

The Galactic dynamics revealed by the filamentary structure in the neutral atomic hydrogen emission

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ECOgal collaboration: S. Molinari, R. S. Klessen, P. Hennebelle, S. C. O. Glover, A. Trafficante, E. Schisano, D. Elia, M. Sormani, R. Treß, P. Girichidis, R. J. Smith, T. Colman

**Emission by
atomic hydrogen gas
in the Milky Way**

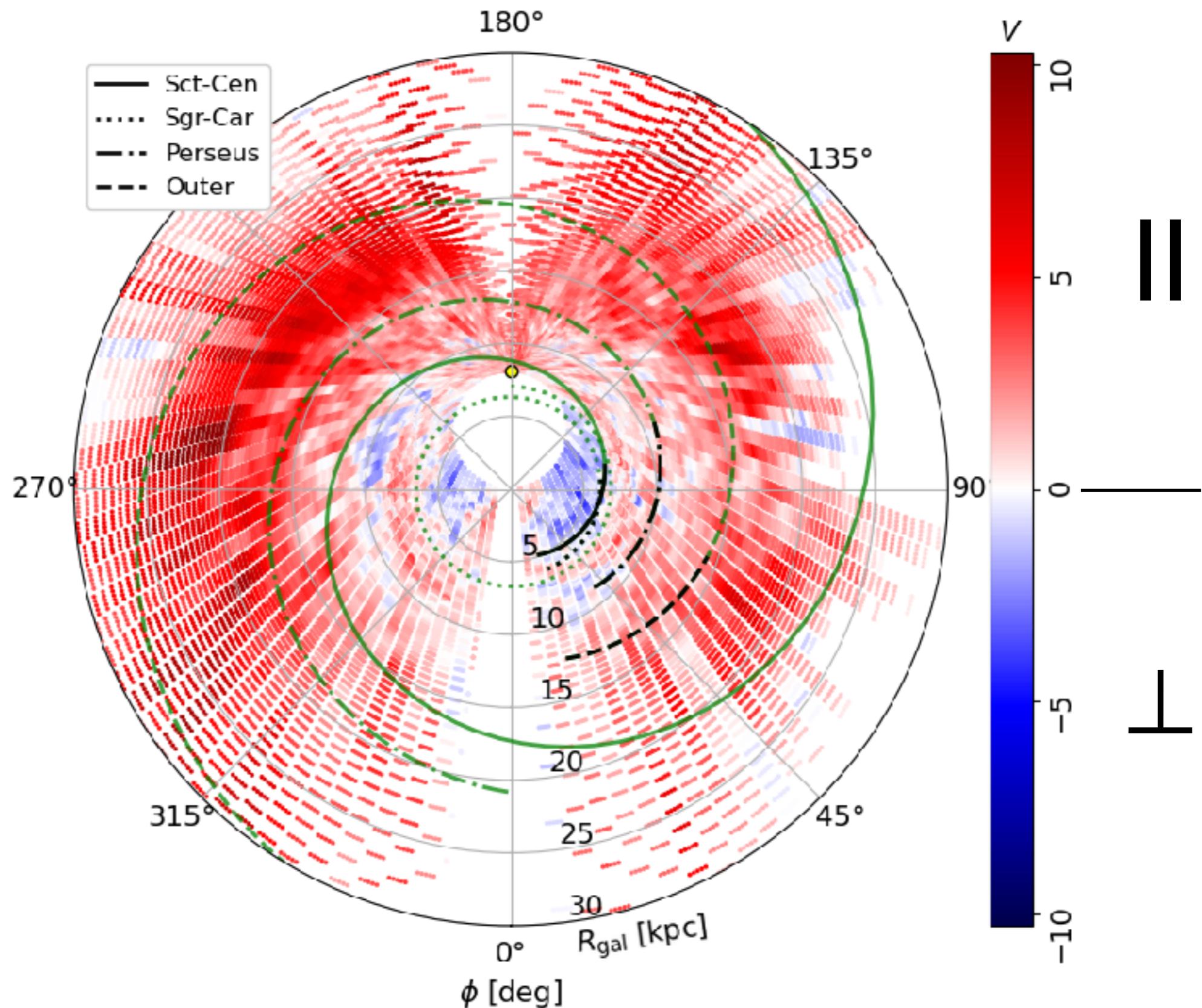
GALFA-HI survey

Juan Diego Soler and the ECOGAL collaboration



Orientation of HI filaments with respect to the Galactic plane

Soler, J.D. et al. A&A (2022)



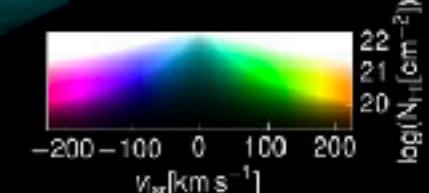
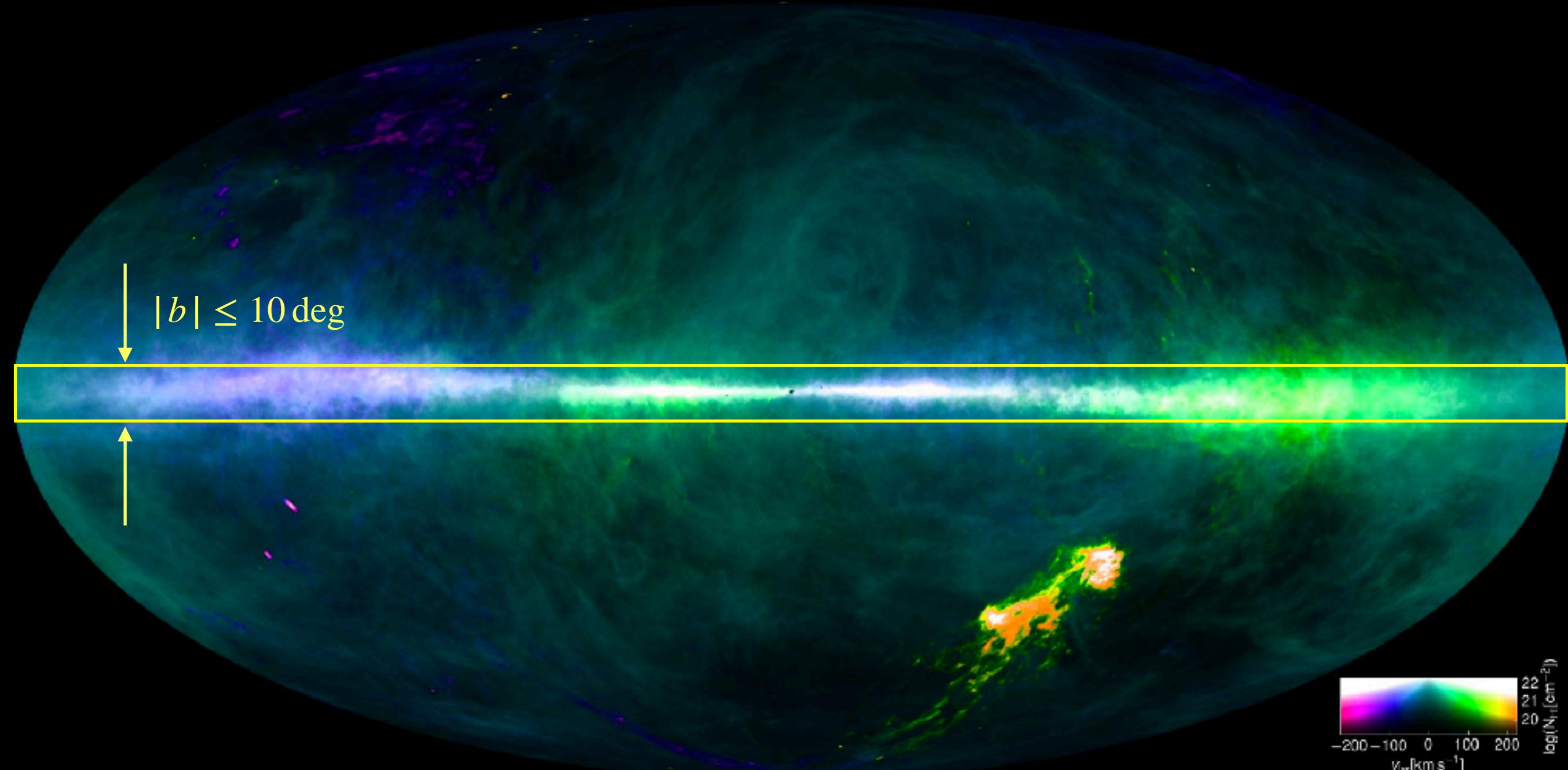
Atomic hydrogen emission

HI4PI

HI4PI Collaboration. A&A (2016)

