The forming slow solar wind imaged along streamer rays
by the Wide-Angle Imager on the *Parker Solar Probe*

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[Poirier et al. 2020, published in ApJS]

irap astrophysique & planétologie

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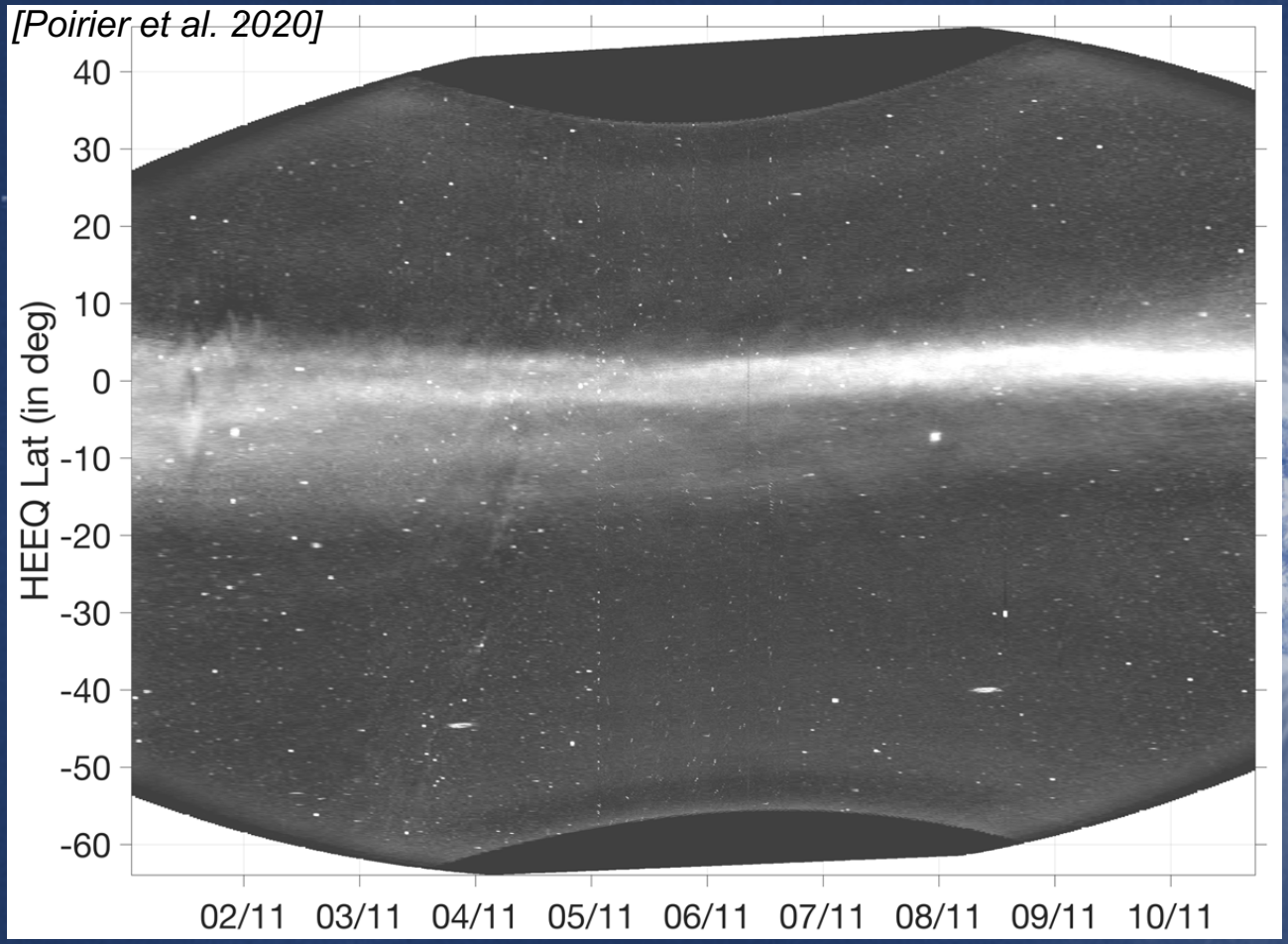
> What does this figure represent?

> Here you see the K-corona in white-light as imaged by WISPR-I during 10 days of observations.

