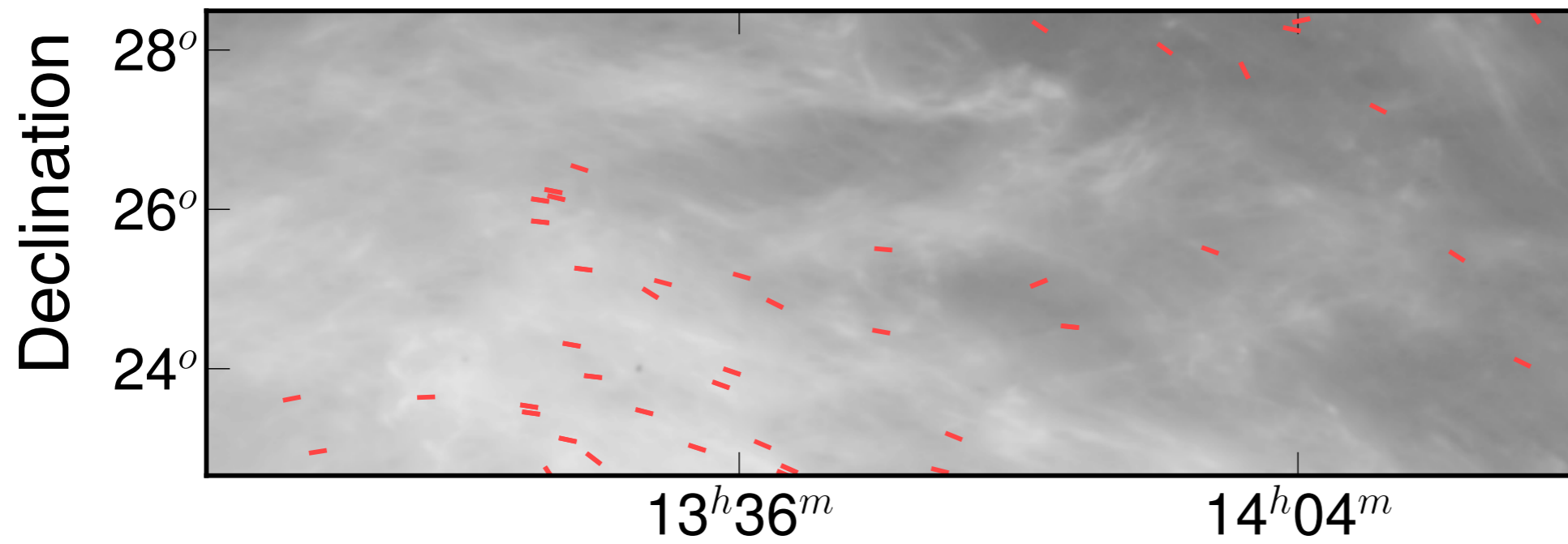
Toward a resolved field strength measure

RHT output is sampled around a star.

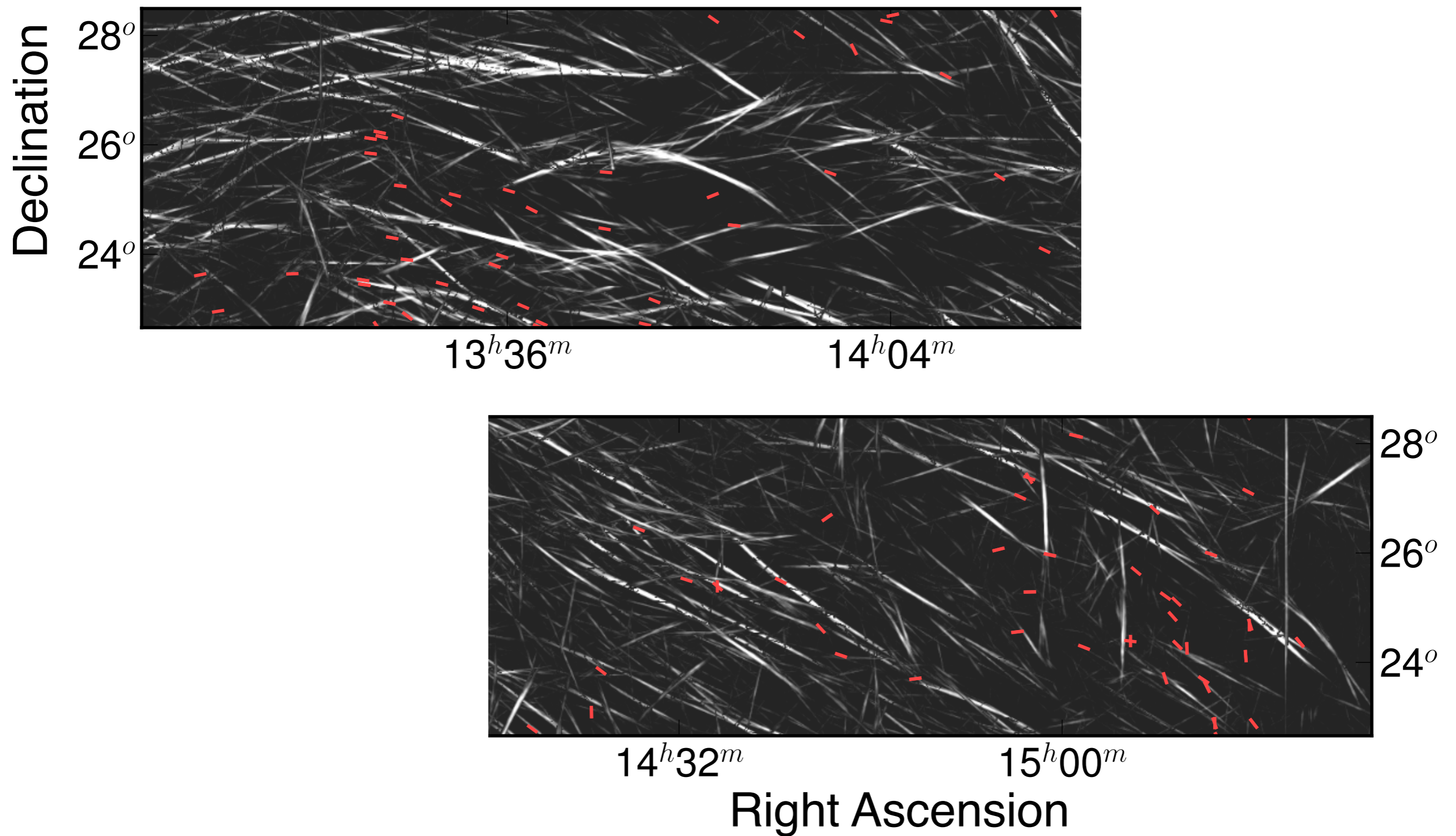


GALFA reveals fine linear structure.

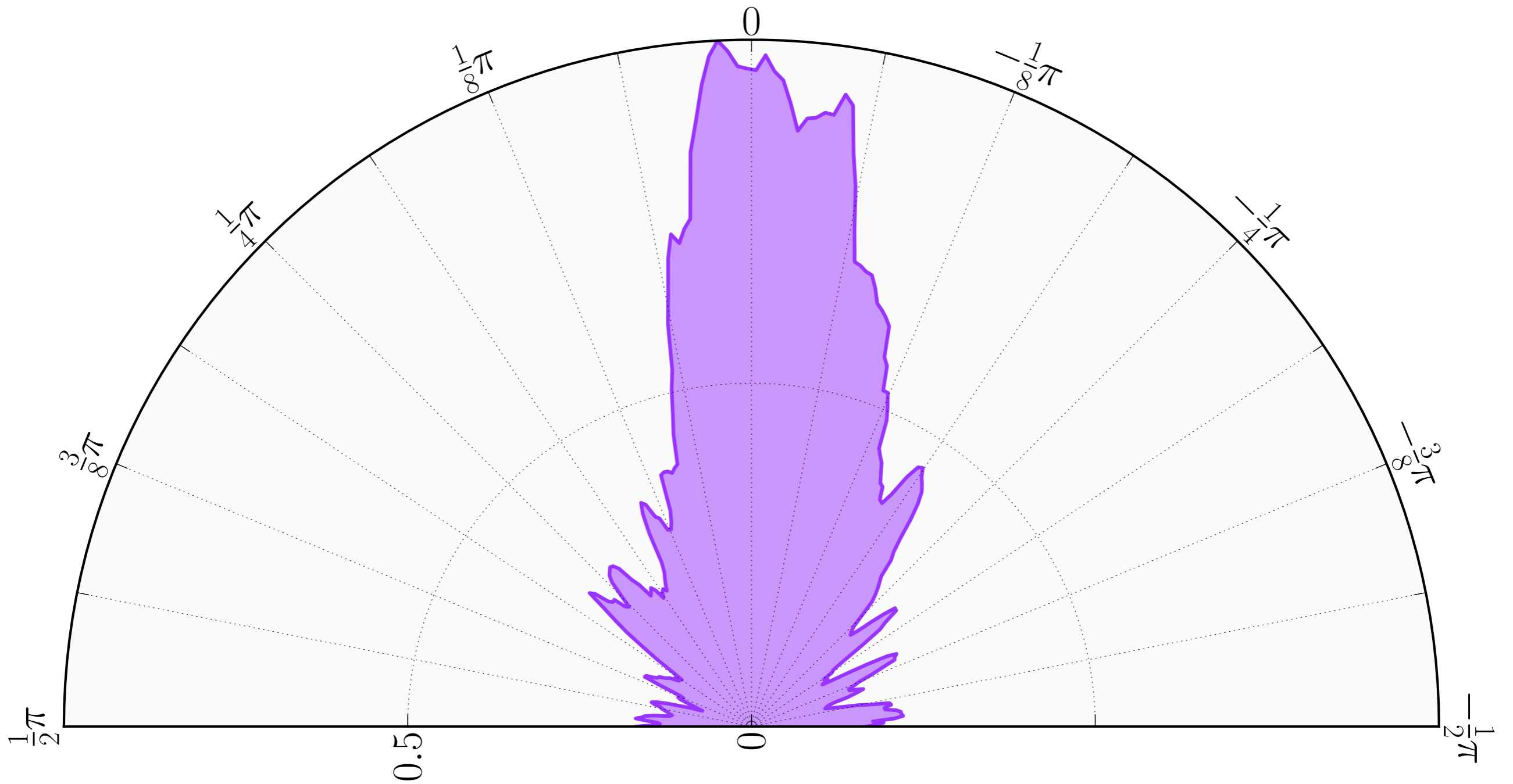
$4' = 0.1 \text{ pc at } 100 \text{ pc}$



GALFA reveals fine linear structure.