16.5' FWHM

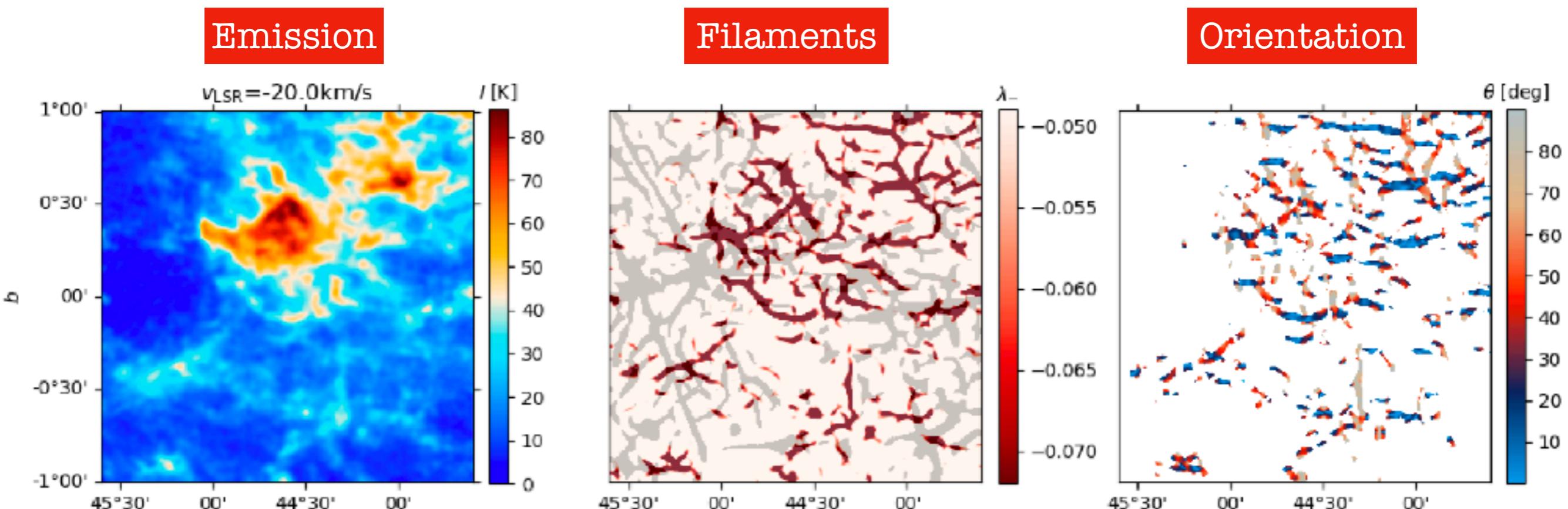
$\Delta v = 1.29 \text{ km/s}$



Benjamin Winkel & HI4PI Collaboration

HI filaments - Hessian matrix method

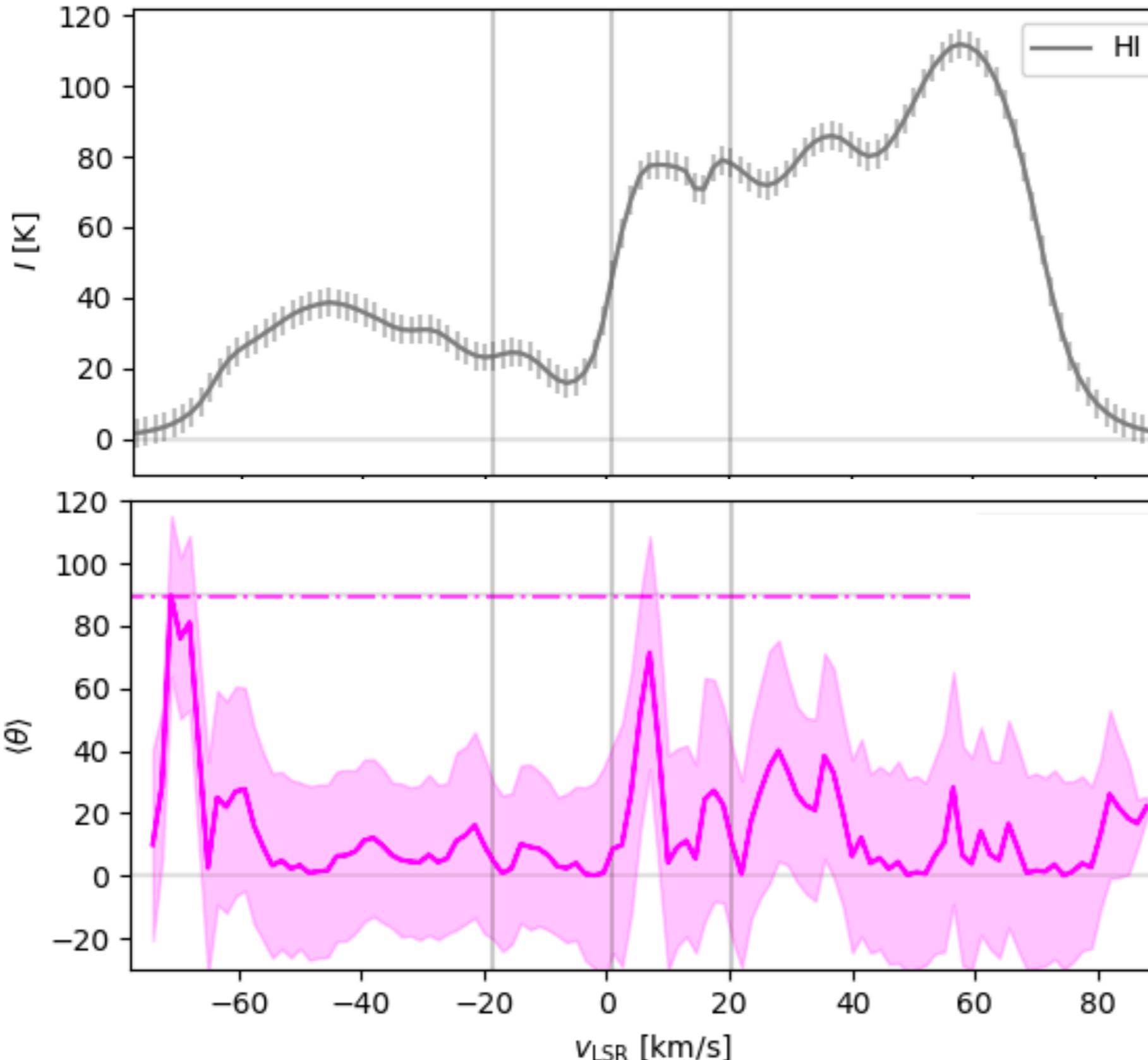
THOR-HI. Beuther et al. A&A (2016)
Soler, J.D. et al. A&A (2020)



HI filament orientation

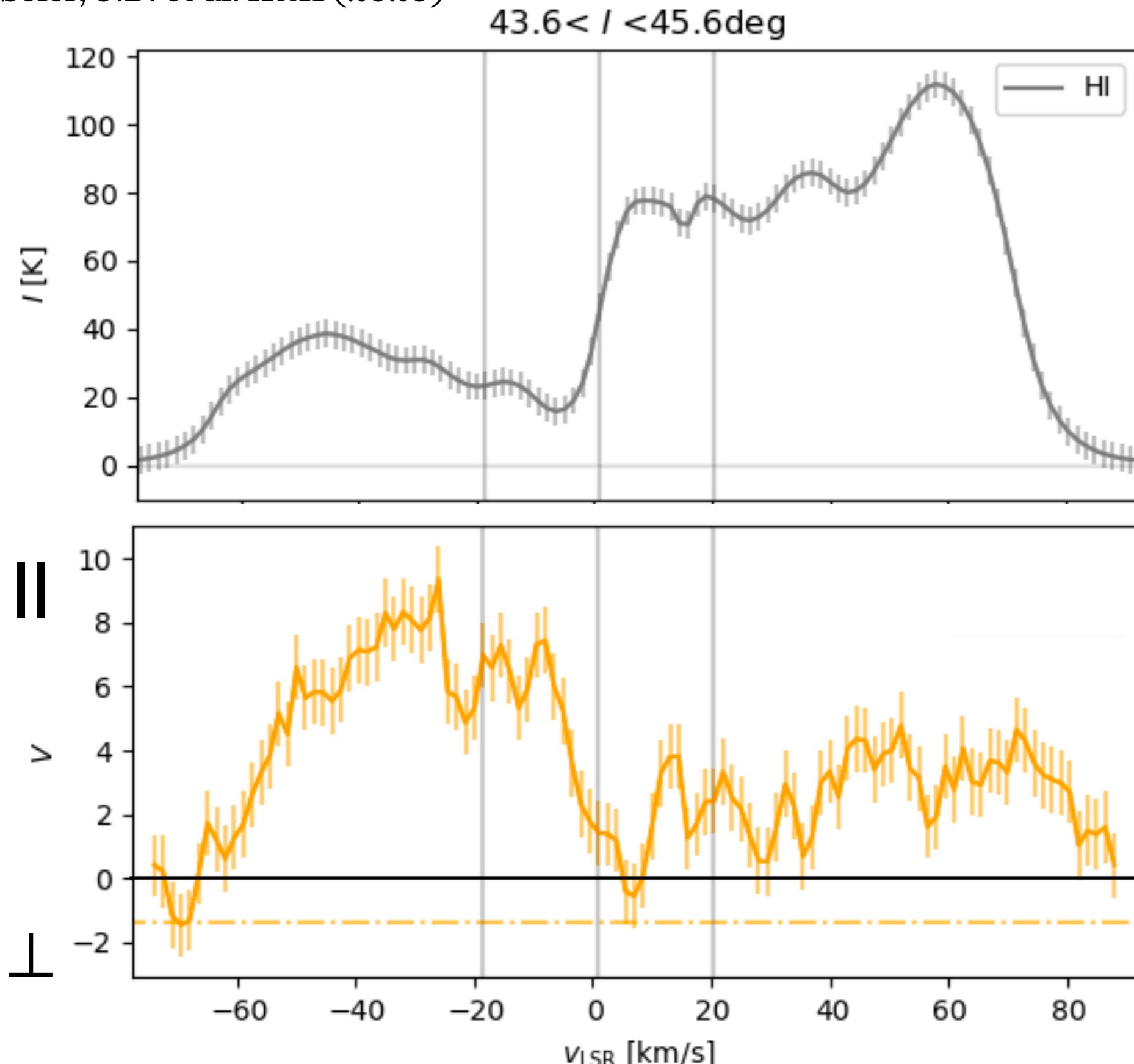
Soler, J.D. et al. A&A (2020)

$43.6 < l < 45.6 \text{deg}$



HI filament orientation

Soler, J.D. et al. A&A (2020)



Projected Rayleigh statistic

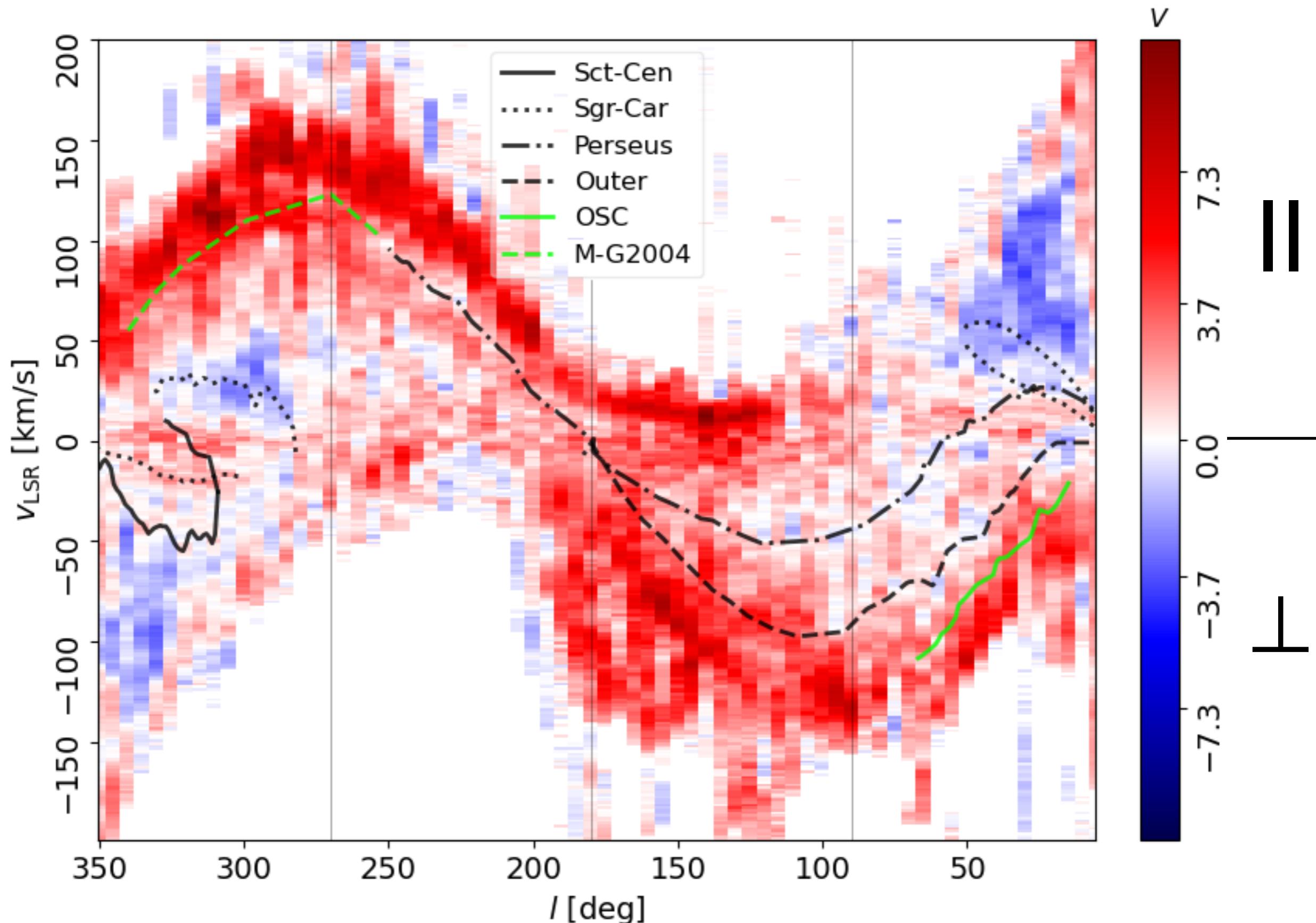
Jow et al. (2018)

Soler et al. (2019)

$$V = \frac{\sum_{ij}^{n,m} w_{ij} \cos(2\theta_{ij})}{\sqrt{\sum_{ij}^{n,m} w_{ij}/2}}$$