> Ok but I still can not visualize what it is…

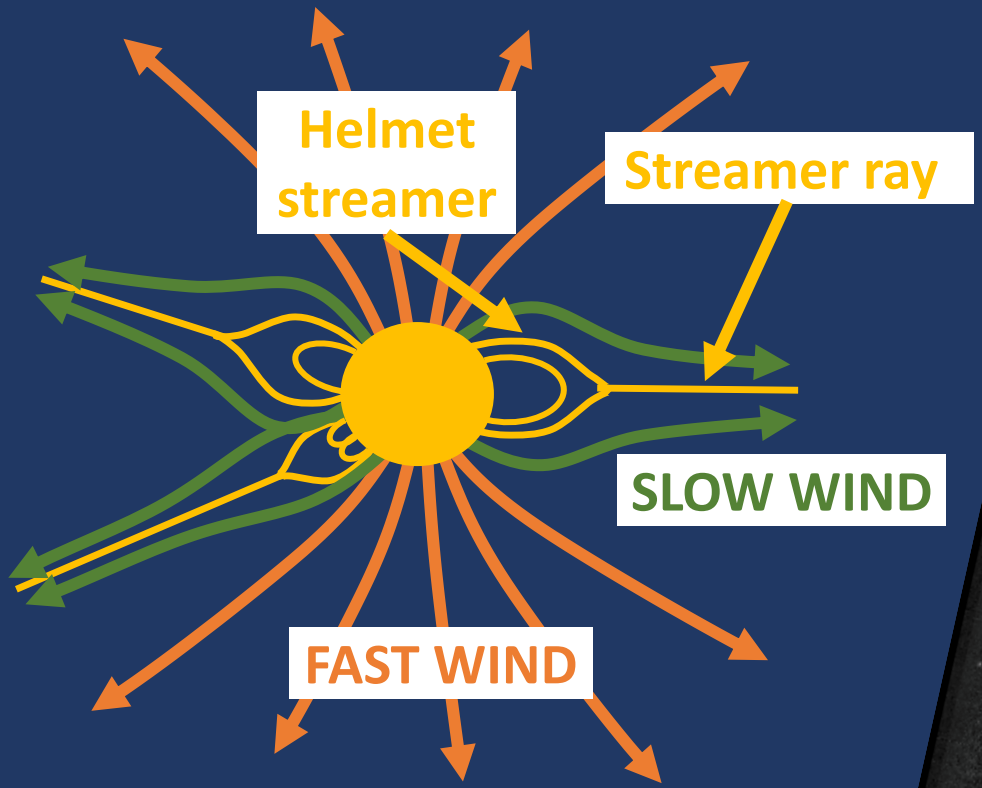


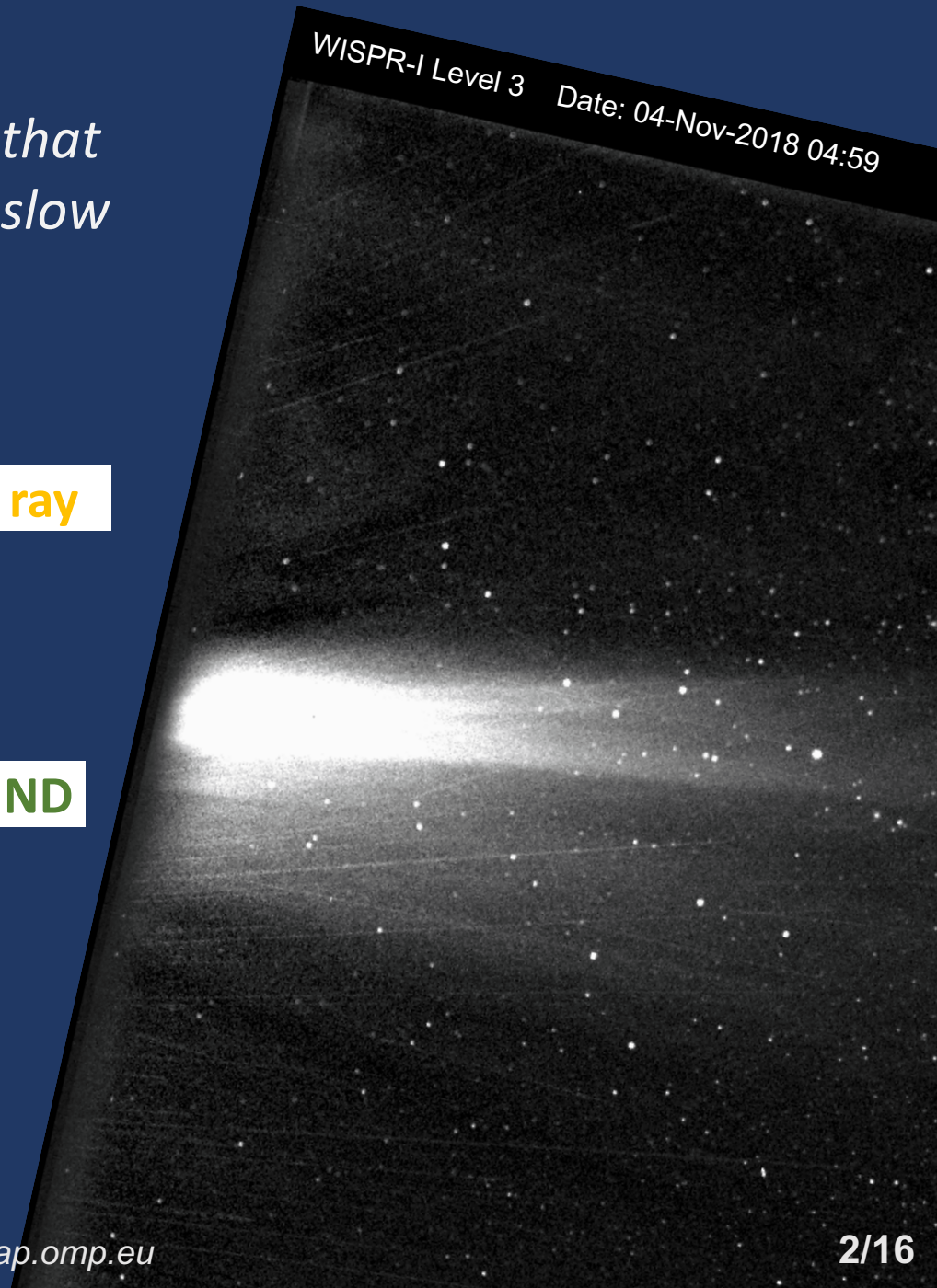
> Have a look at 'movie_PSP_encounter1.avi' which is attached to this pdf.

Note: - attached files can be accessed via the left pane.
- otherwise you can download directly the animated movie at this link.

> Ok but why is it interesting?