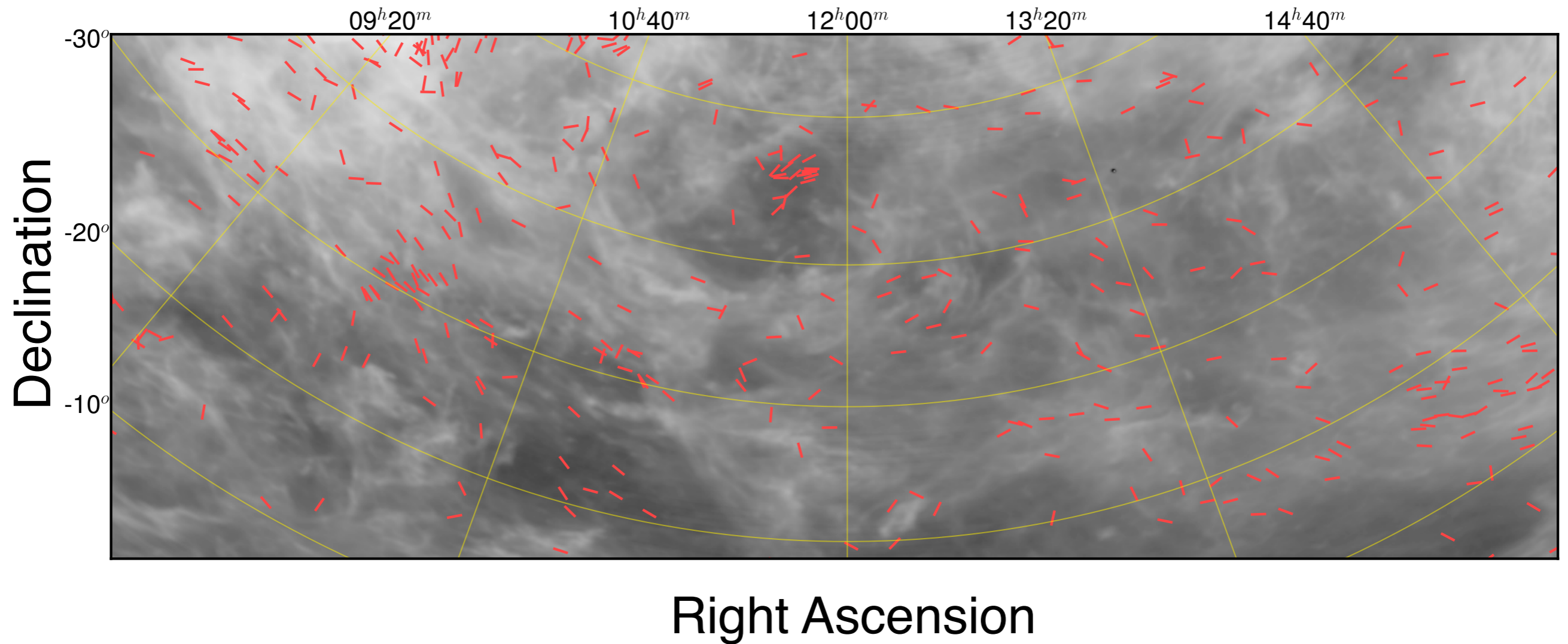


The linear features correlate with starlight polarization.



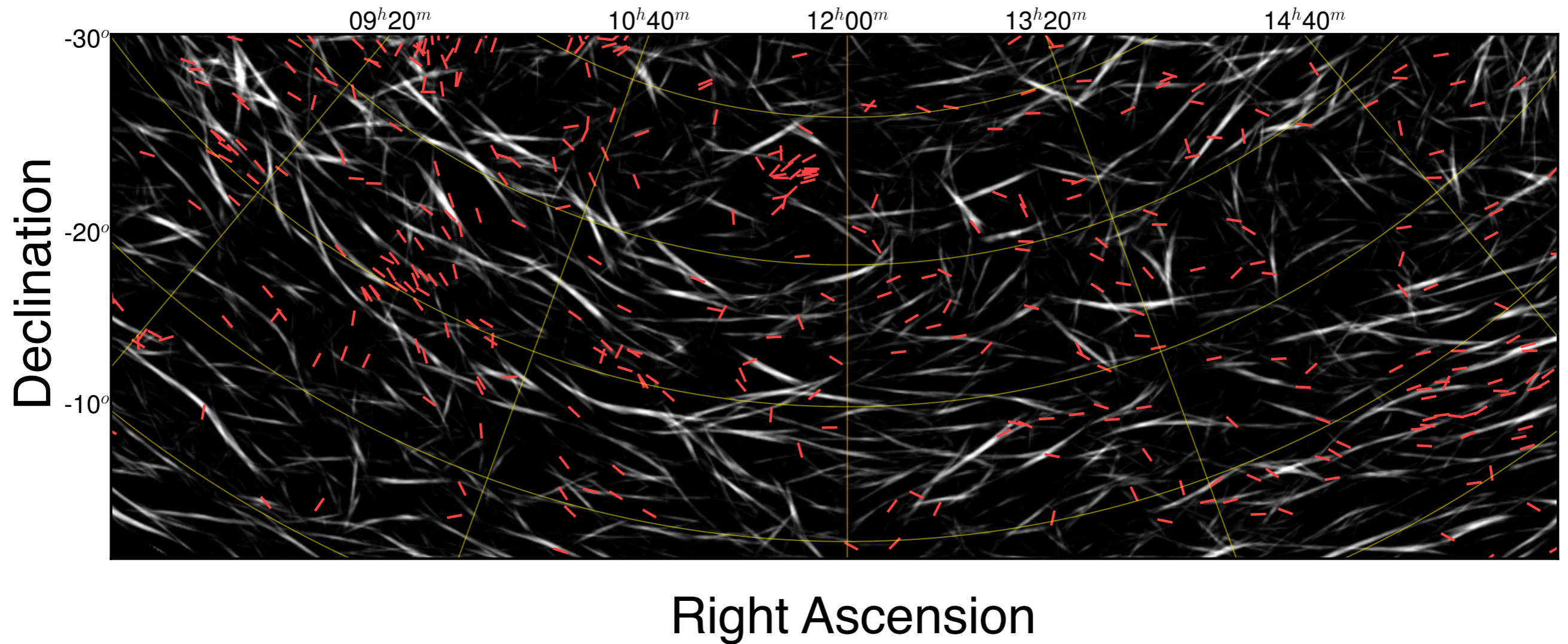
GASS is a complementary data set in the southern hemisphere.