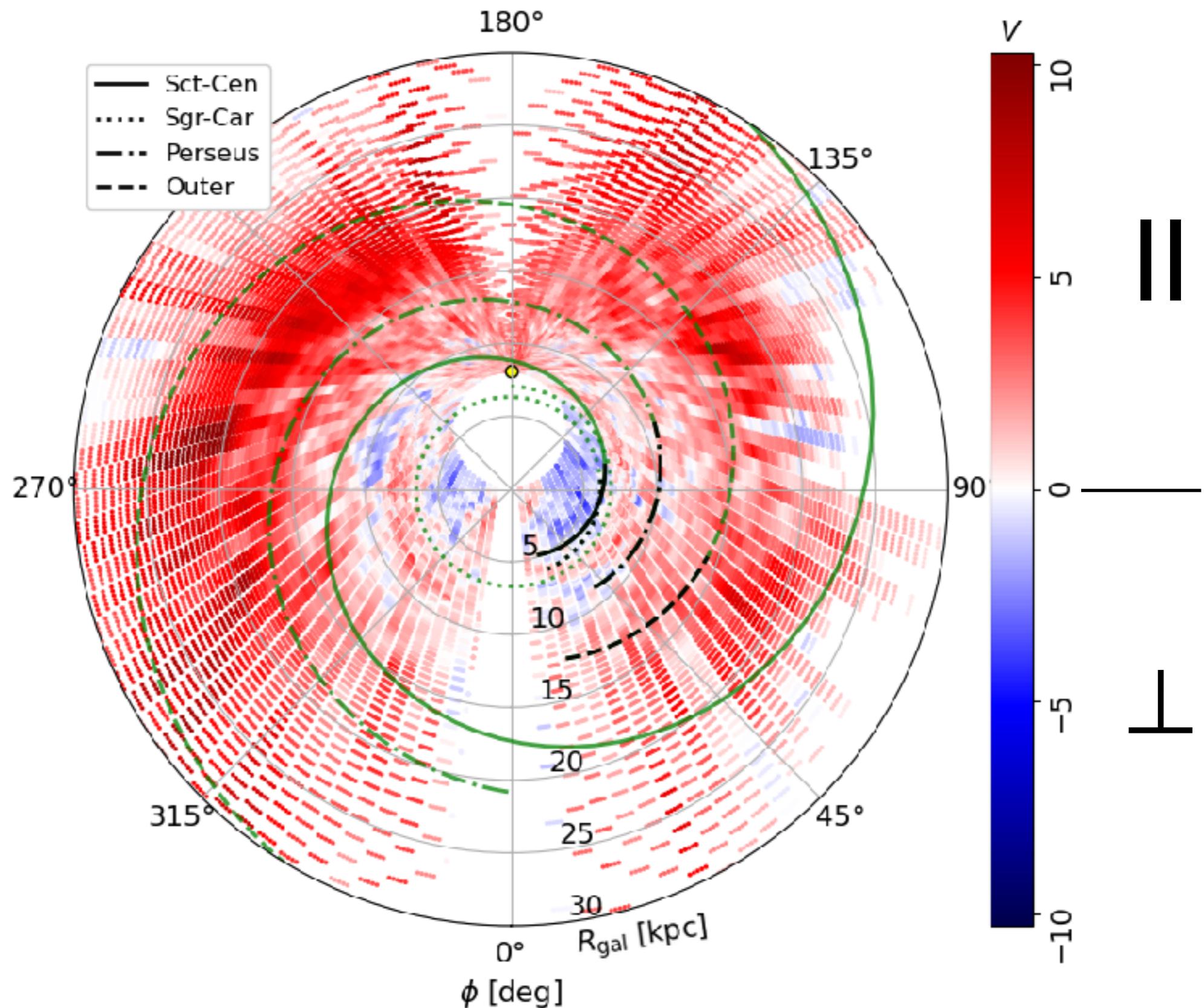
HI filament orientation

Soler, J.D. et al. A&A (2022)



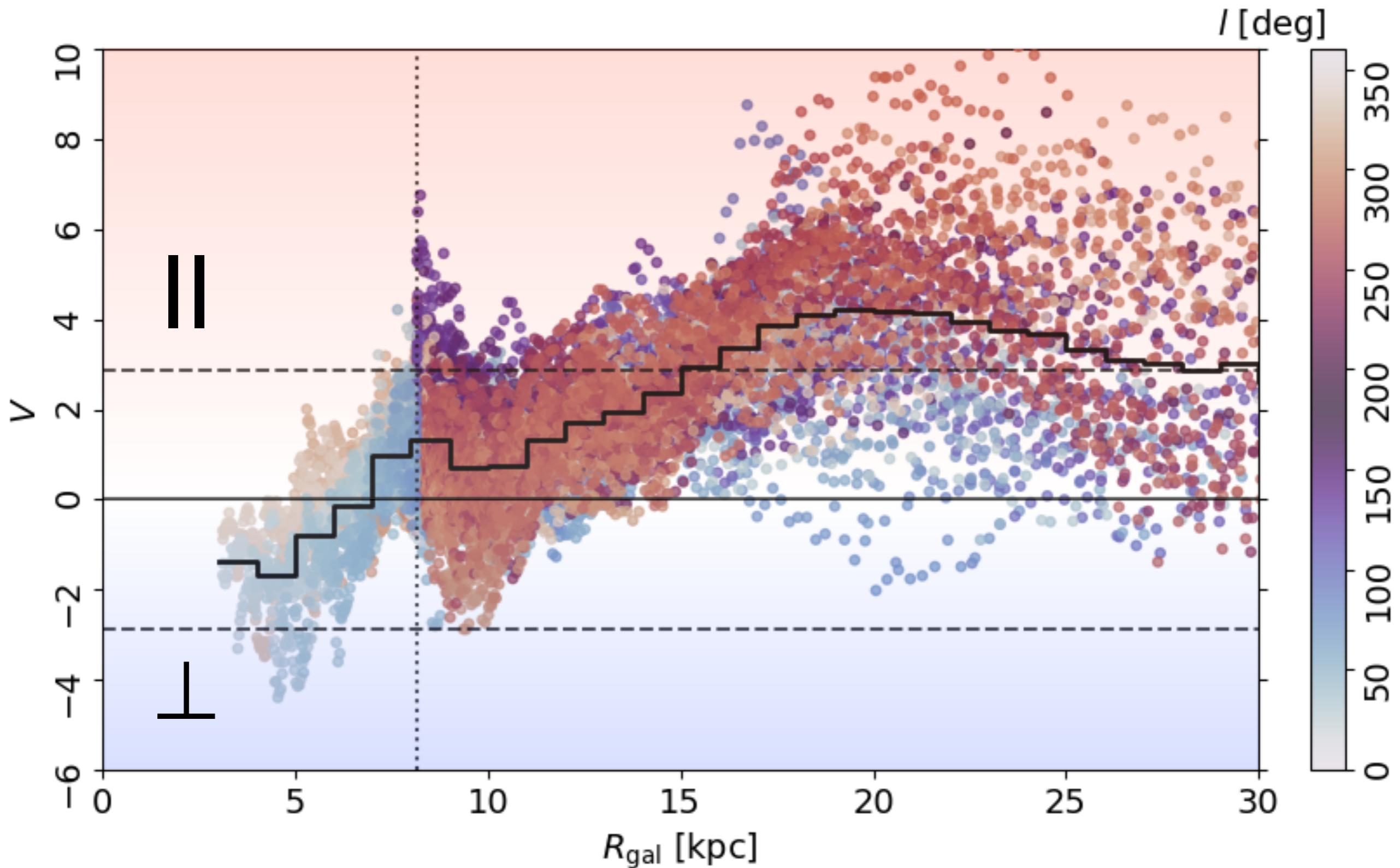
HI filament orientation

Soler, J.D. et al. A&A (2022)



HI filament orientation

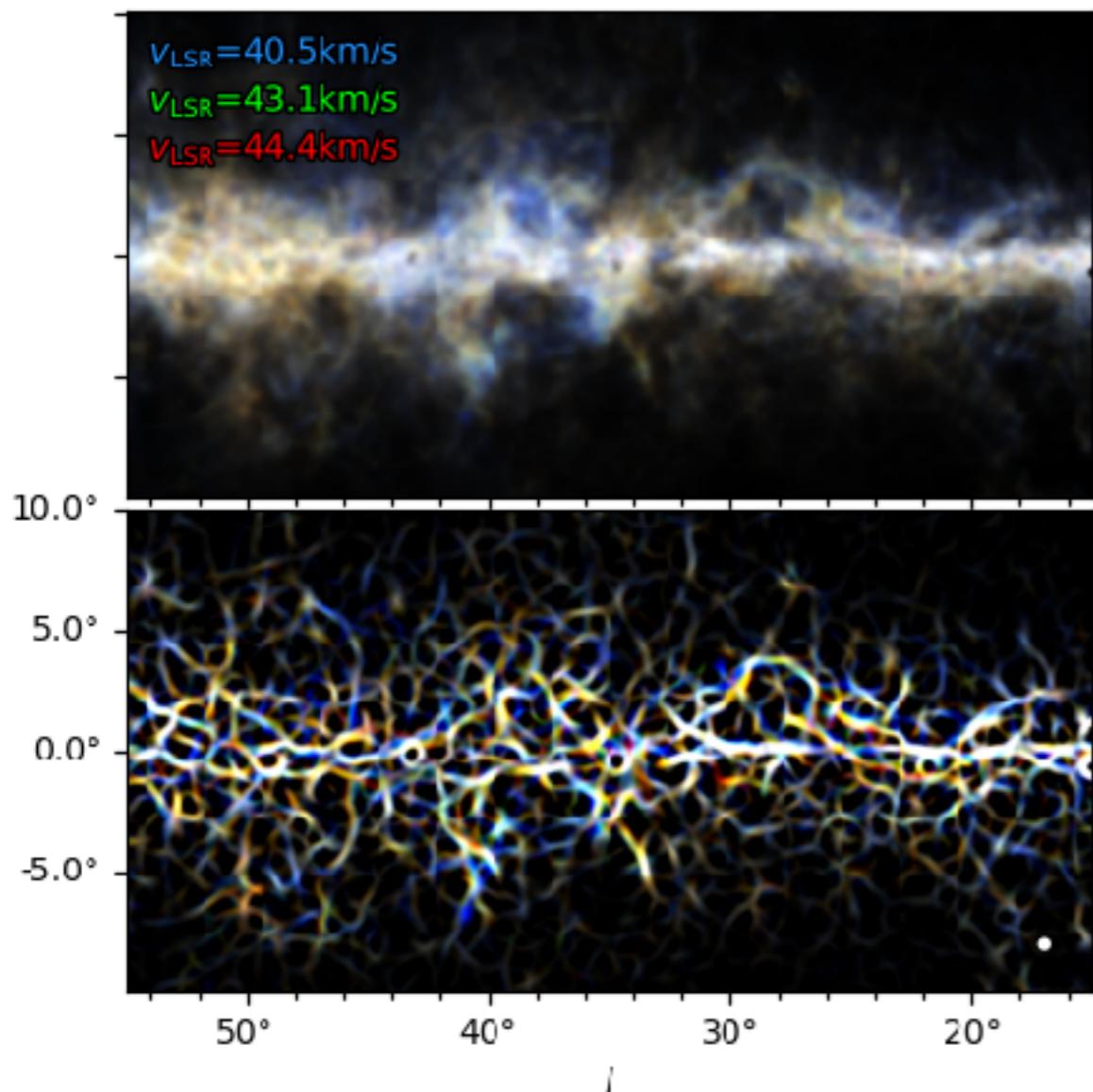
Soler, J.D. et al. A&A (2022)