> *WISPR is like a «microscope» that provides a better insight of the slow solar wind.*

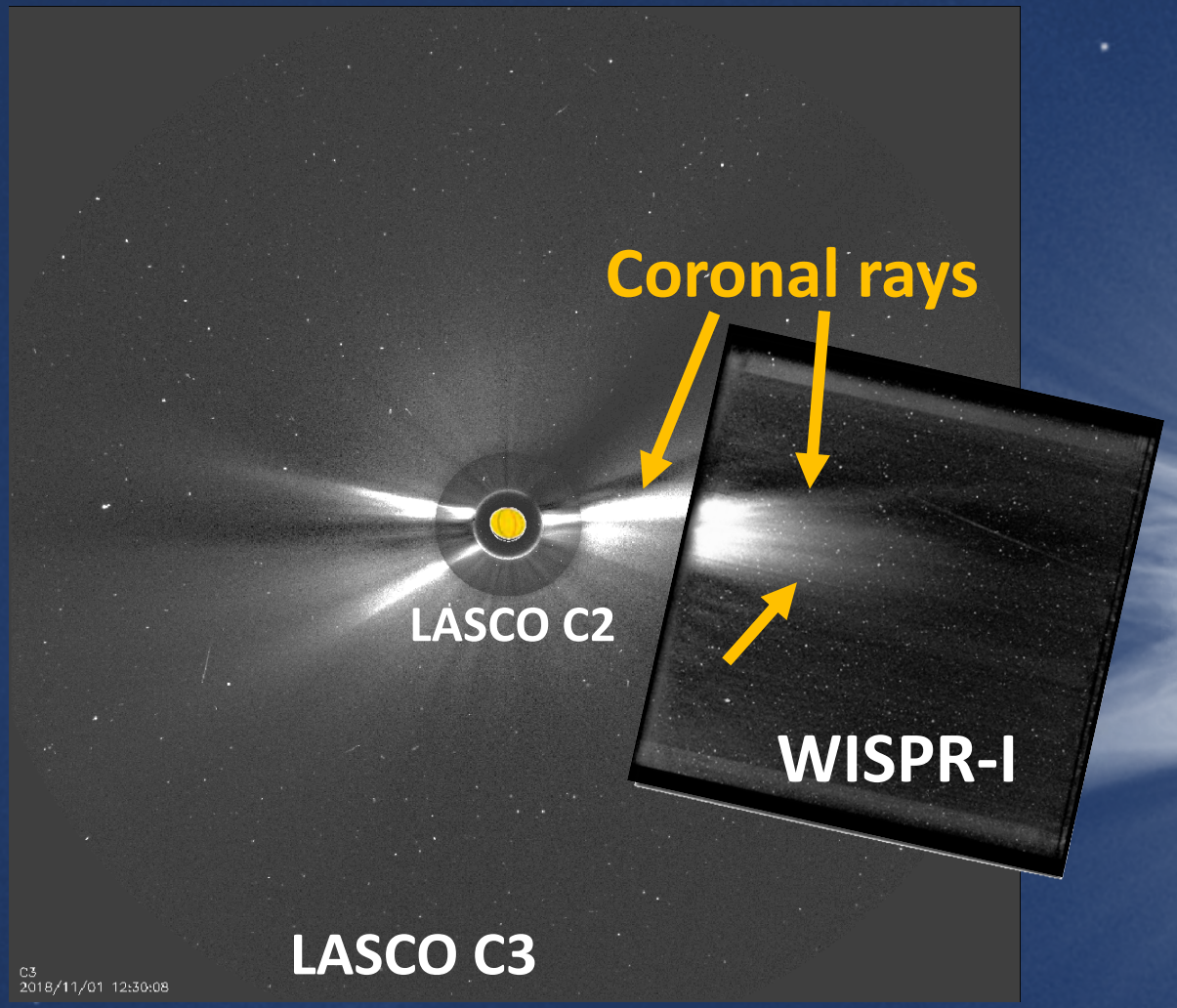




> To what extent is it different from 1 AU observations?