$16' = 0.5 \text{ pc at } 100 \text{ pc}$

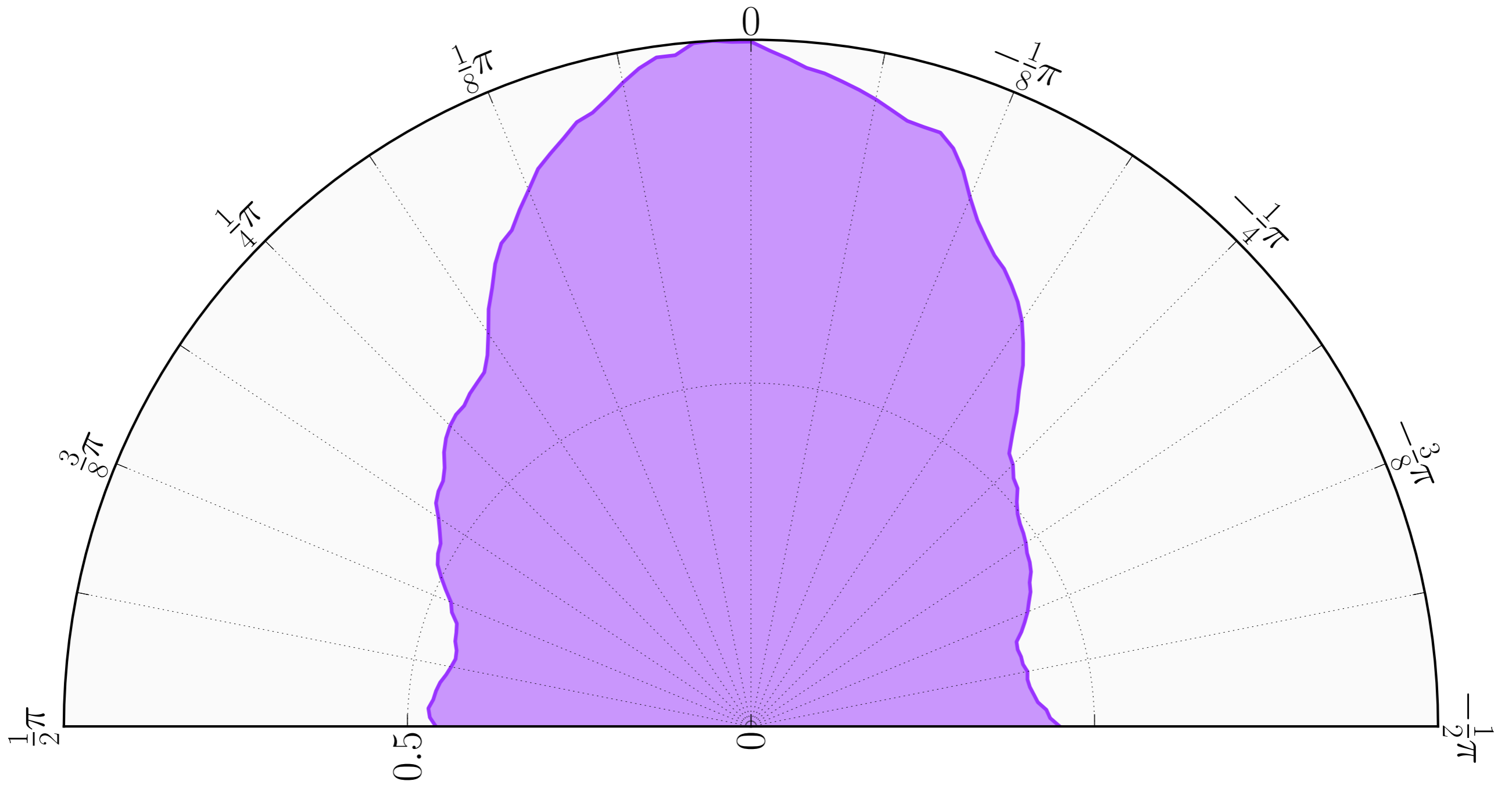


GASS is a complementary data set in the southern hemisphere.

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The correlation is weaker at the GASS resolution.



Fibers in the interstellar medium

The Rolling Hough Transform (RHT)

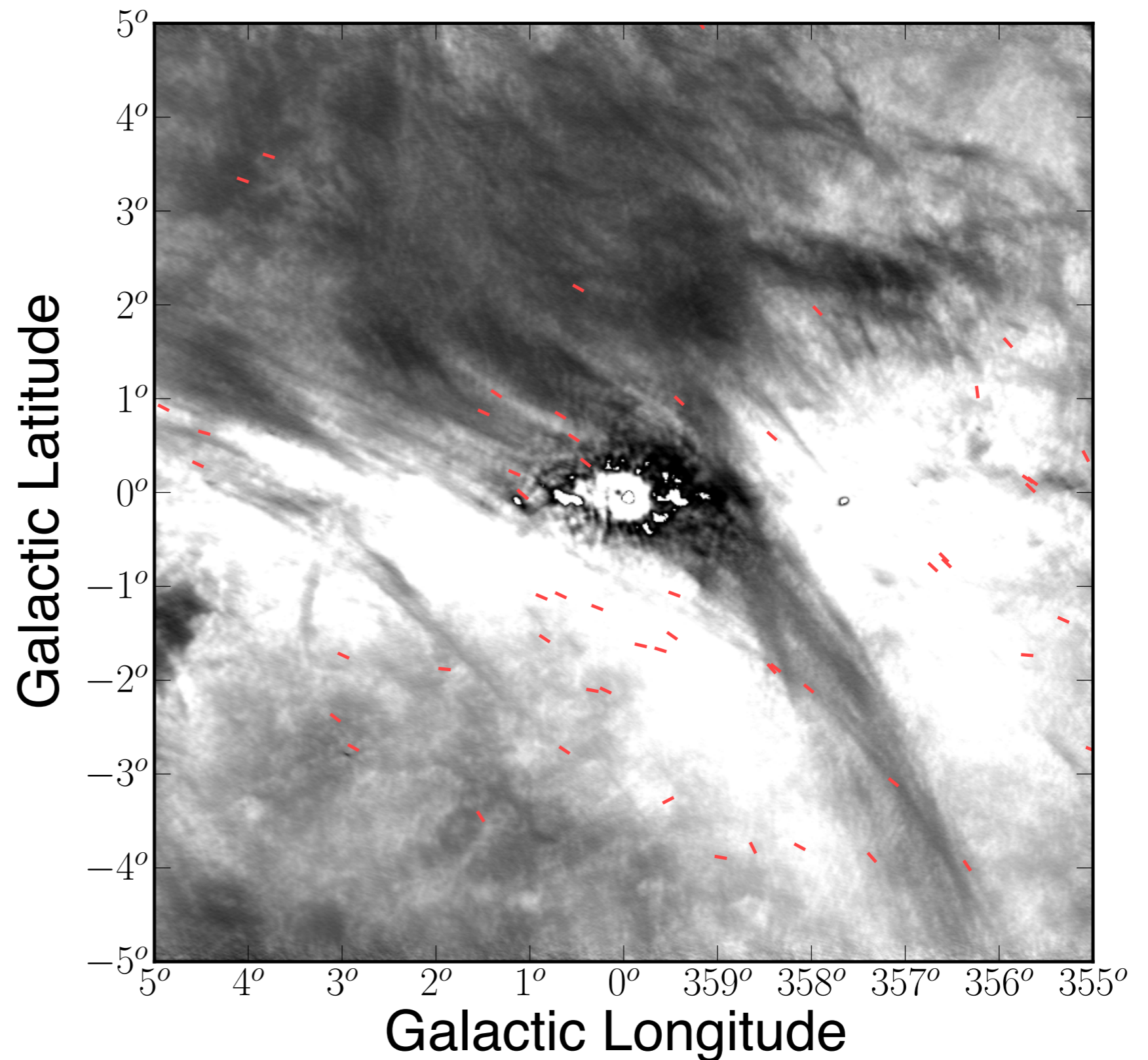
Comparisons with starlight polarization

Investigating a cold cloud

Toward a resolved field strength measure

The Riegel-Crutcher cloud consists of magnetically dominated HI fibers.