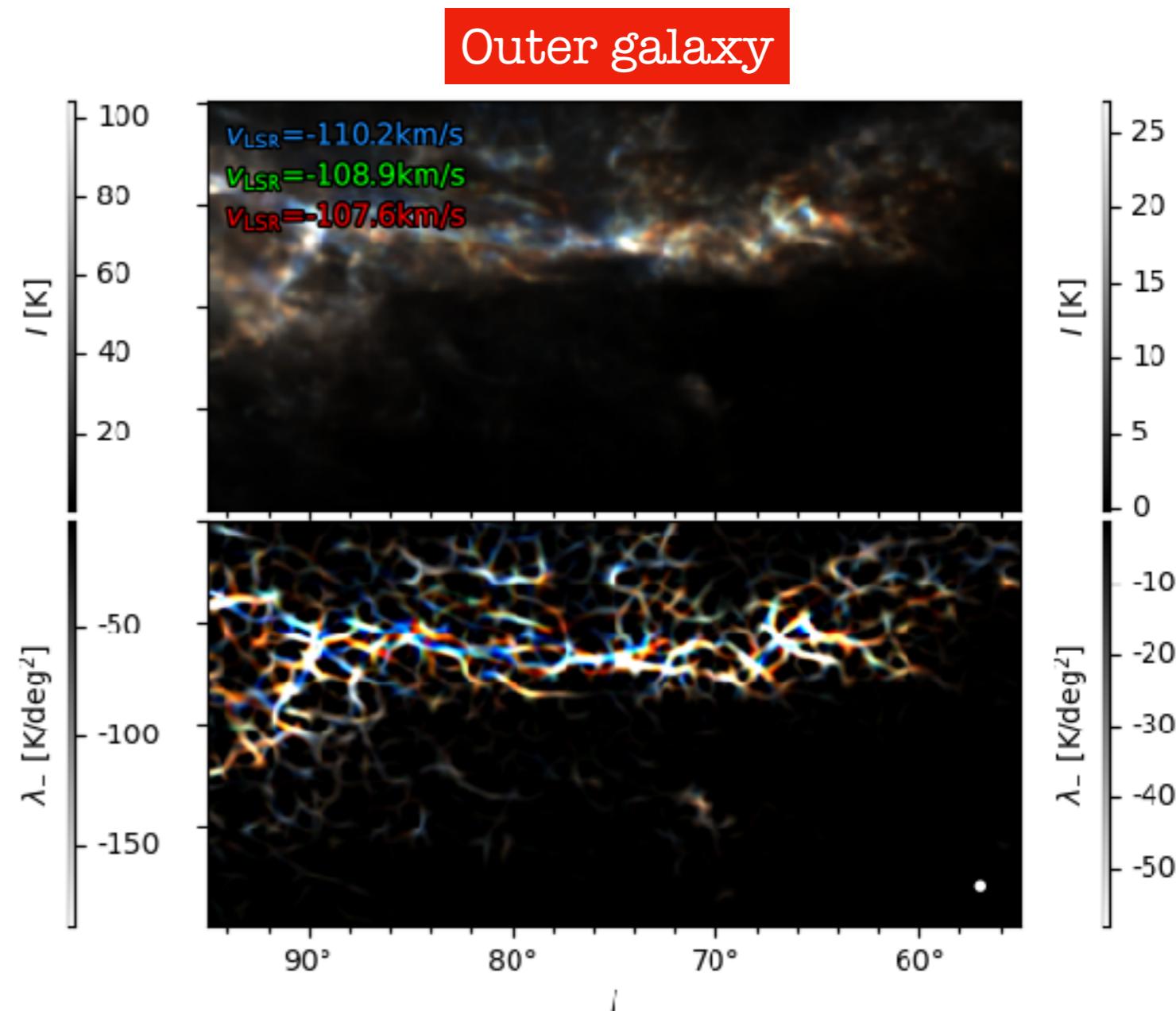
HI filaments

Soler, J.D. et al. A&A (2022)