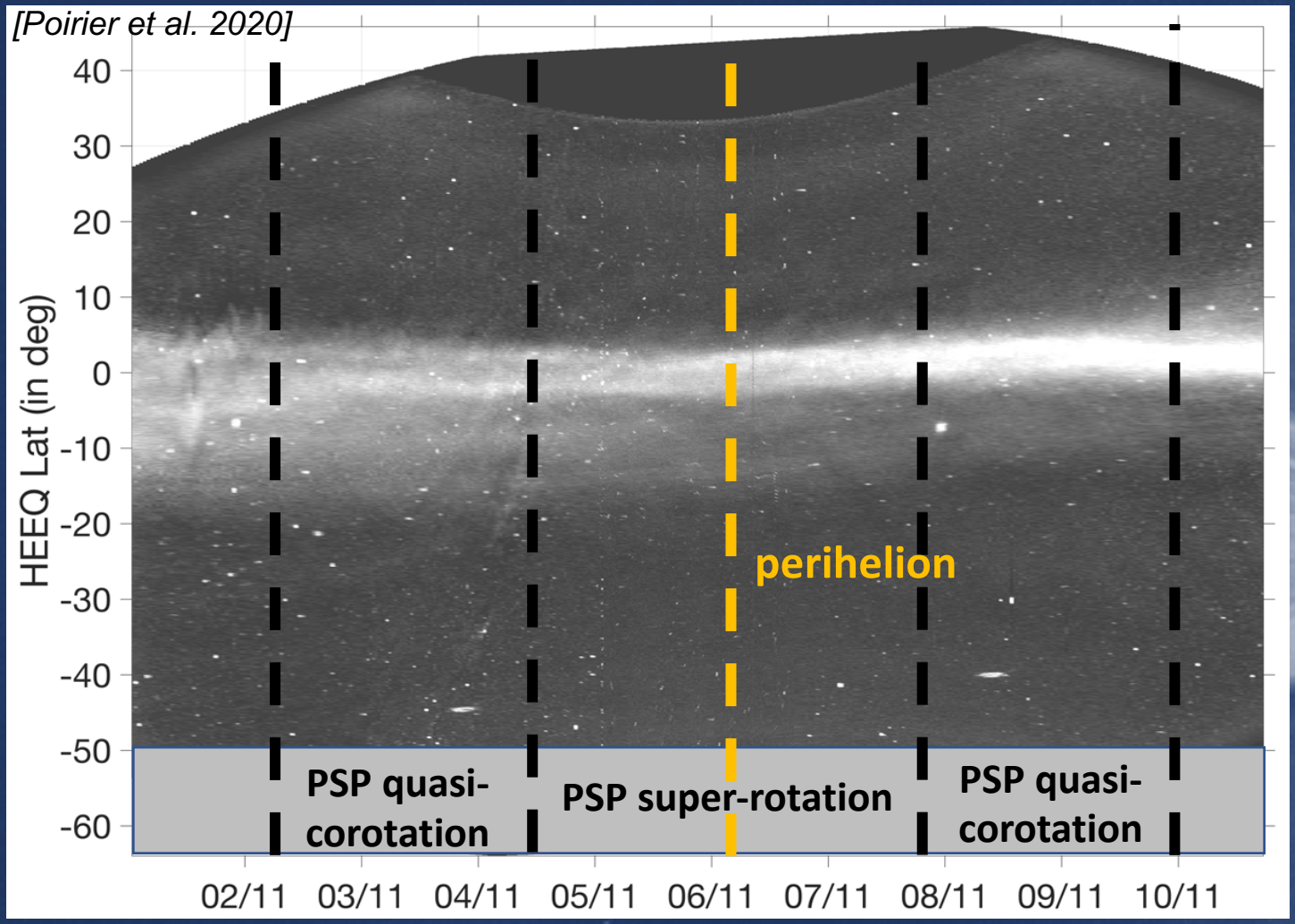
1 AU:
- LASCO C2
- LASCO C3

<0.25 AU:
- WISPR-I



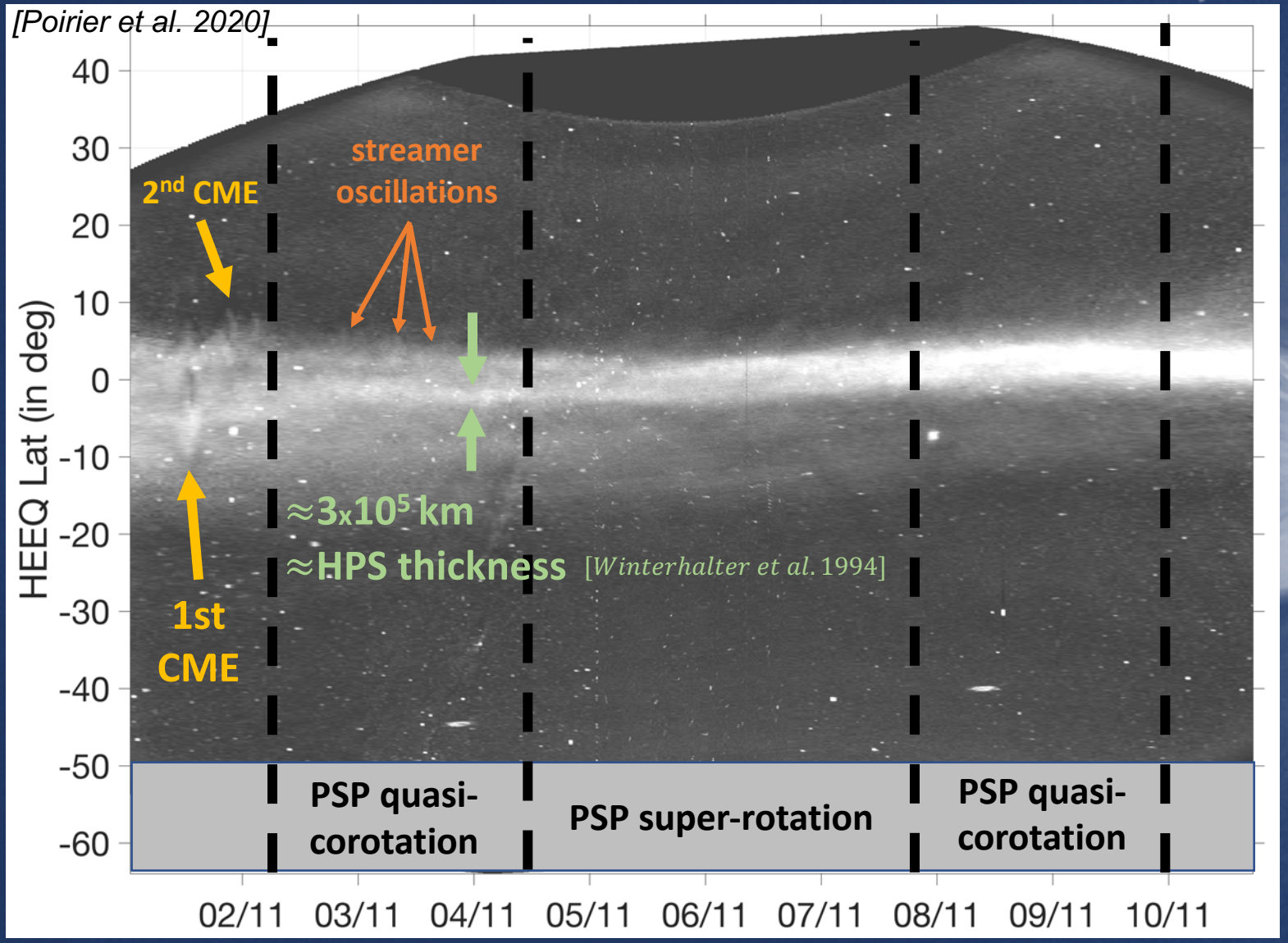
> Being much closer to the Sun, WISPR unveils finer structures within the streamer rays and heliospheric plasma sheet (HPS).