+4.95 km/s

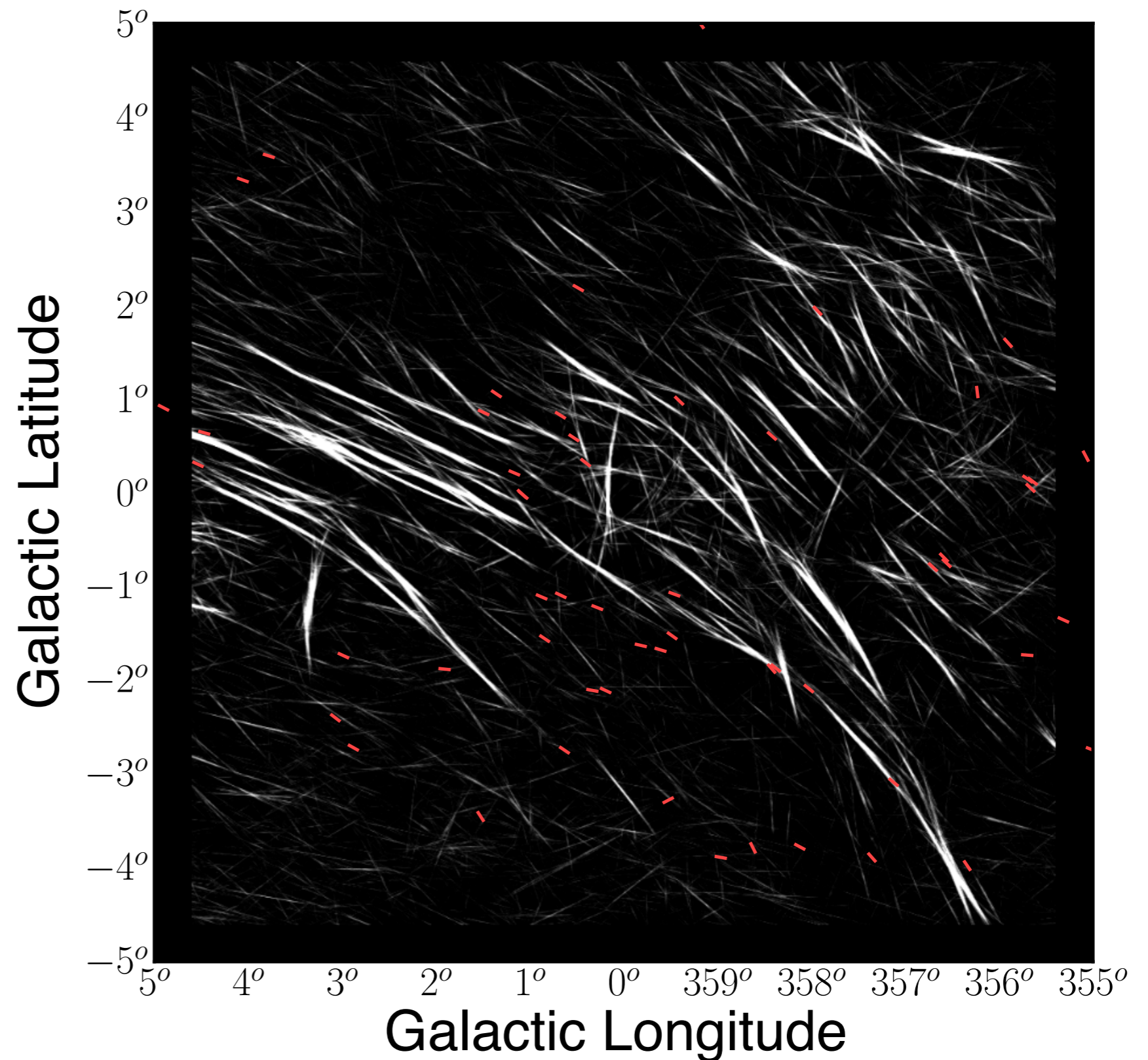


$100'' = 0.06 pc$ at $125 pc$

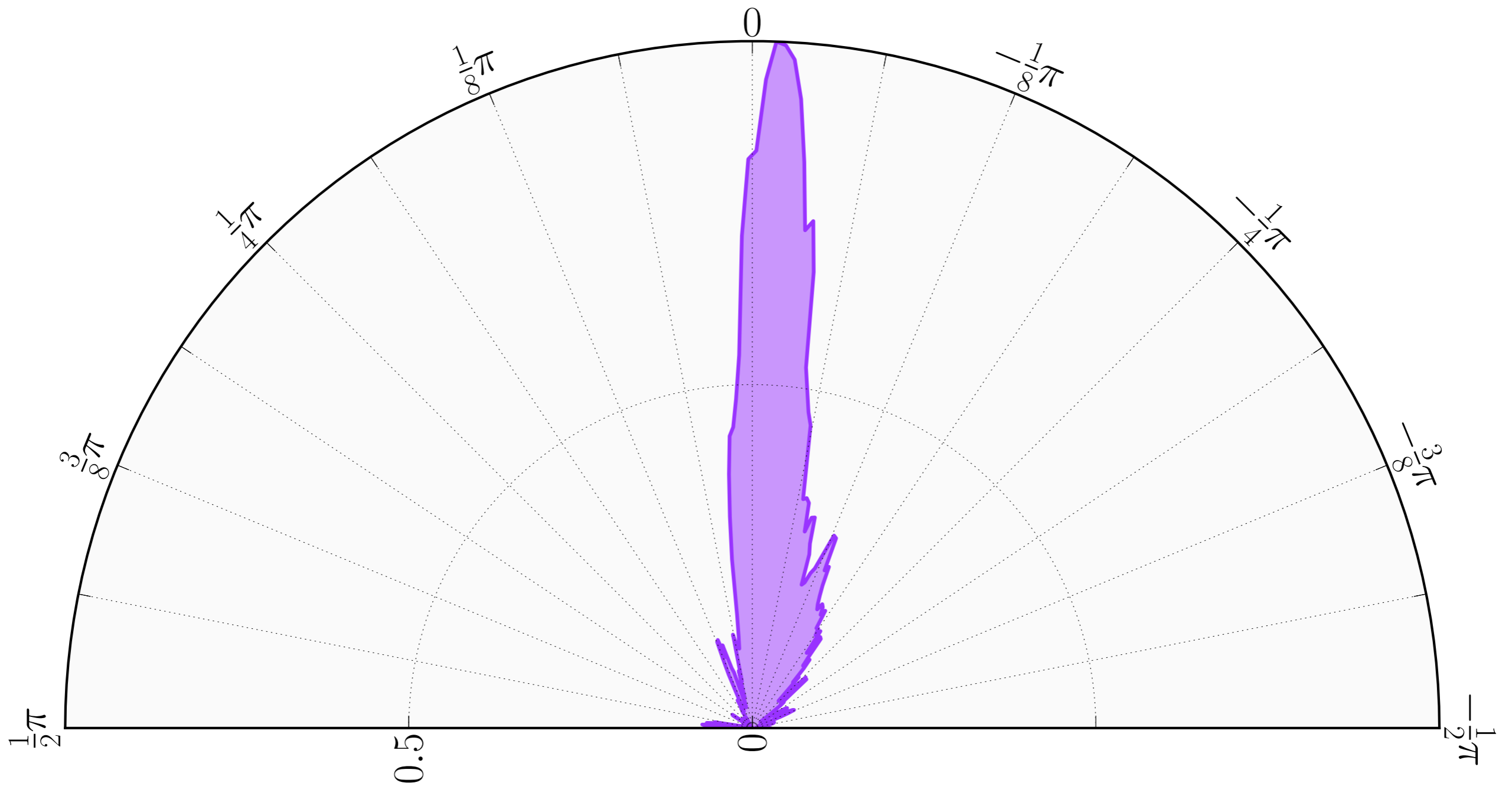
SGPS GC Survey
McClure-Griffiths+ 2006

The RHT is sharply aligned
with the starlight polarization.

+4.95 km/s

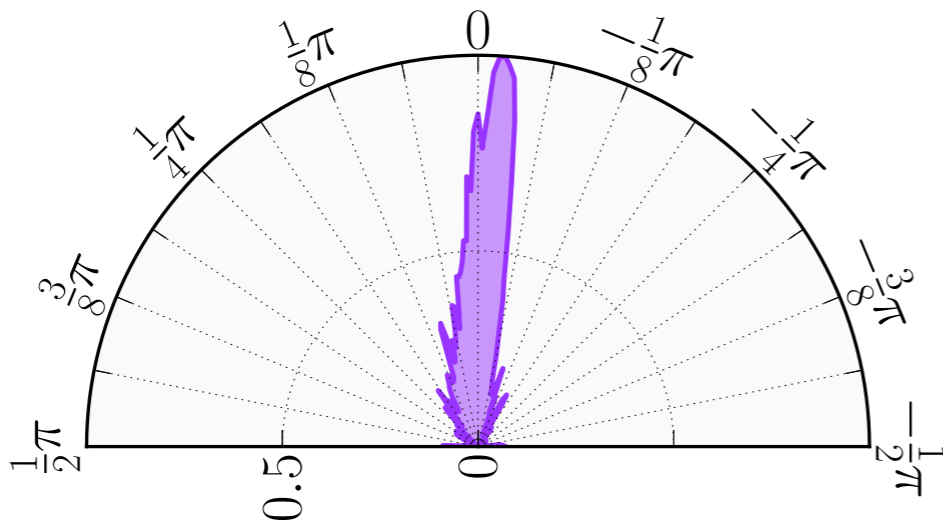


The RHT is sharply aligned with the starlight polarization.

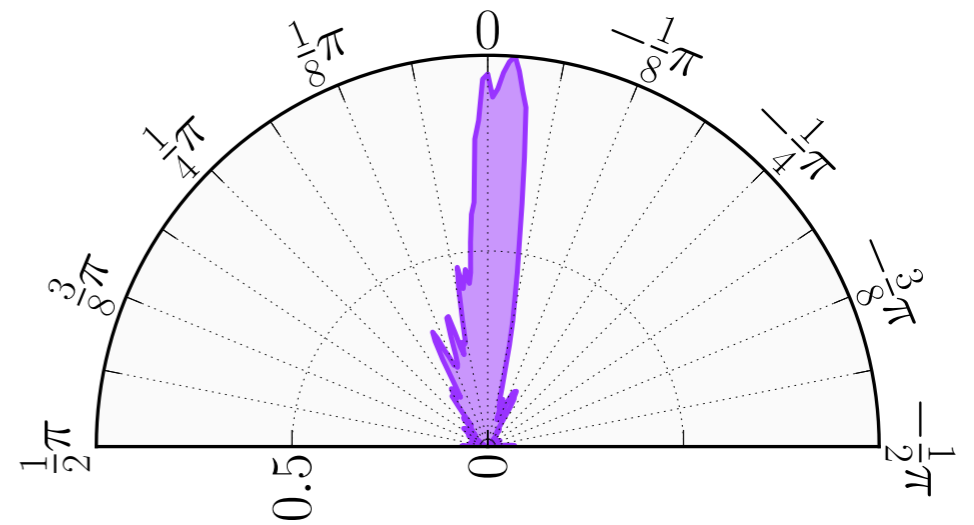


Alignment is sharper for finer sampling beams.