Inner galaxy

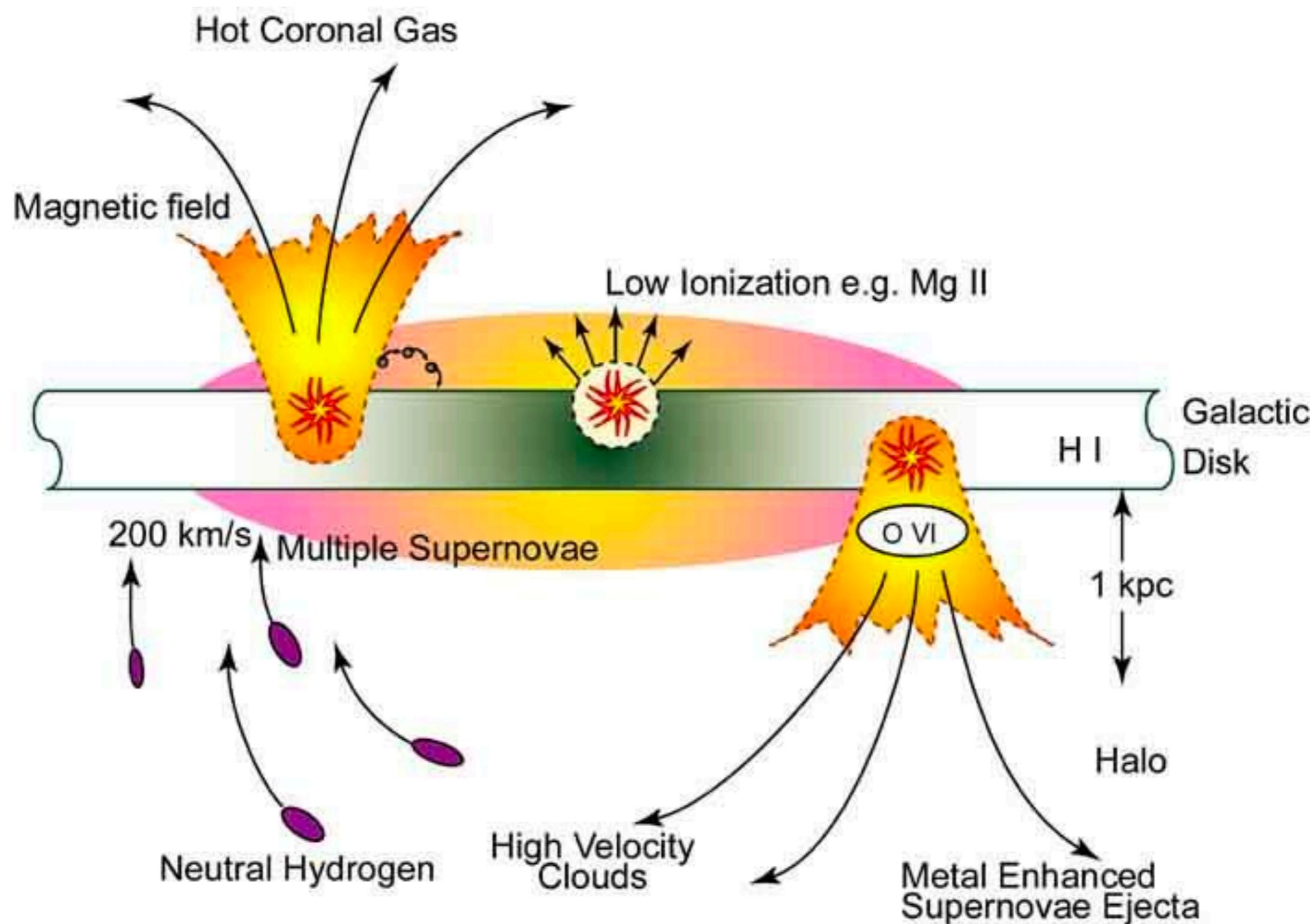


Outer galaxy



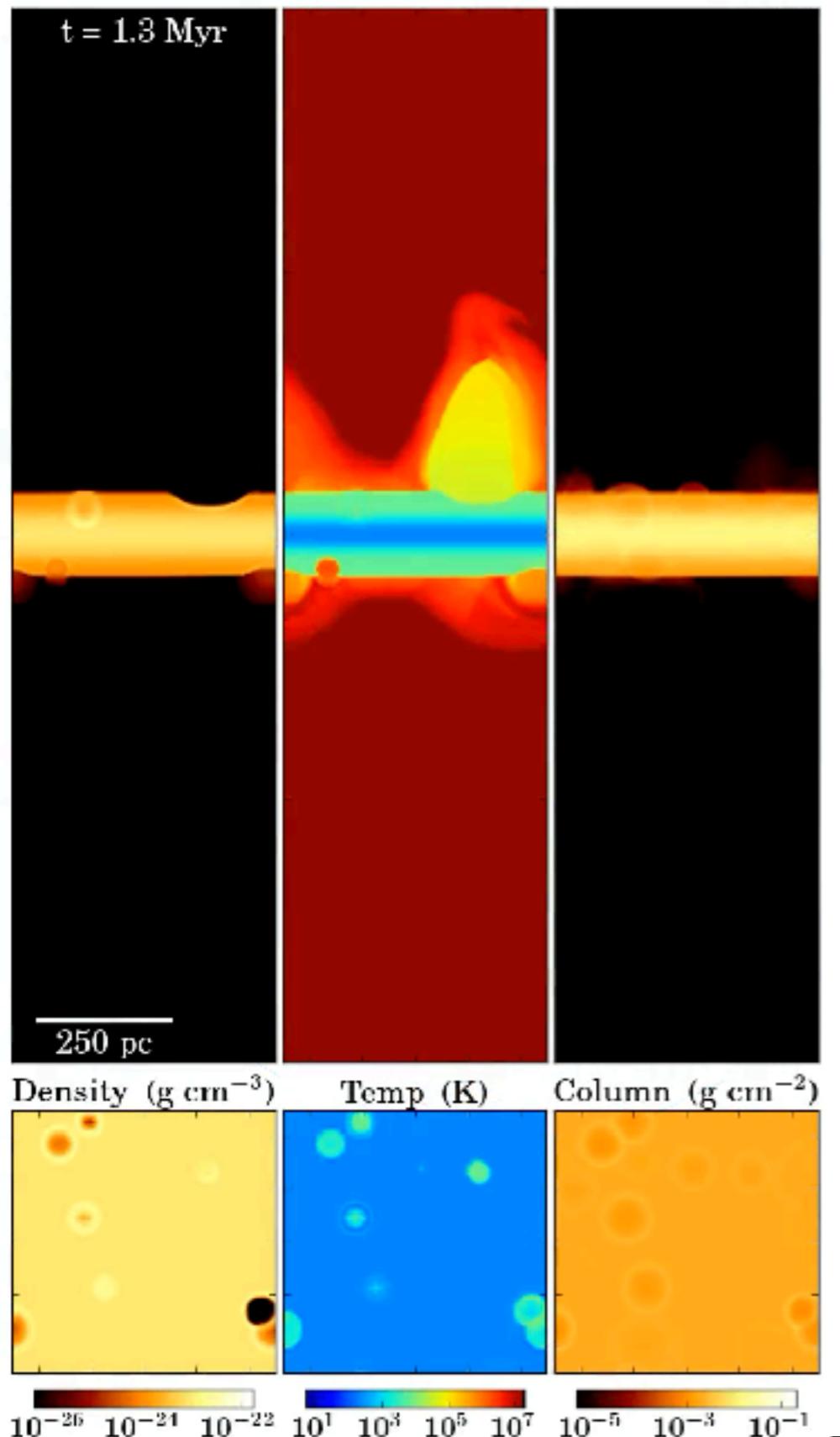
Atomic worms and chimneys

Heiles, 1994



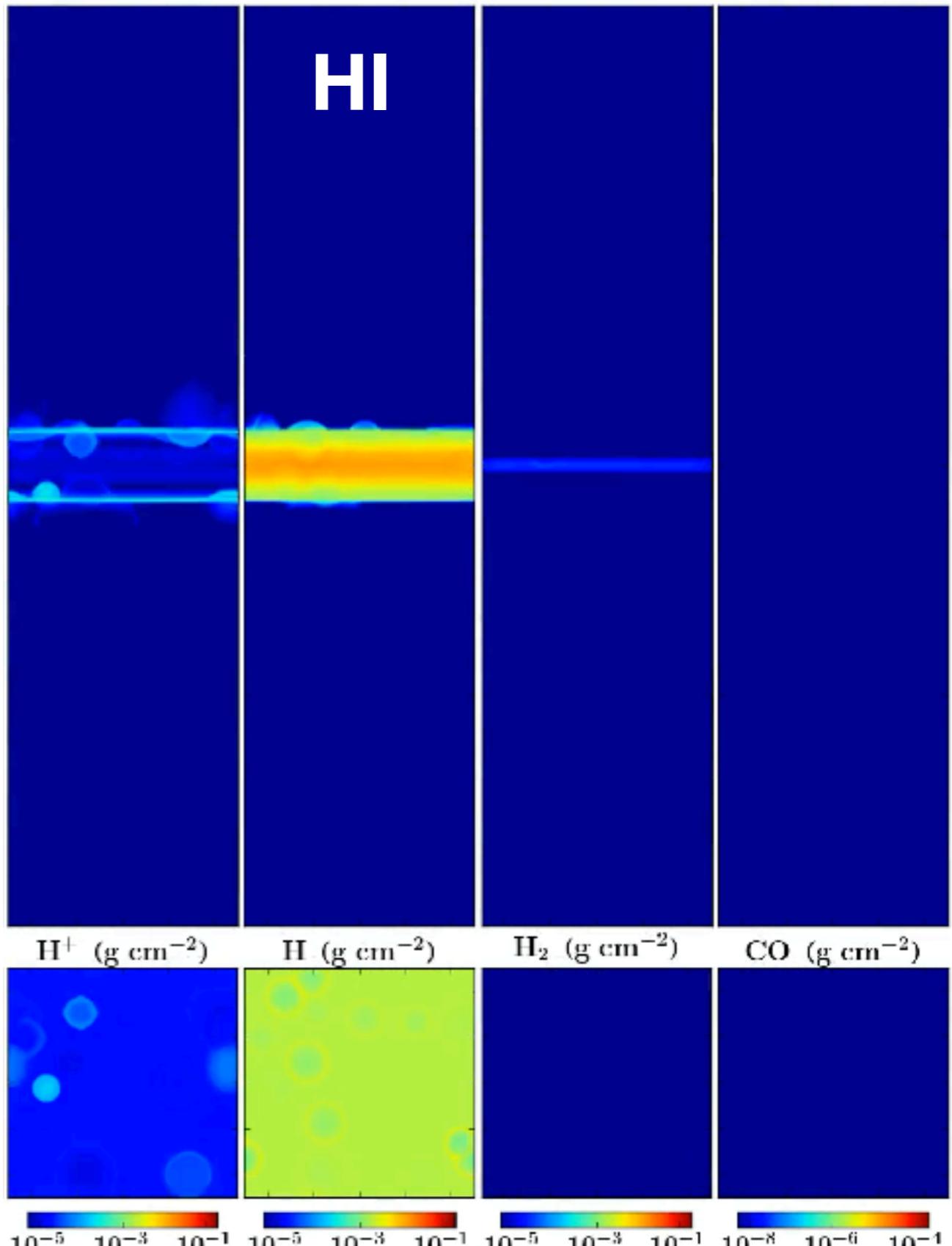
Atomic filament orientation and HI bubbles

Girichidis et al. MNRAS (2021). SILCC: Simulating the LifeCycle of molecular Clouds



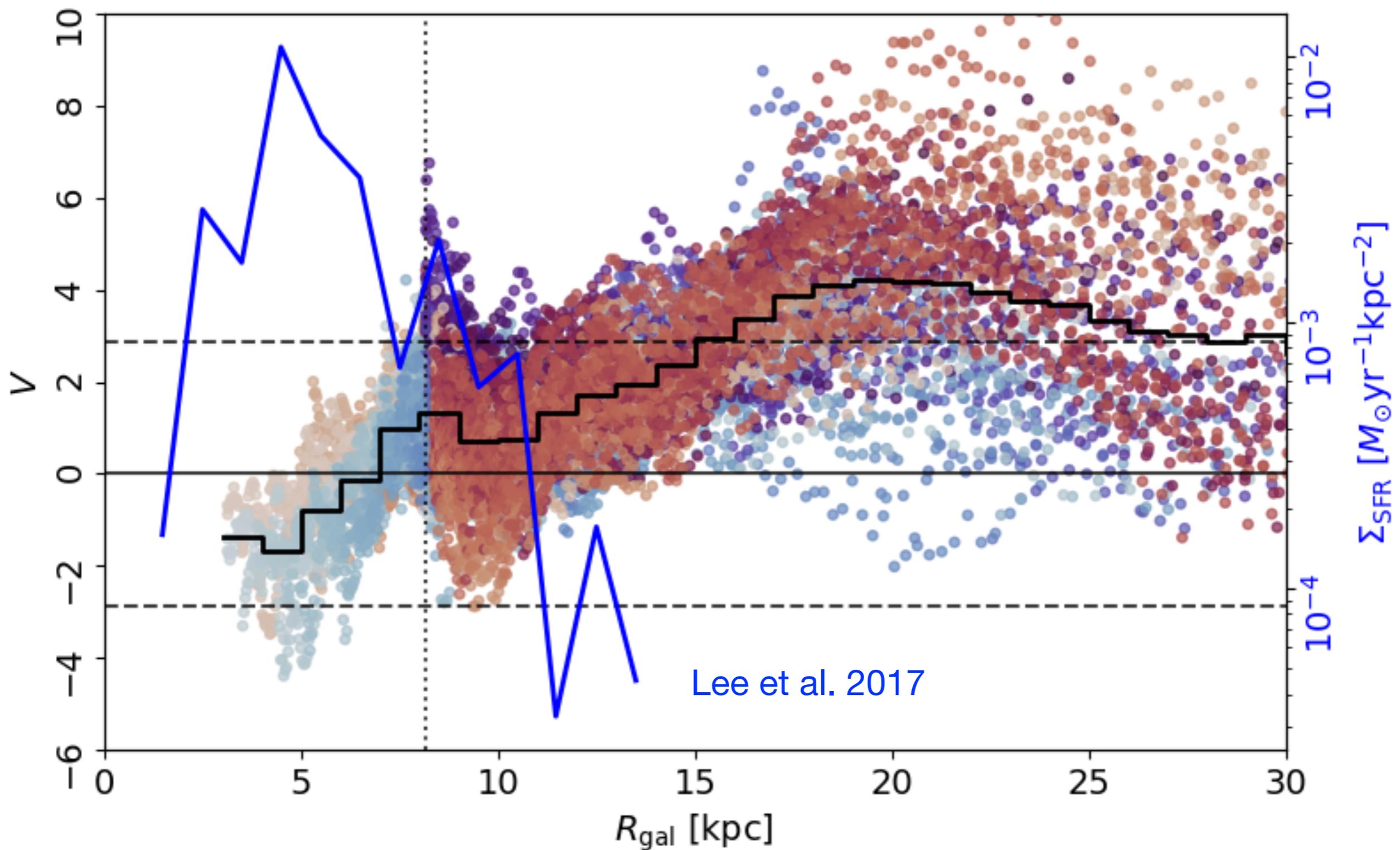
Atomic filament orientation and HI bubbles

Girichidis et al. MNRAS (2021). SILCC: Simulating the LifeCycle of molecular Clouds



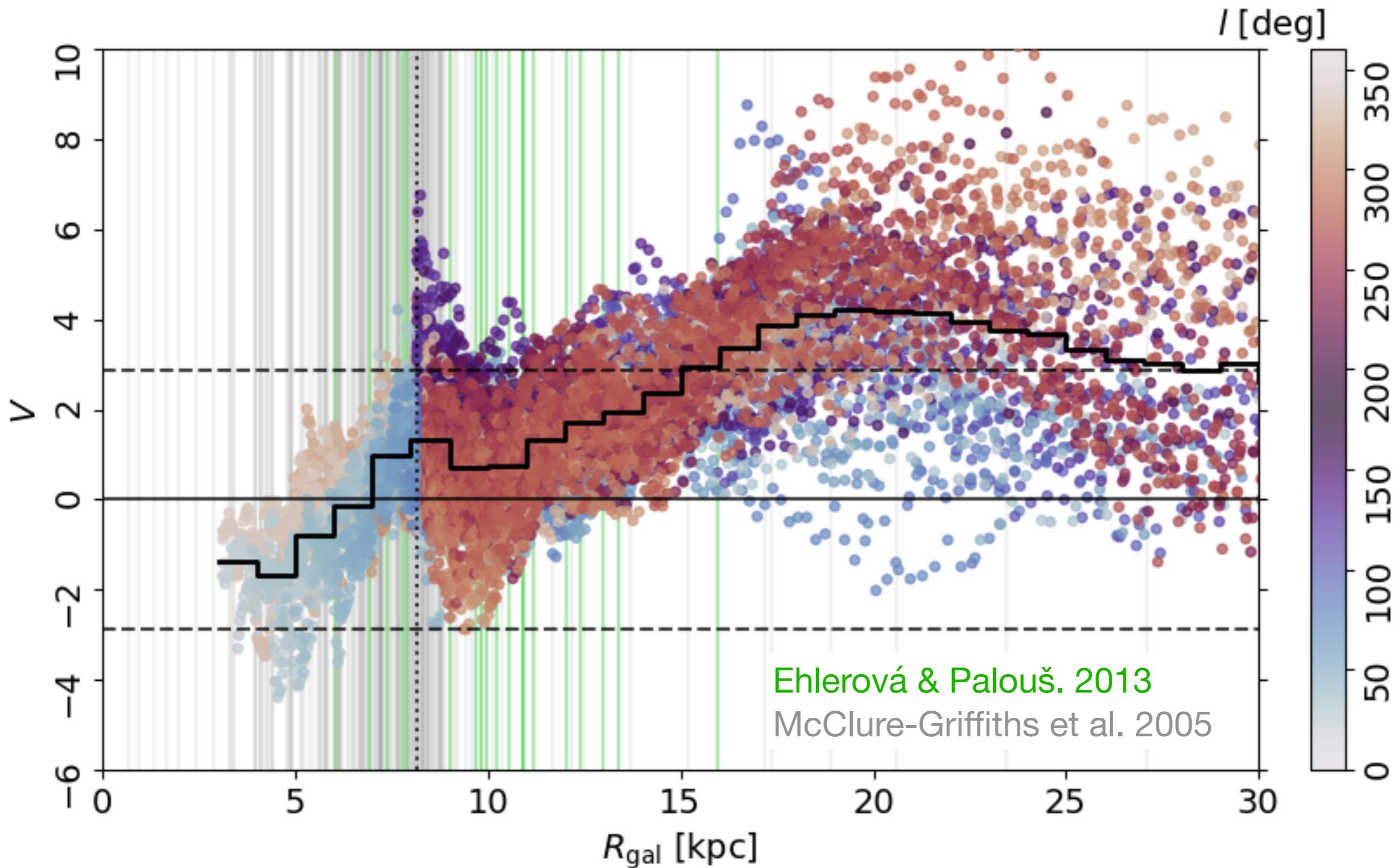
HI filament orientation and star formation

Soler, J.D. et al. A&A (2022)