> Why WISPR images are so unique?



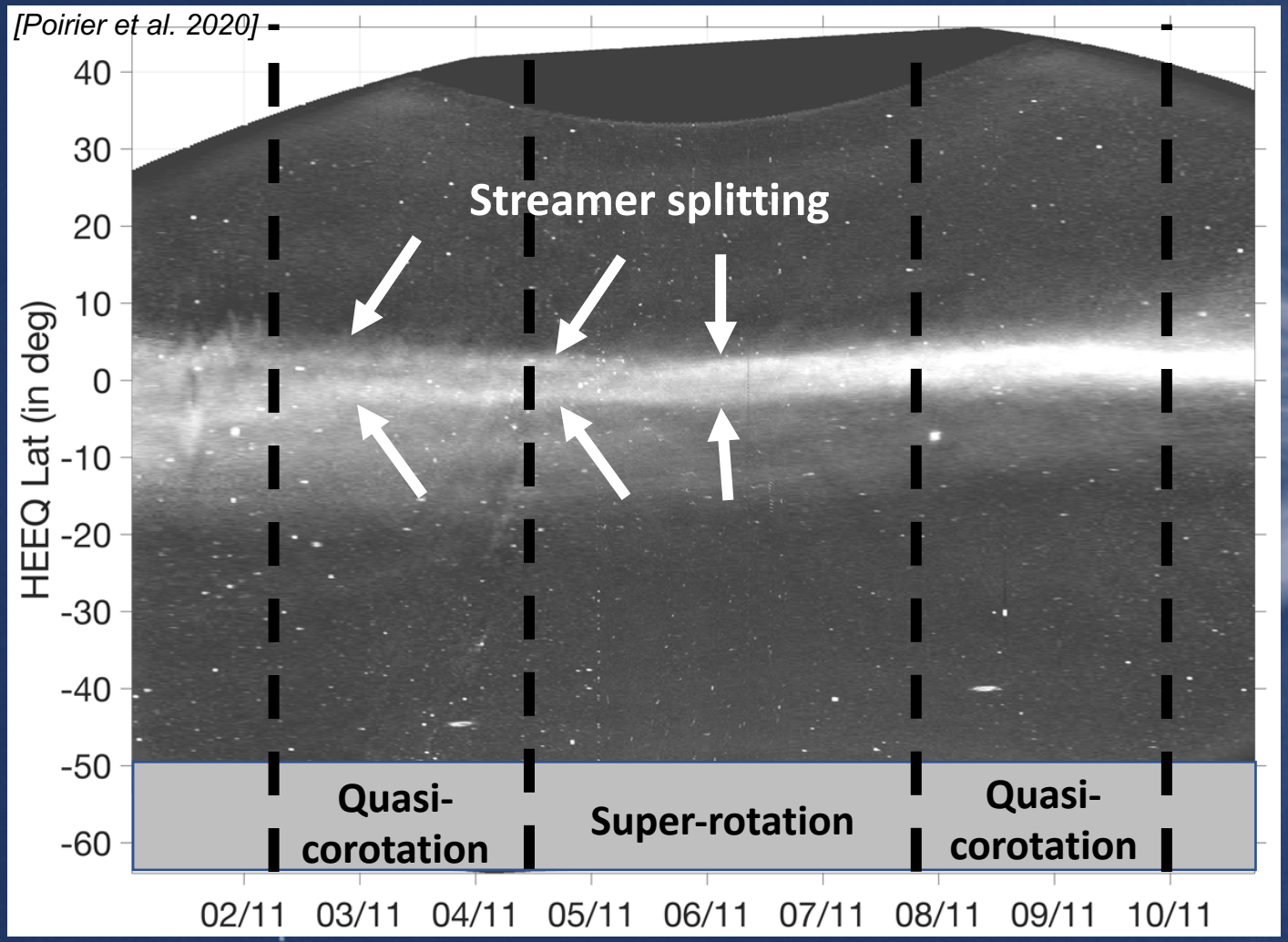
> *The fast motion of PSP enables to capture for the first time the temporal variability of streamers when PSP stays nearly static relatively to the rotating corona.*

> So how should we interpret these observations?

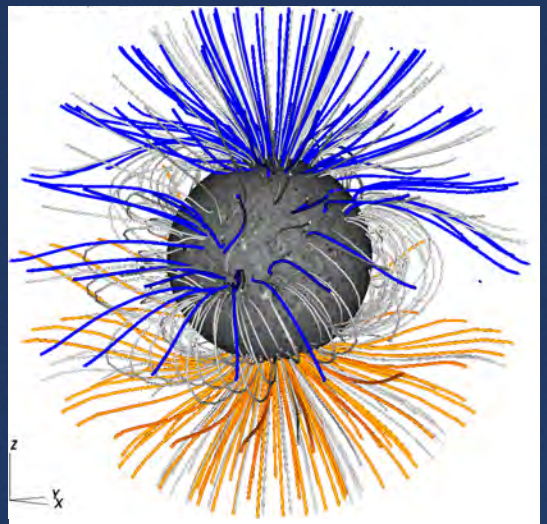


> I can also see a splitting of the streamer ray into two parts, what is it?