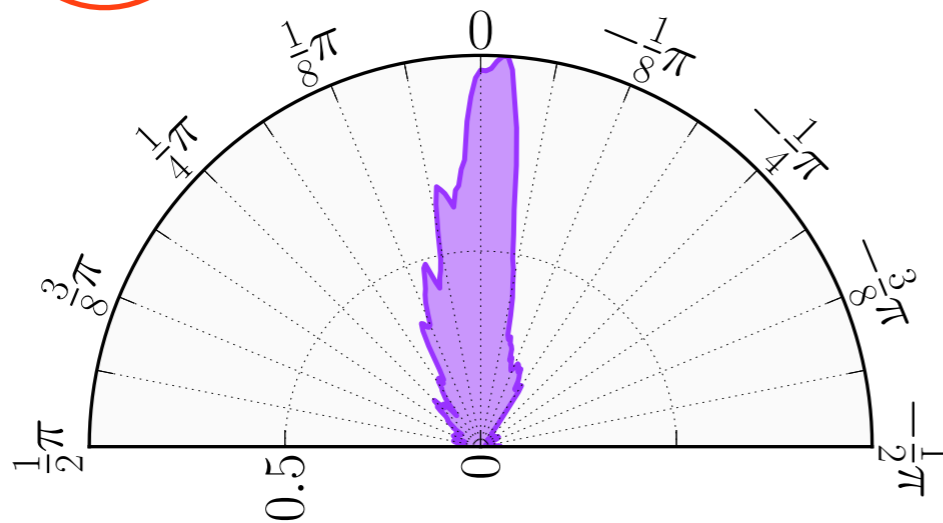
○ $2.3' = 0.08 \text{ pc}$



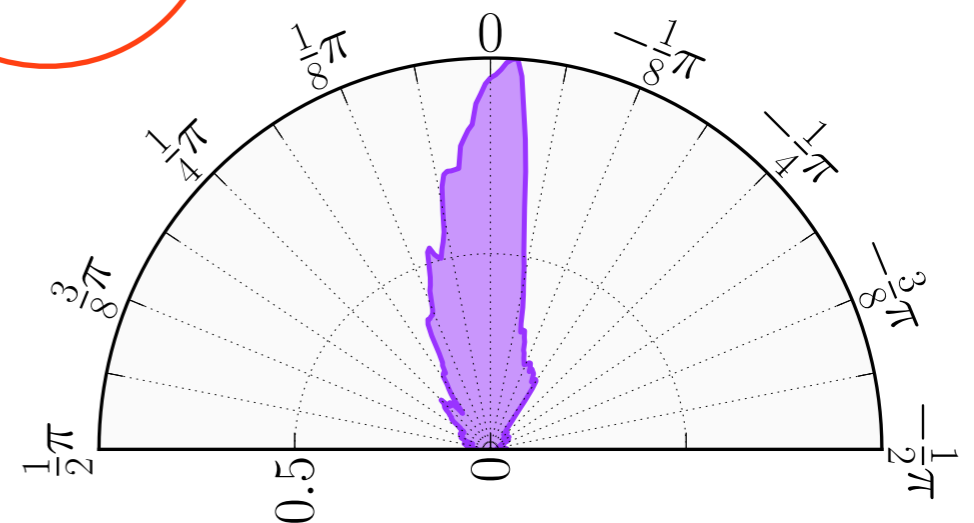
○ $5.8' = 0.2 \text{ pc}$



○ $17.5' = 0.6 \text{ pc}$

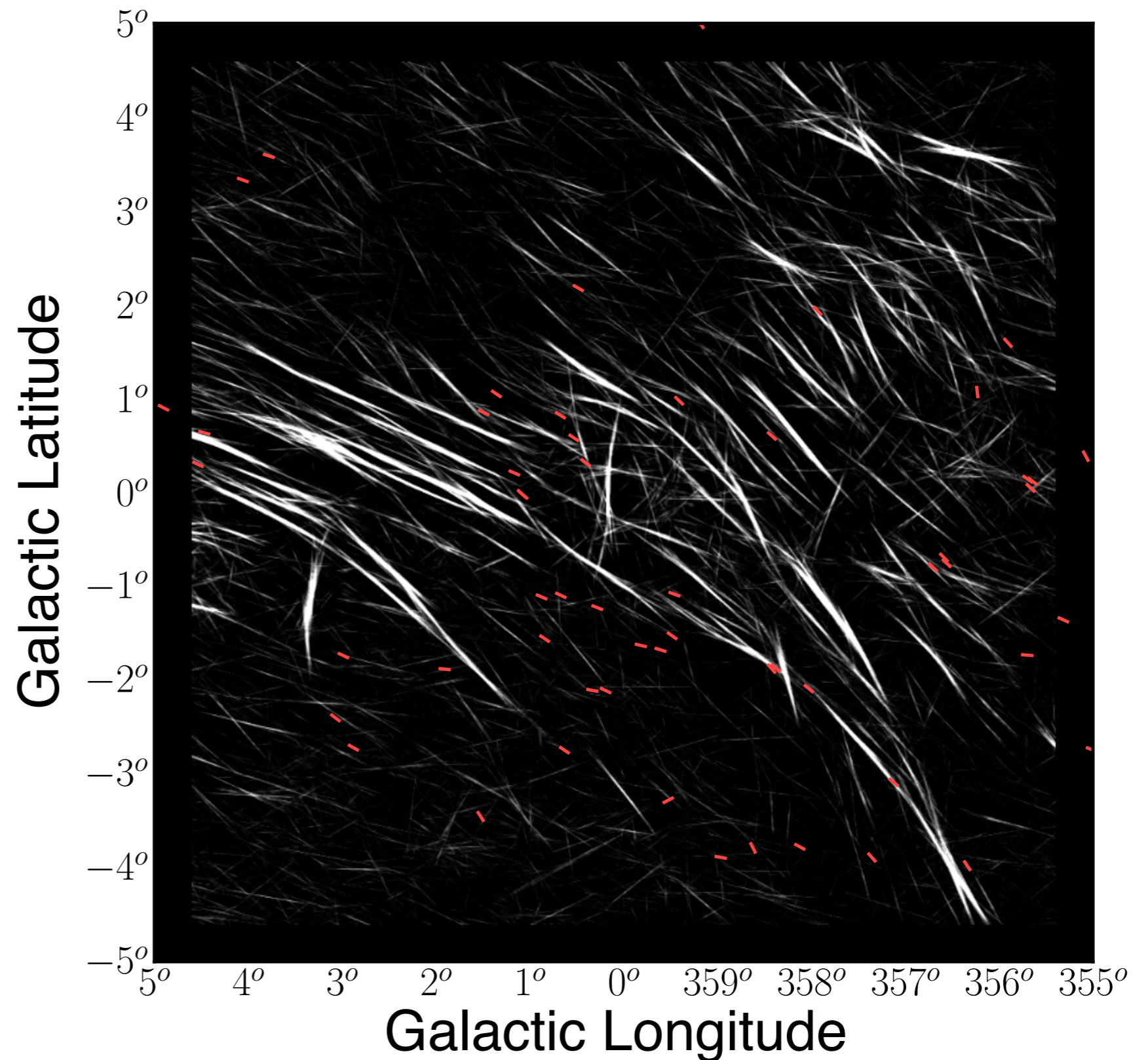


○ $29' = 1.1 \text{ pc}$



The RHT traces small-scale magnetic field variation.

+4.95 km/s



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Toward a resolved field strength measure

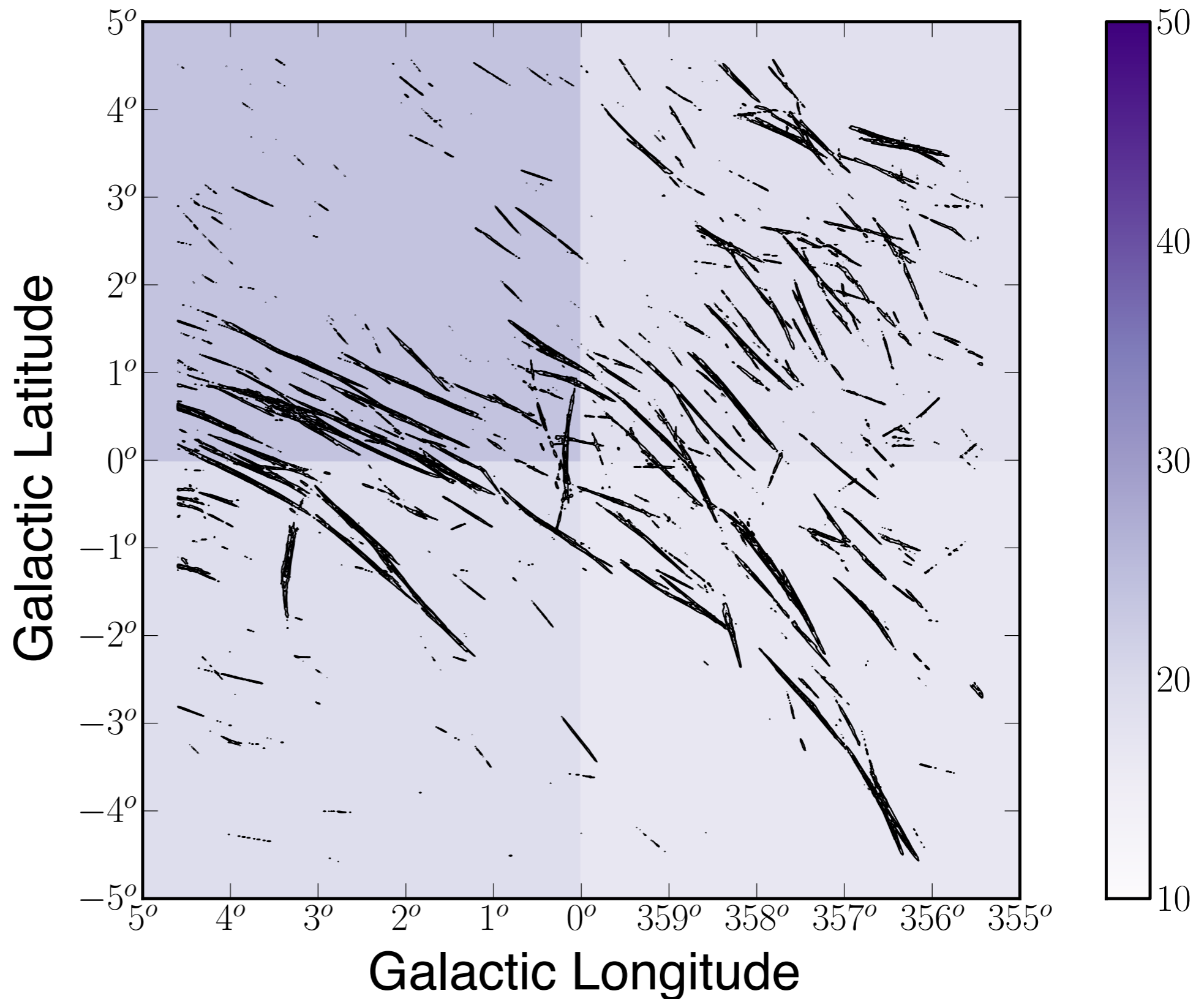
The Chandrasekhar-Fermi method estimates the field strength.