HI filament orientation and HI bubbles

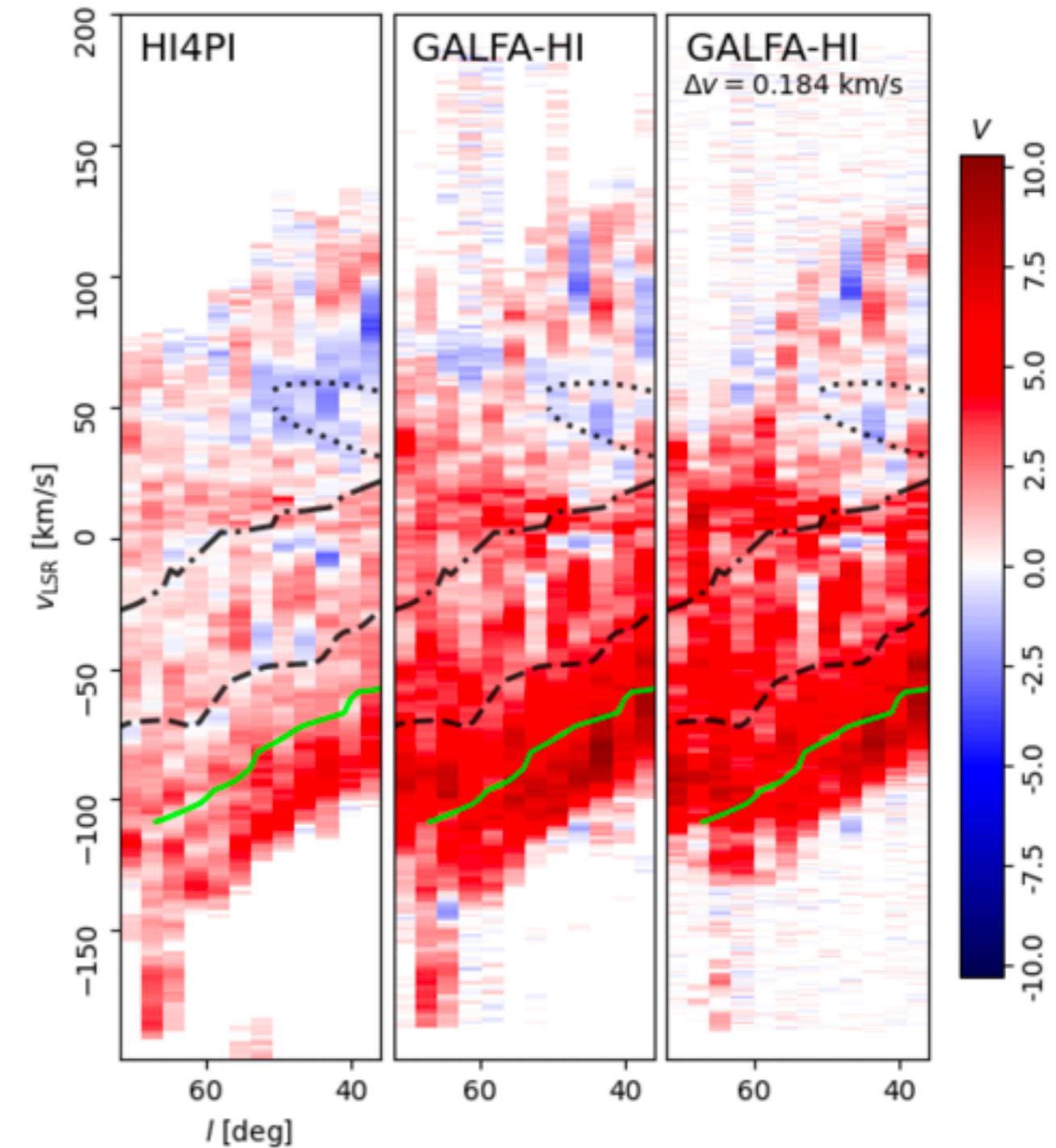
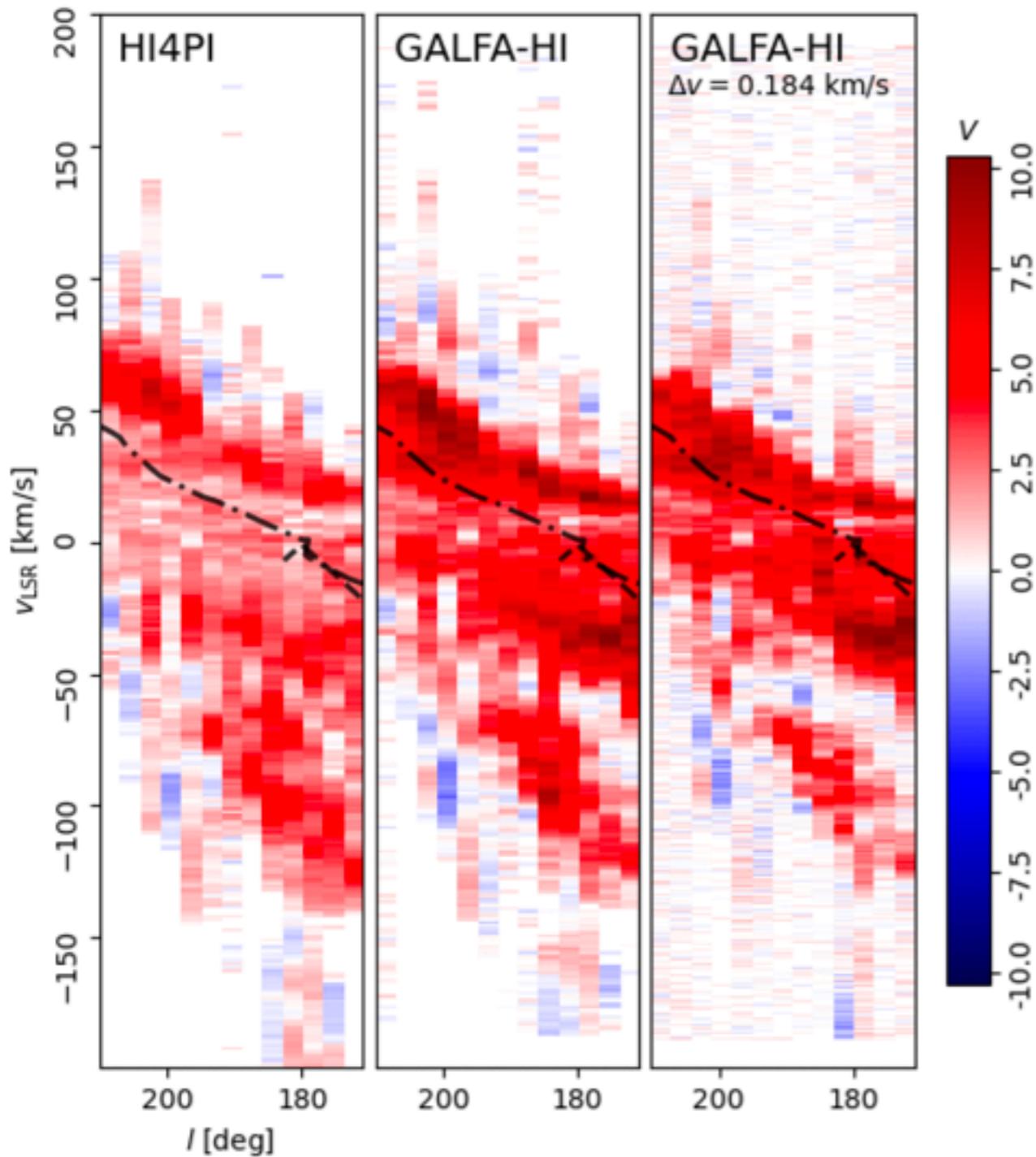
Soler, J.D. et al. A&A (2022)



HI filaments at higher angular resolution

GALFA-HI
4' FWHM
 $\Delta v = 0.184 \text{ km/s}$

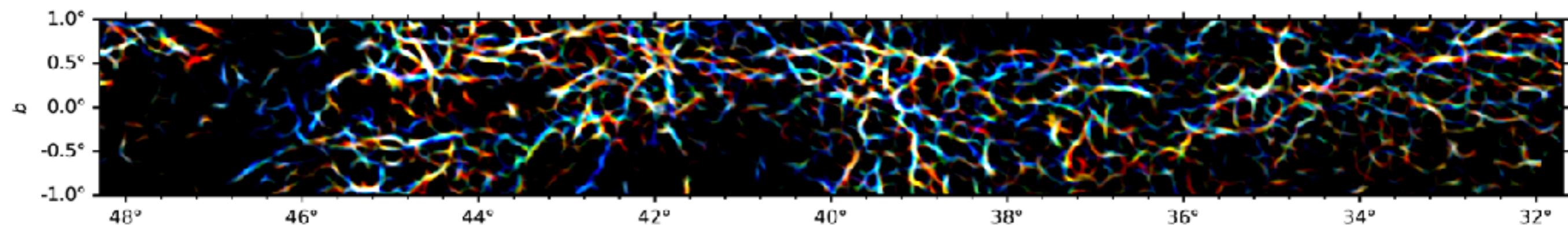
GALFA-HI, Peek et al. ApJ (2018)
Soler, J.D. et al. A&A (2022)



HI filaments (GALFA)

GALFA-HI. Peek et al. ApJ (2018)
Soler, J.D. et al. A&A (2020,2022)

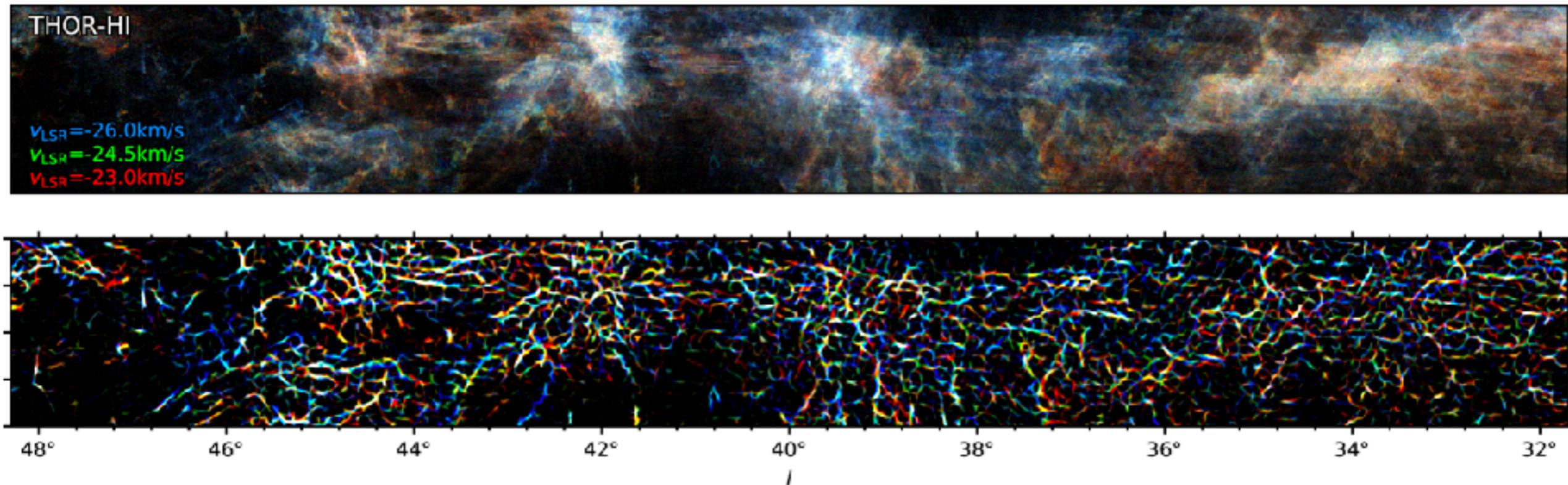
GALFA-HI
4' FWHM
 $\Delta v=0.184$ km/s



HI filaments (THOR)