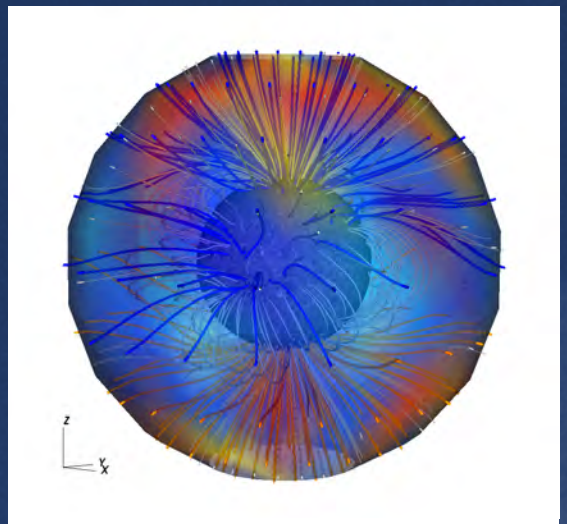
> *This thing was much more difficult to interpret, so we exploited 3D simulations of the corona in order to find an answer.*



> *Here is a brief description of the model.*



MAGNETIC CUBE



DENSITY CUBE

SYNTHETIC WL IMAGE

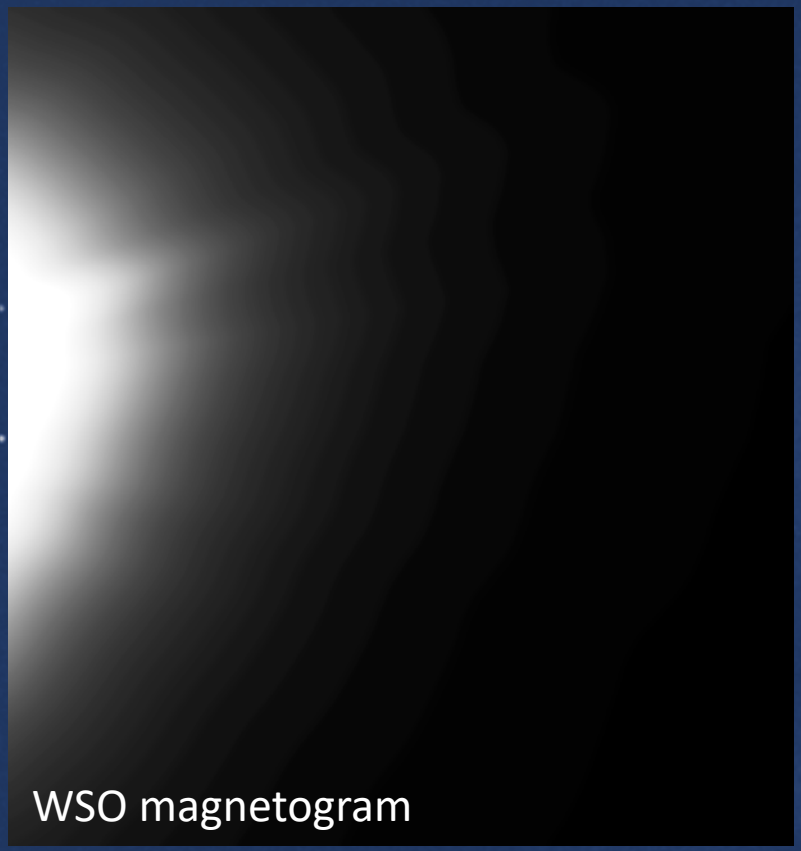
MULTI-VP MHD model

[Pinto & Rouillard 2017]

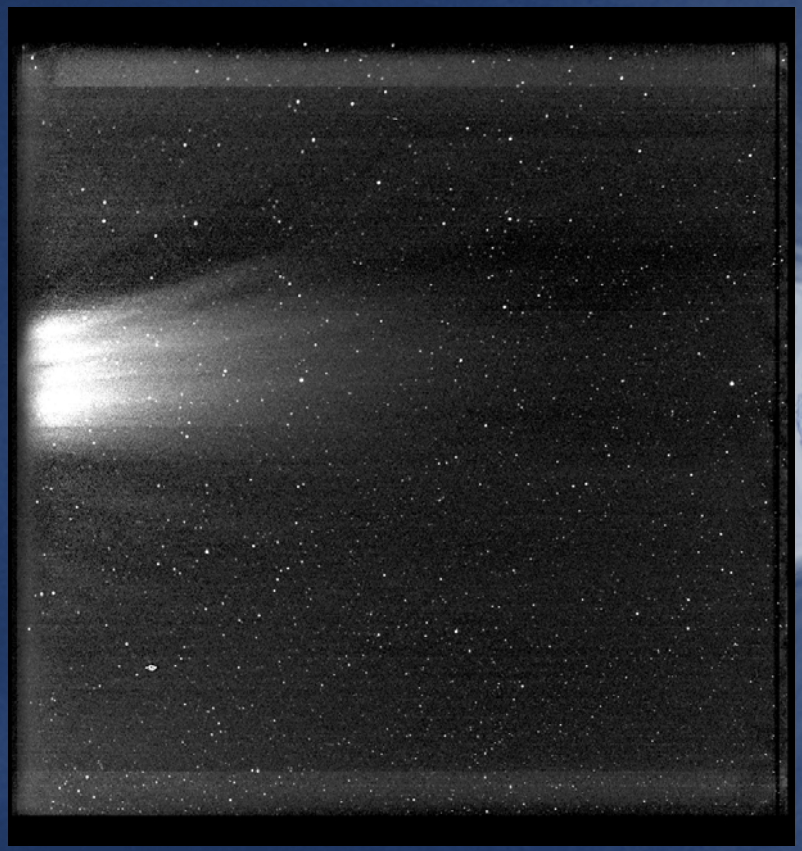
- **1-D MULTI-TUBES → 3-D**
- **Single and two-fluid**
- **Conductive and radiative losses**
- **Heating functions**

> *From the modeled electron density, we produced synthetic images based on the Thomson scattering theory (see Howard & Tappin 2009).*