$$\langle B \rangle^2 = \xi 4\pi\rho \frac{\sigma_v^2}{\sigma(\tan \delta_p)^2}$$

$$\delta_p \equiv \theta_p - \langle \theta_p \rangle$$

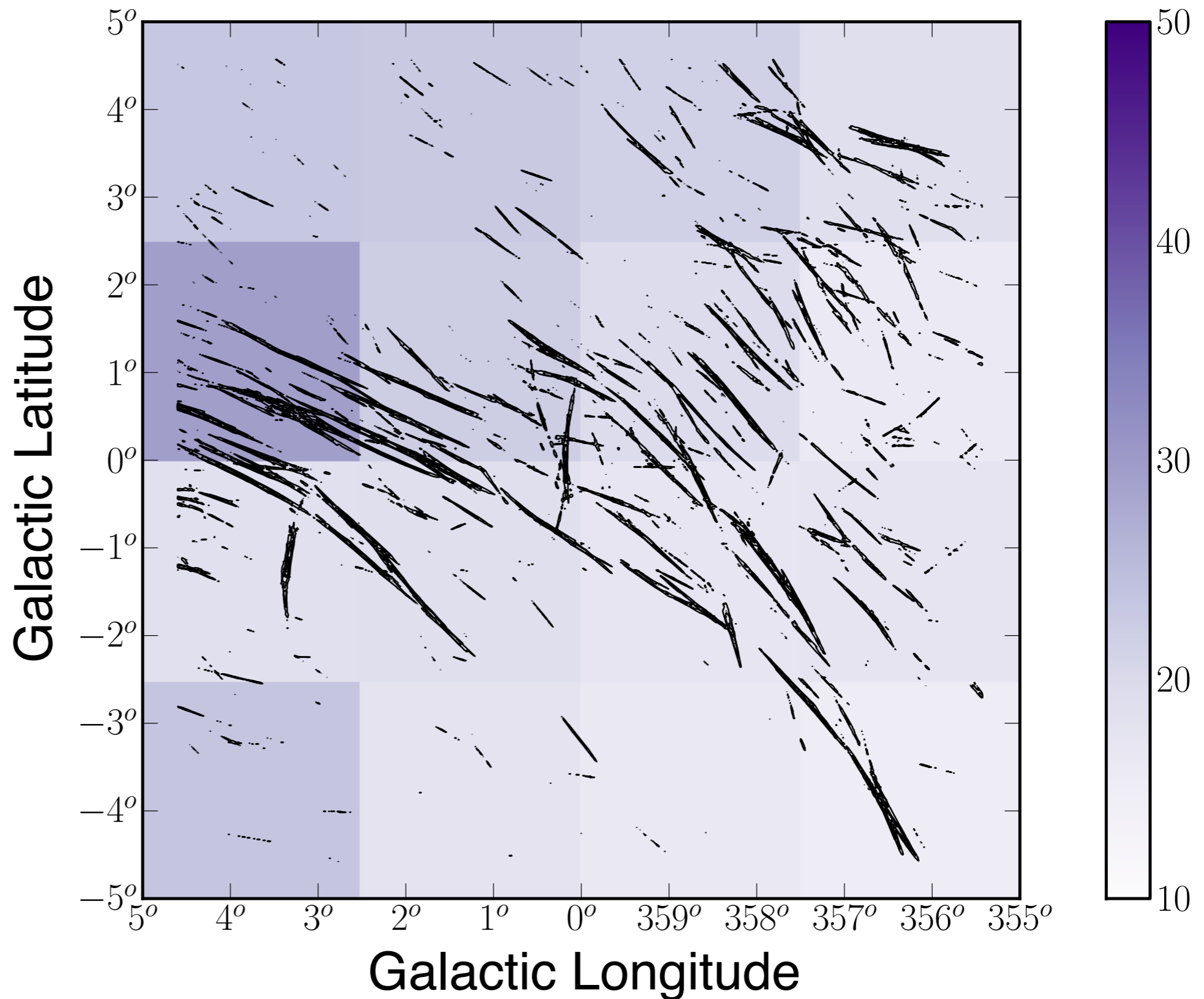
Can the RHT lead to a resolved field strength estimation?

$\langle B \rangle$ (μG)



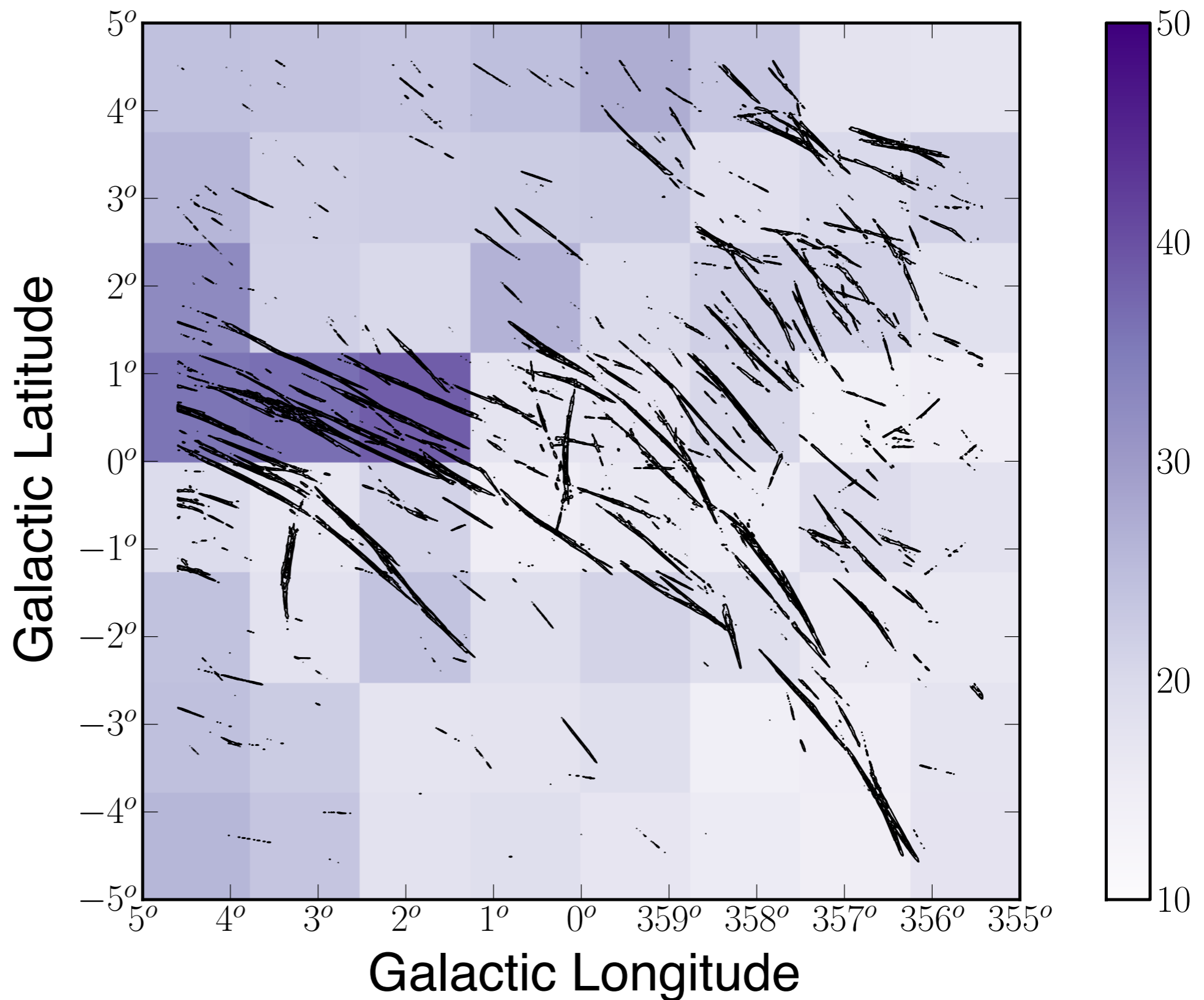
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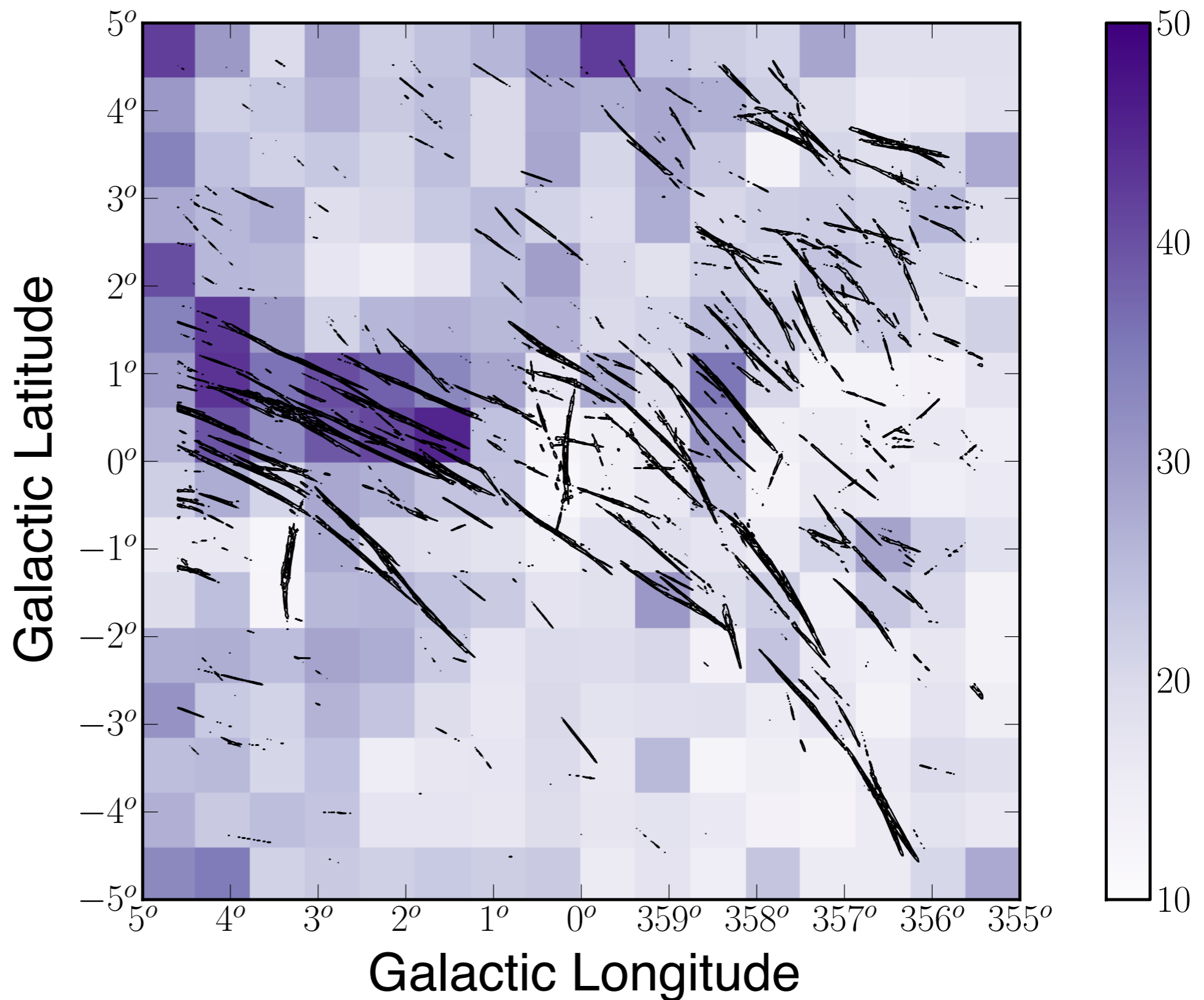
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Conclusions