THOR-HI. Beuther et al. A&A (2016); Wang et al. A&A (2020)
Soler, J.D. et al. A&A (2020)

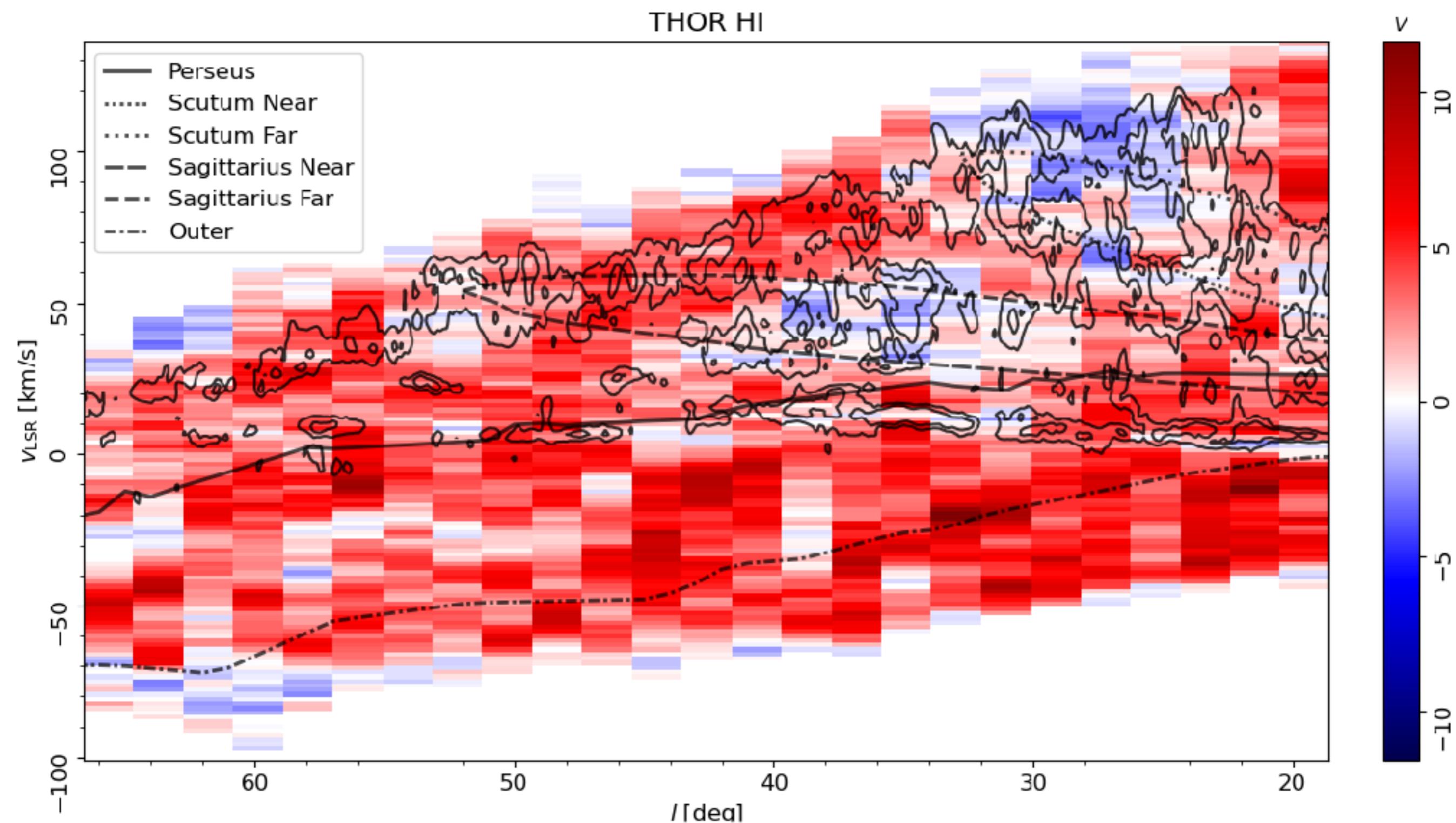
THOR-HI
40" FWHM
 $\Delta v = 1.5 \text{ km/s}$



HI at even higher angular resolution

THOR-HI. Wang et al. A&A (2020), Beuther et al. A&A (2016)
Soler, J.D. et al. A&A (2020)

THOR-HI
40" FWHM
 $\Delta v = 1.5 \text{ km/s}$



HI at even higher angular resolution

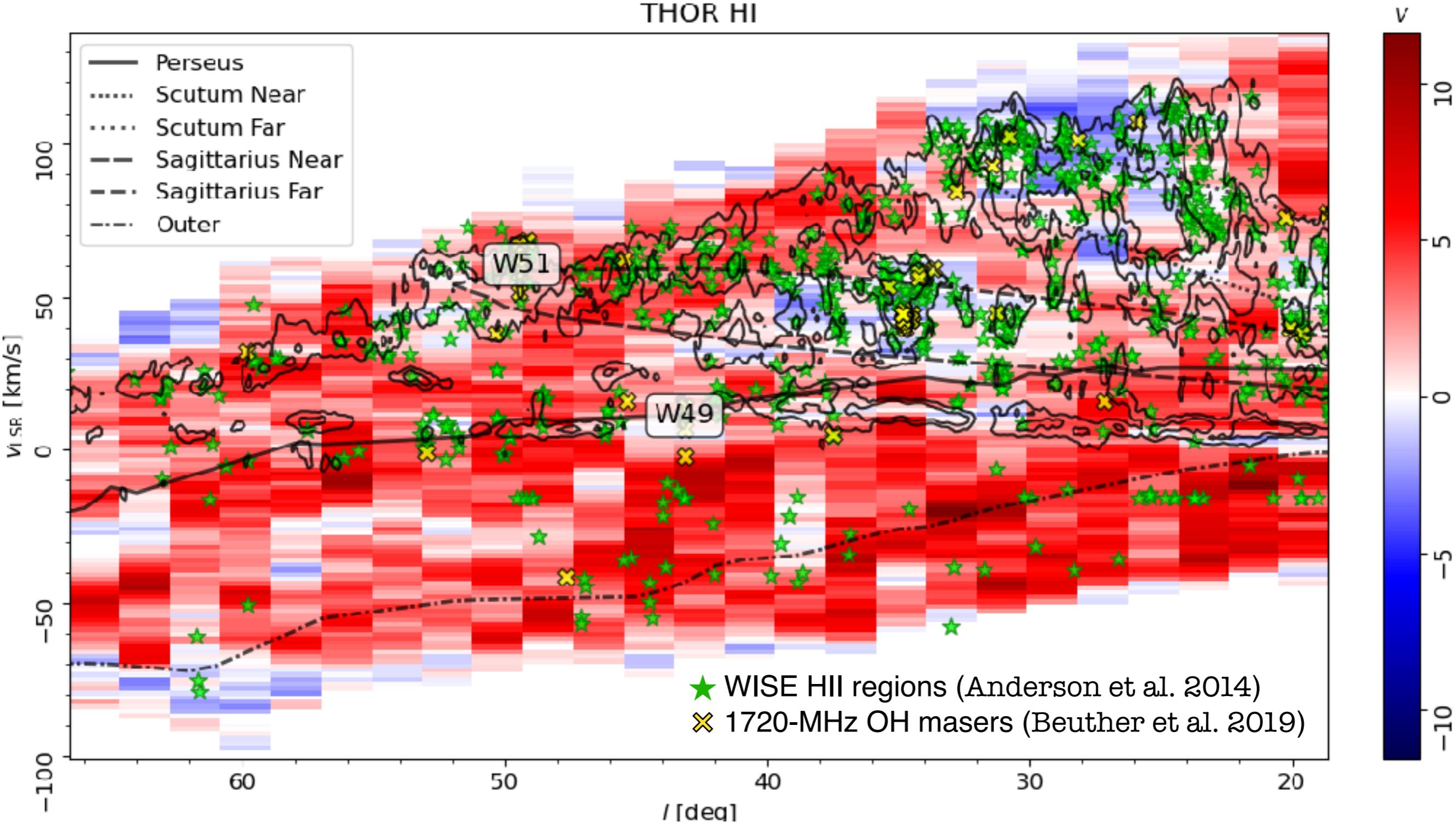
THOR-HI

40" FWHM

$\Delta v = 1.5 \text{ km/s}$

THOR-HI. Wang et al. A&A (2020), Beuther et al. A&A (2016)
Soler, J.D. et al. A&A (2020)

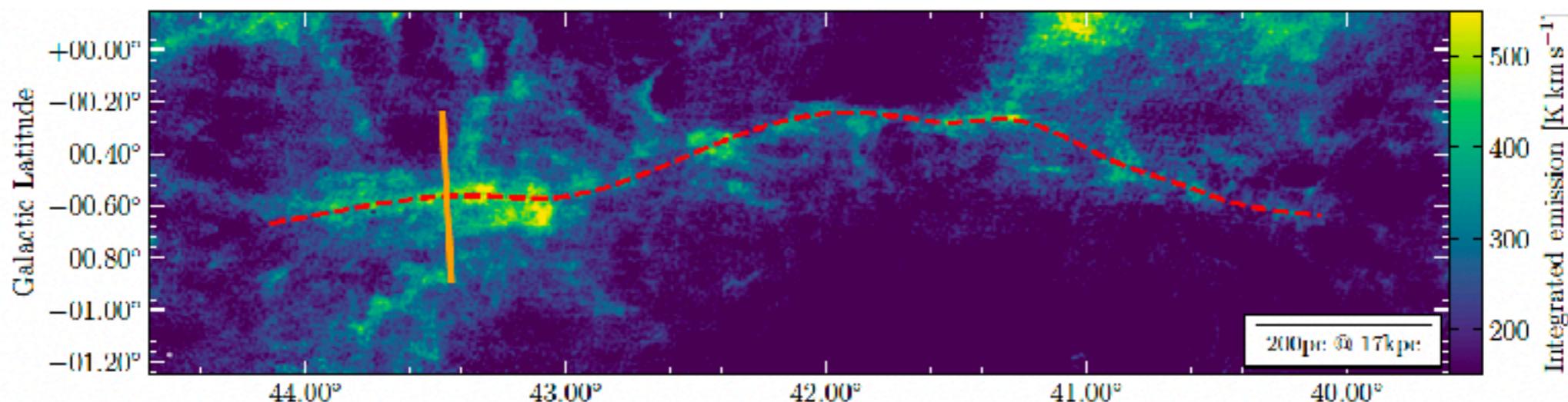
THOR HI



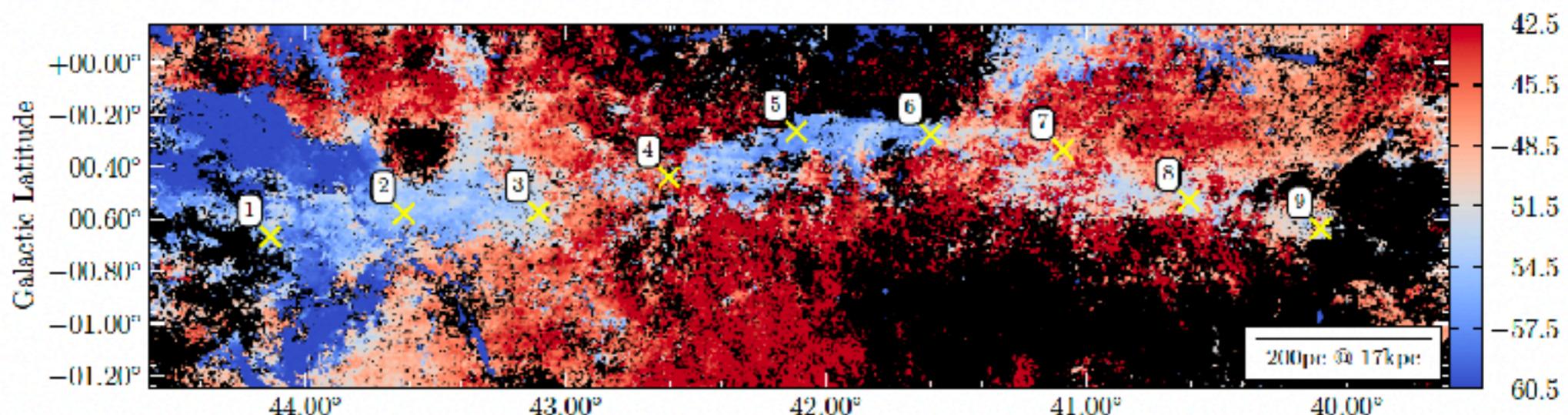
The Magdalena (Maggie) filament

Syed, J., et al. (2022), Soler, J.D. et al. (2020)