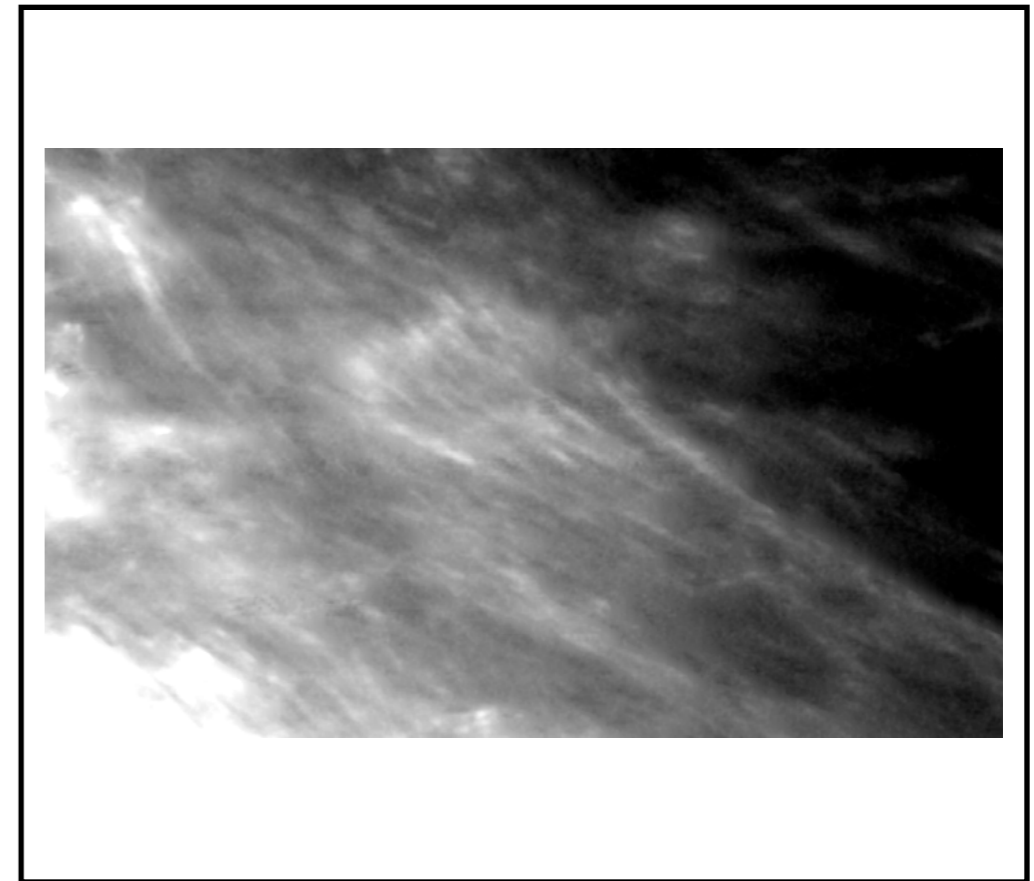
Linear HI features across the sky align with starlight polarization.

The RHT parameterizes linearity.

Alignment improves with smaller physical scales, from GASS to GALFA (0.6 to 0.1 pc at 100 pc).

The Riegel-Crutcher cloud shows striking alignment, down to the survey resolution (0.06 pc at 125 pc).

The RHT is a step toward a resolved field strength estimation.