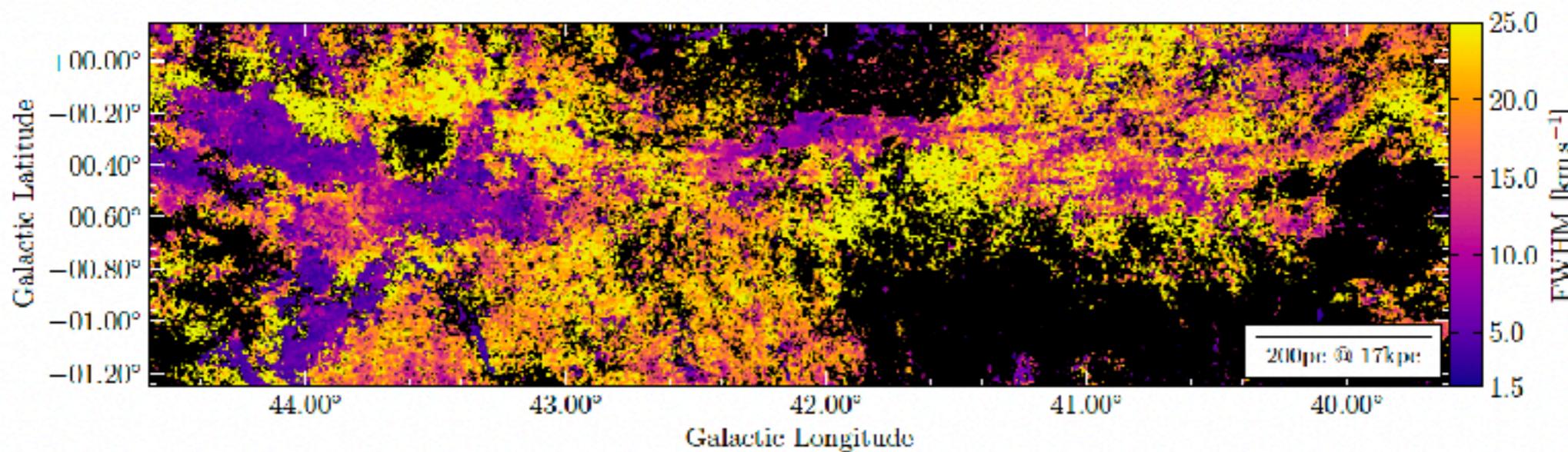
N_{H}



$\langle v \rangle$



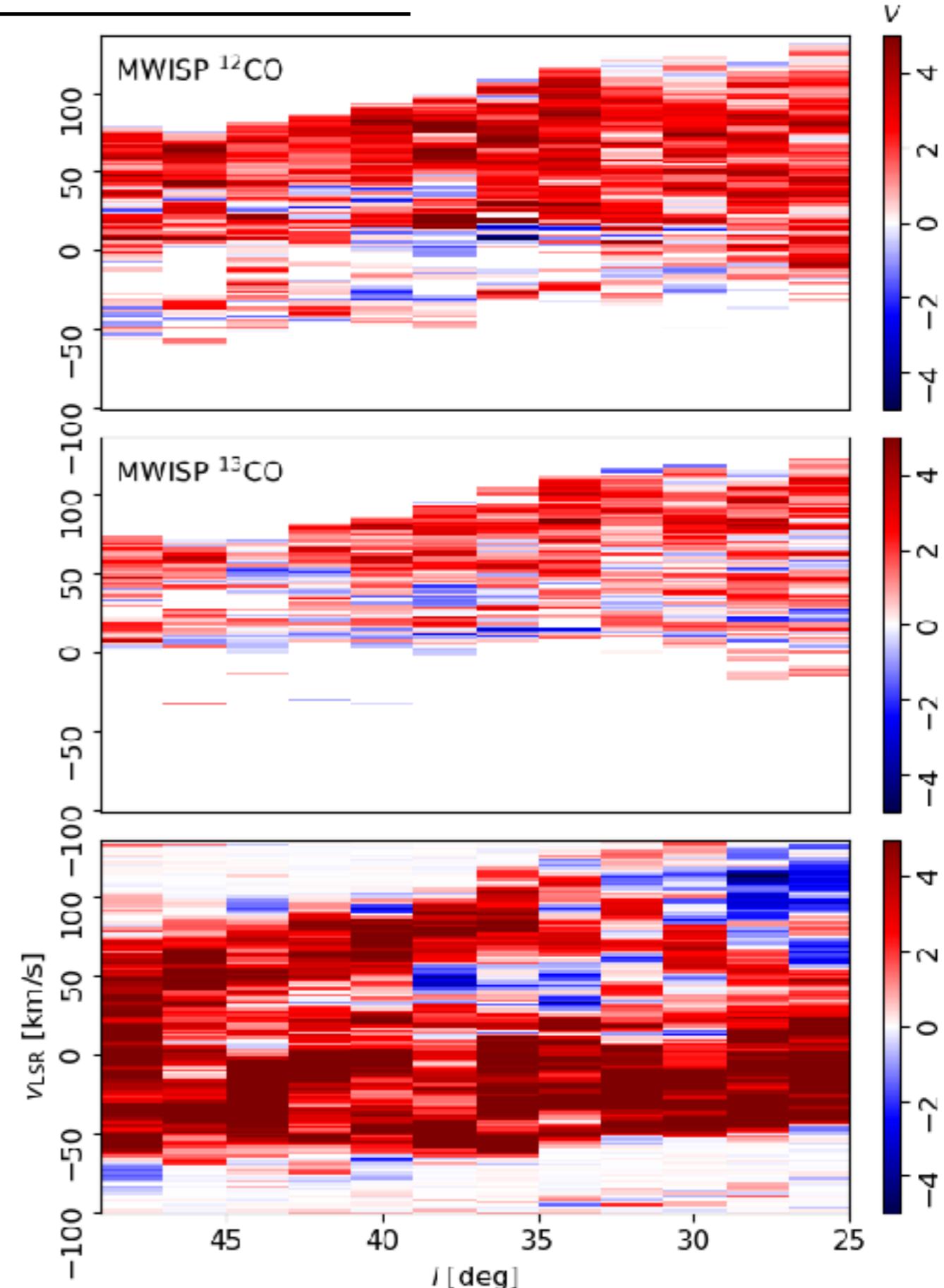
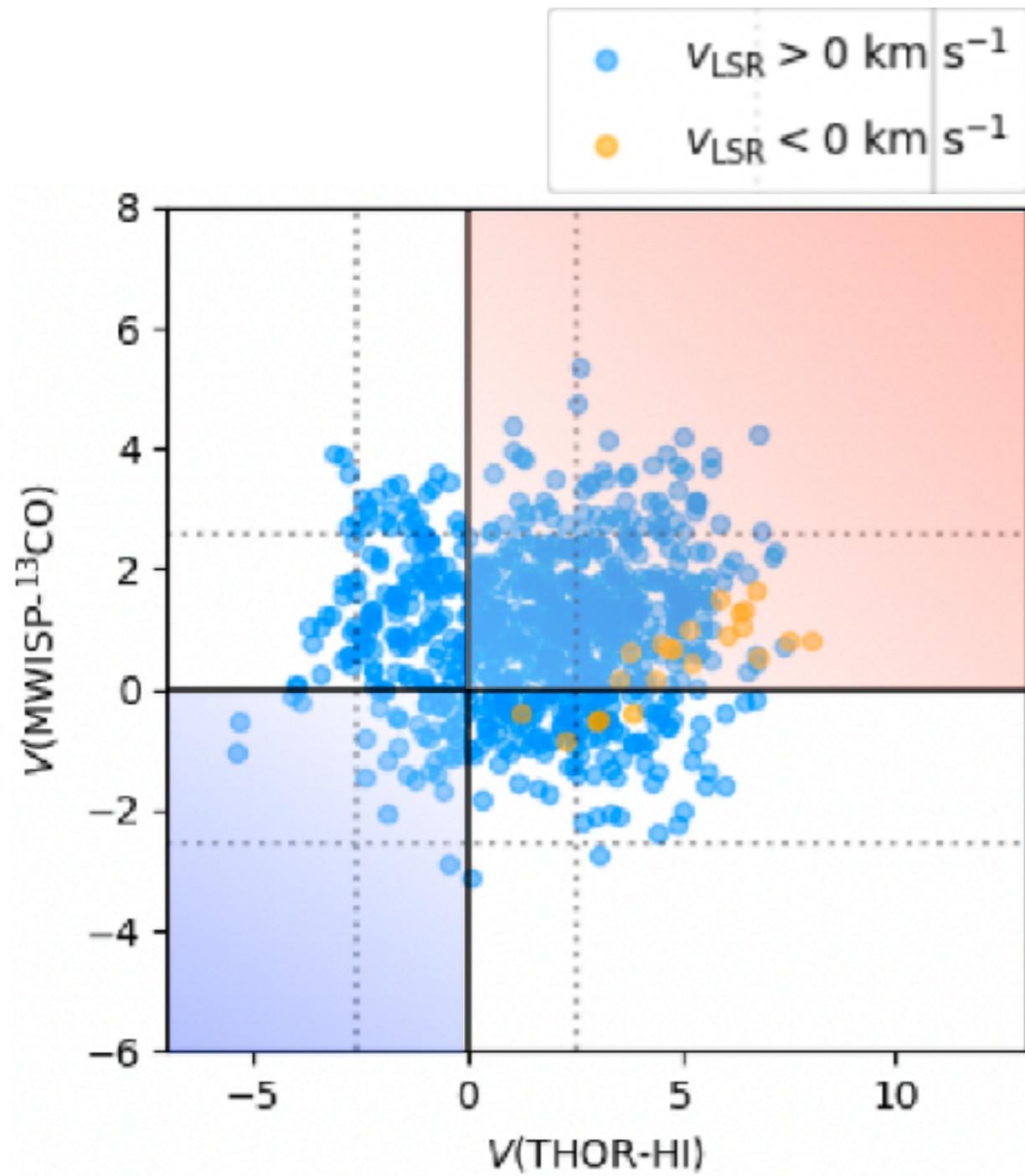
σ_v



CO filament orientation

MWISP CO survey. Sun et al. (2018)

Soler, J.D. et al. A&A (2021)



We studied the **orientation of the filamentary structure** in the **HI emission toward the Galactic plane.**

We found that the **HI filament orientation changes** from mostly perpendicular to mostly parallel to the Galactic plane **with increasing distance from the Galactic center.**

We interpret the **change in the HI filament orientation** with Galactocentric radius as the **signature of the energy and moment input from supernovae.**

The prevalent **HI filament orientation** is **not inherited by the CO filaments.**

Soler, Miville-Deschénes, Molinari et al. A&A (2022)

Soler, Beuther, Syed et al. A&A (2021)

Soler, Beuther, Wang et al. A&A (2020)