Conclusions

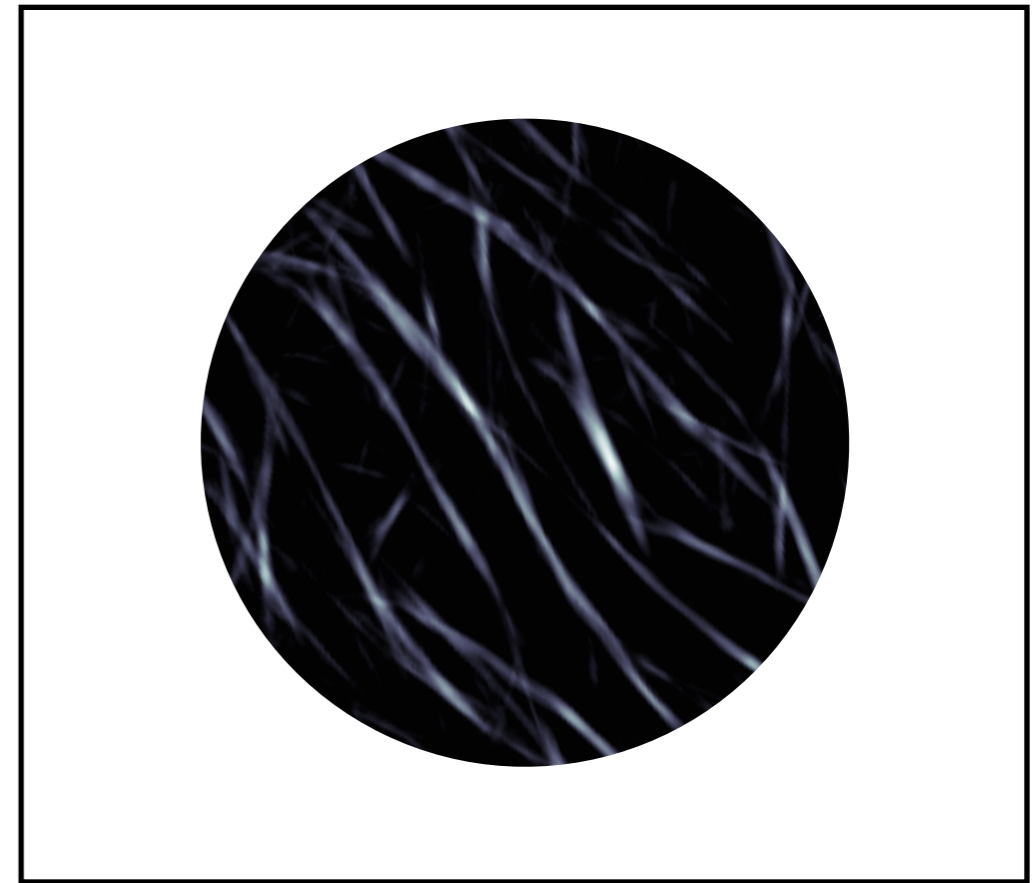
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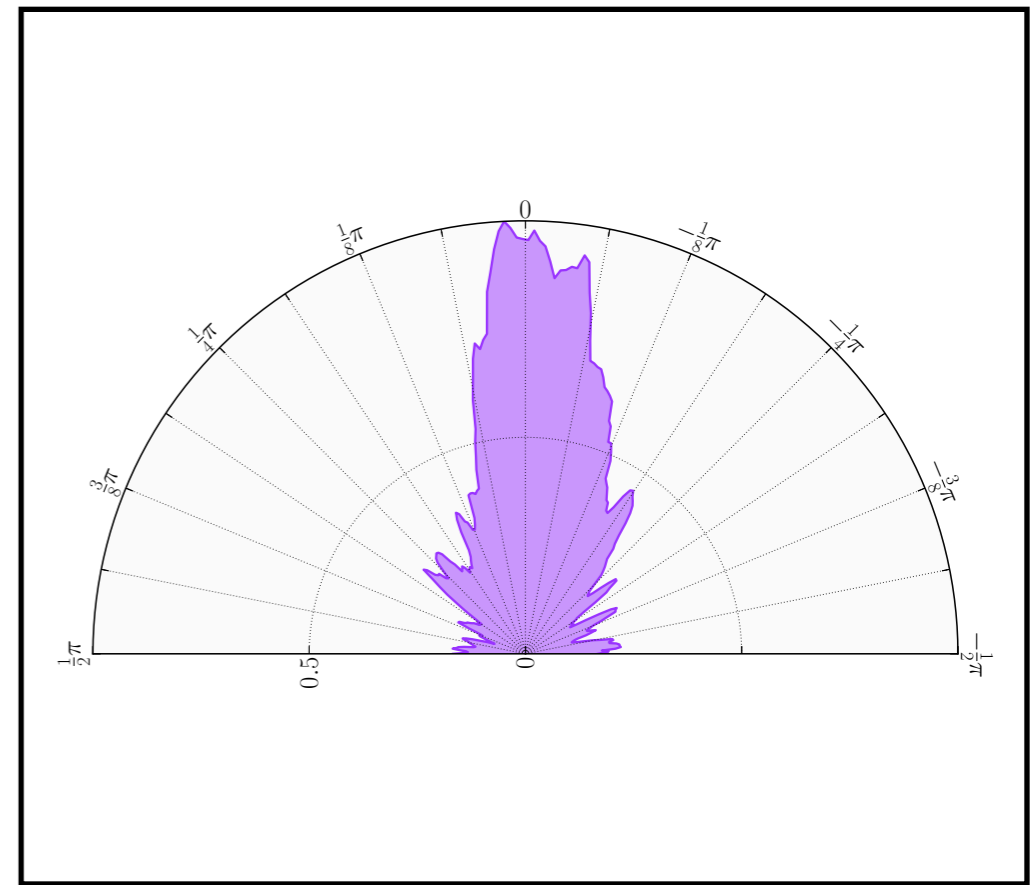
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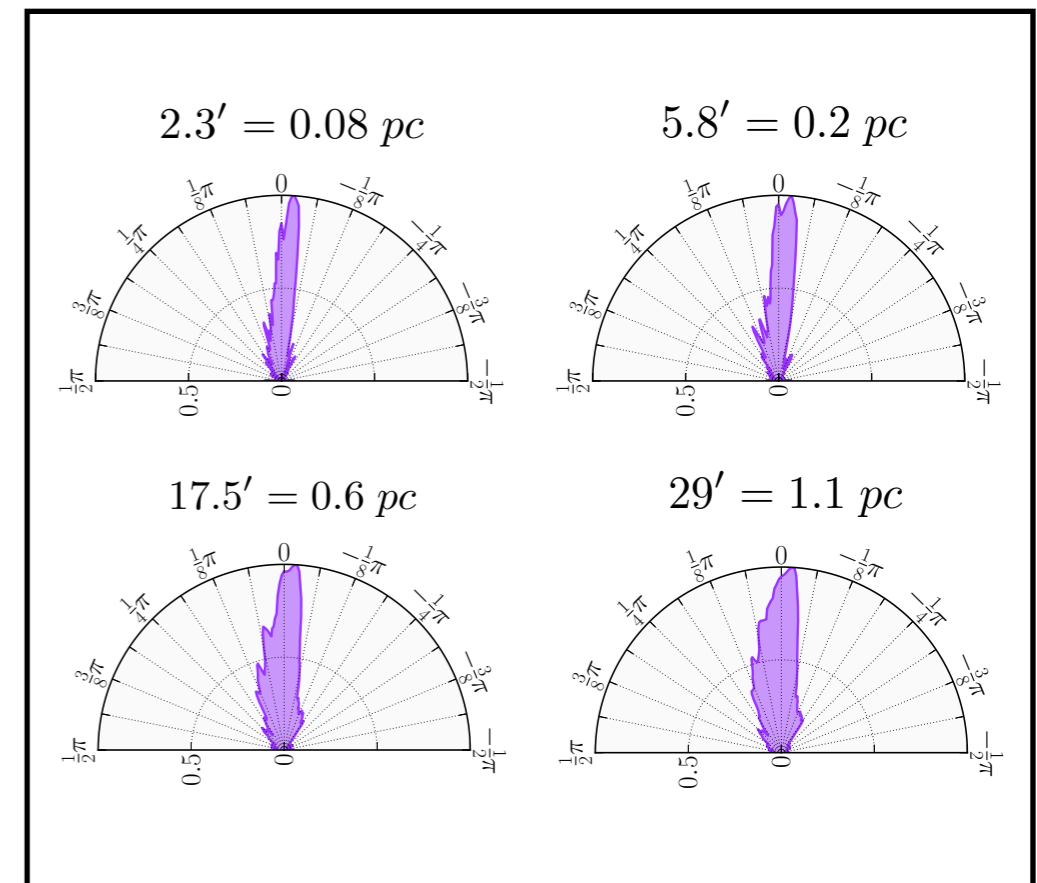
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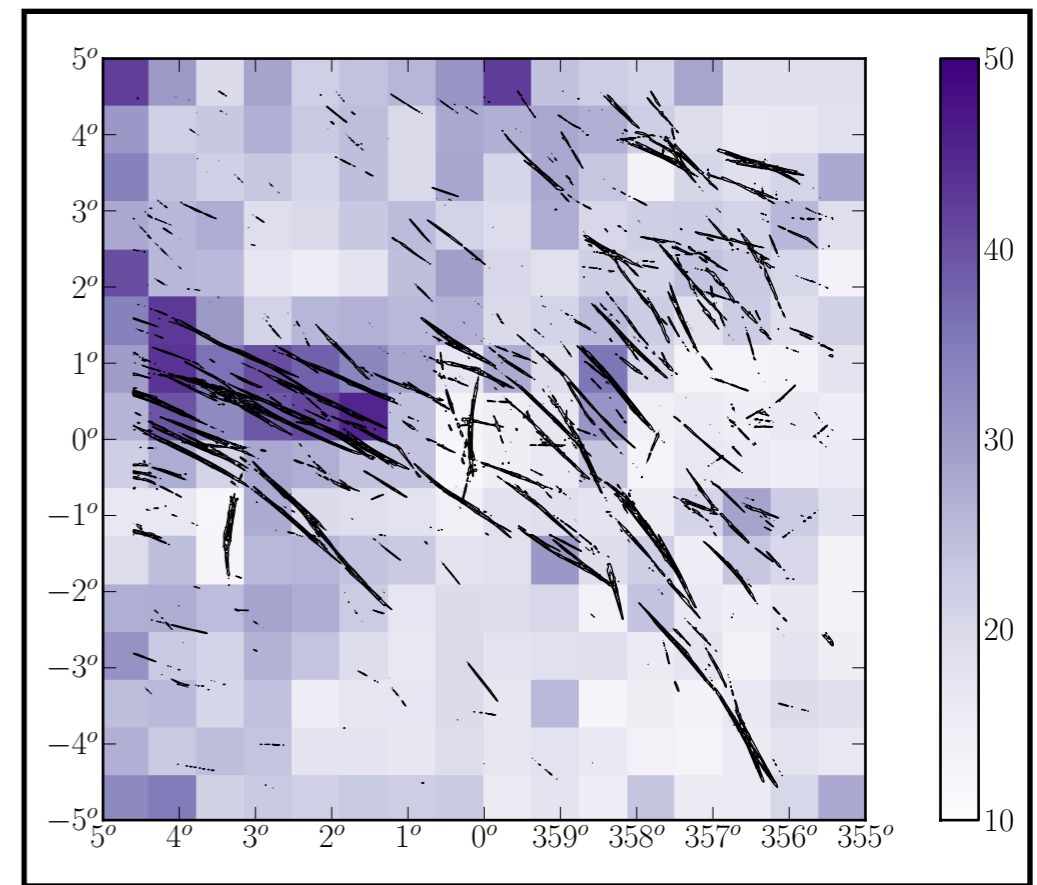
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