SYNTHETIC IMAGE

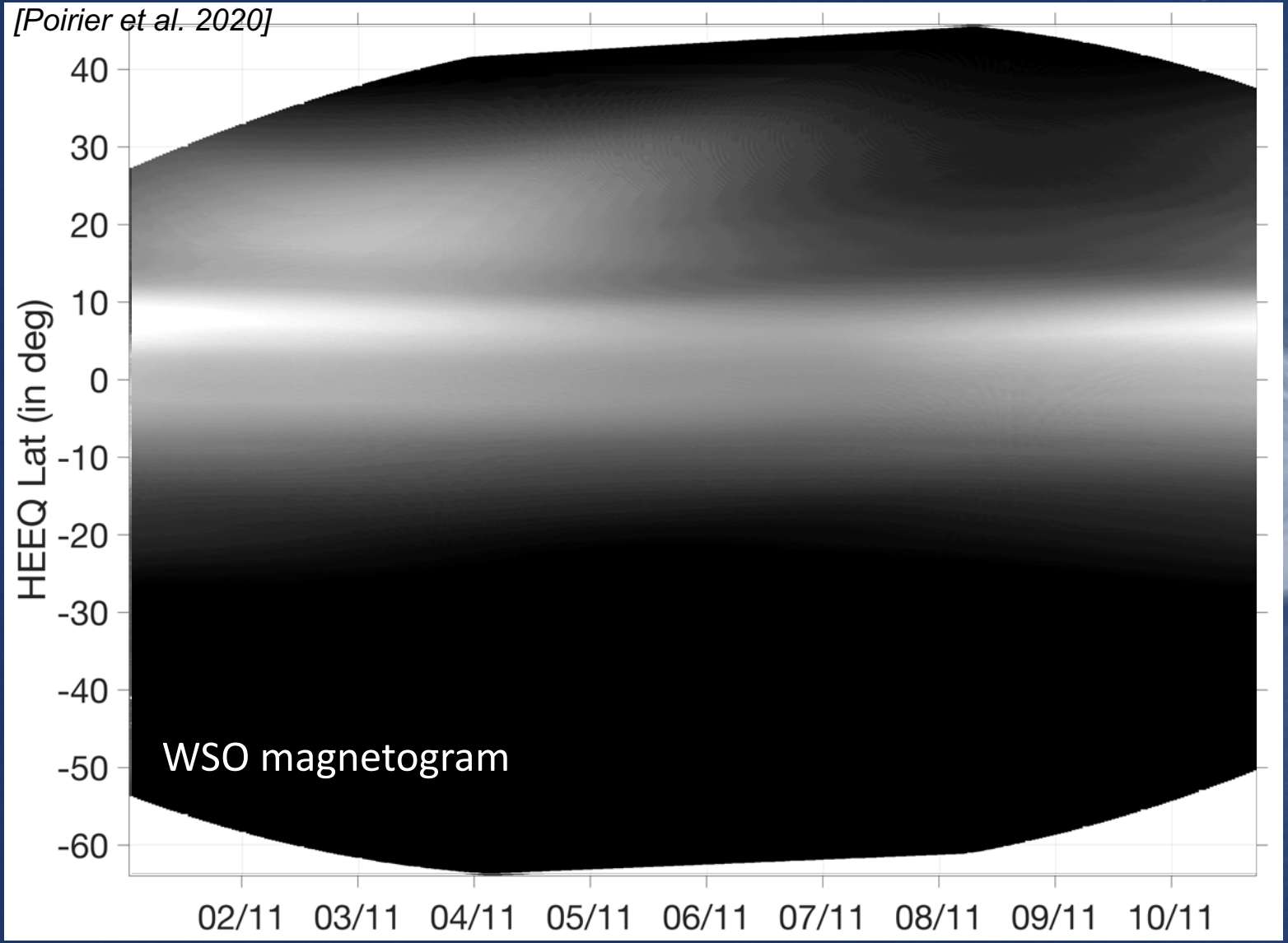


REAL IMAGE



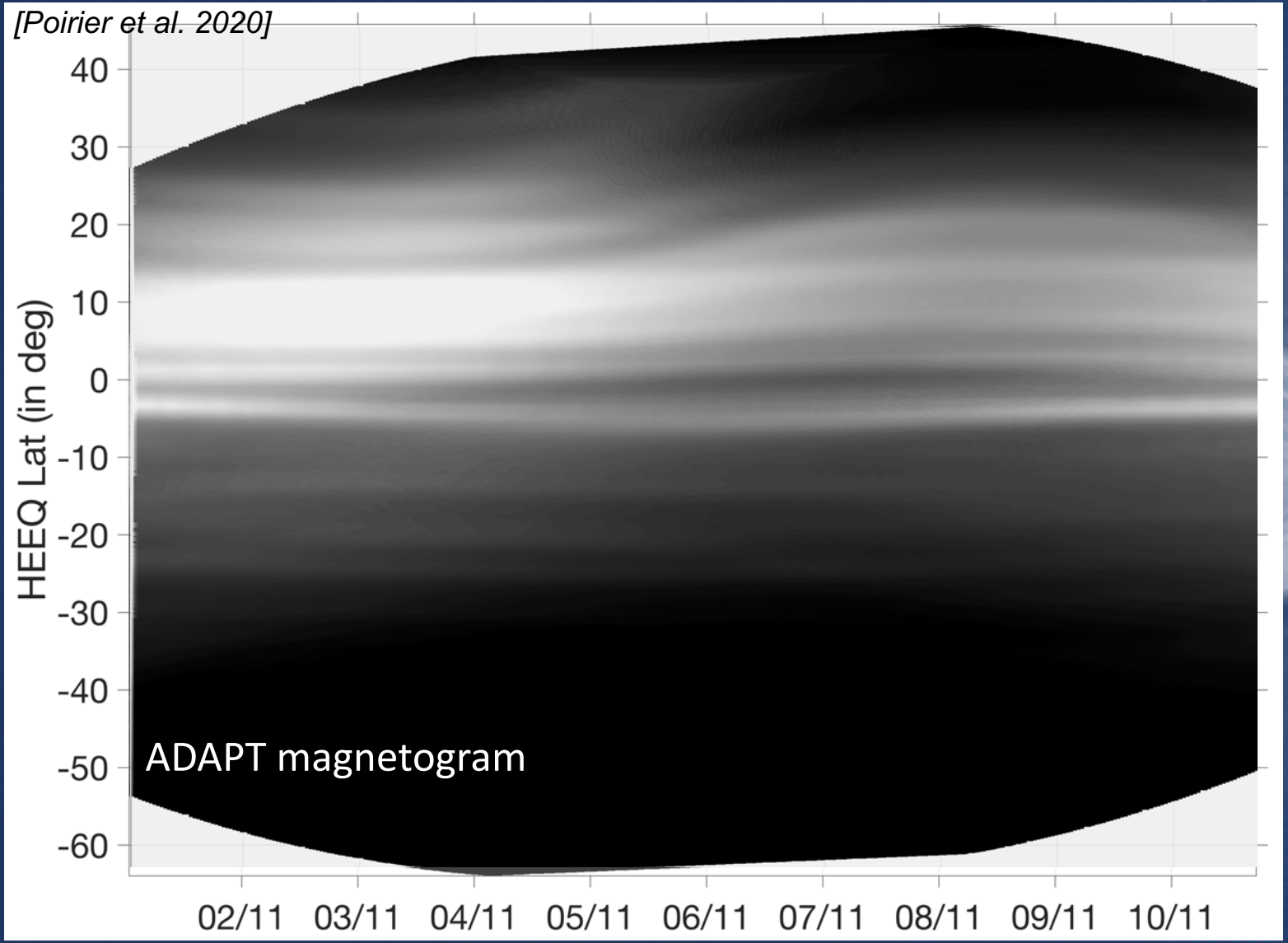
> *We can also produce a 'map' with the synthetic images (as we did before with the real images).*

[Poirier et al. 2020]



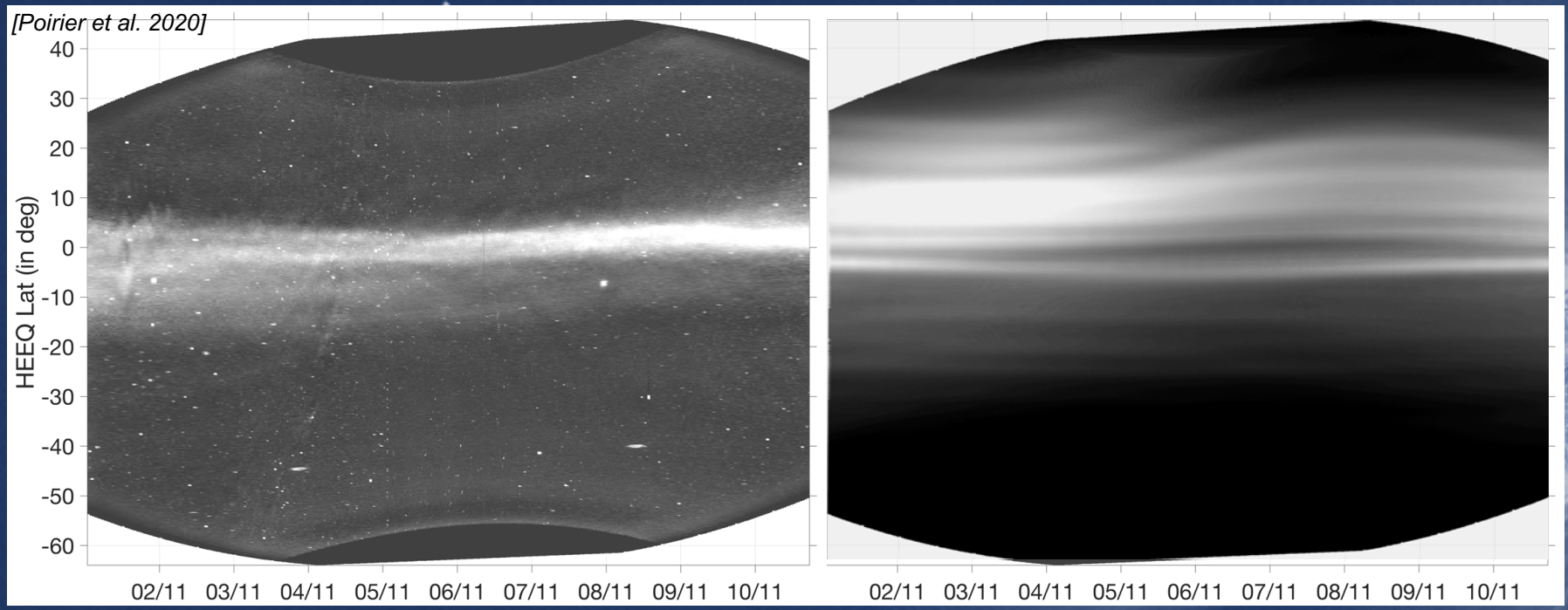
> *We can also play with the input magnetogram,*
here with an ADAPT/GONG map which shows greater details.

[Poirier et al. 2020]



> Cool! But they still look a bit different right?

> *That's true! There are many reasons which are discussed in detail in [Poirier et al. 2020, ApJS]*

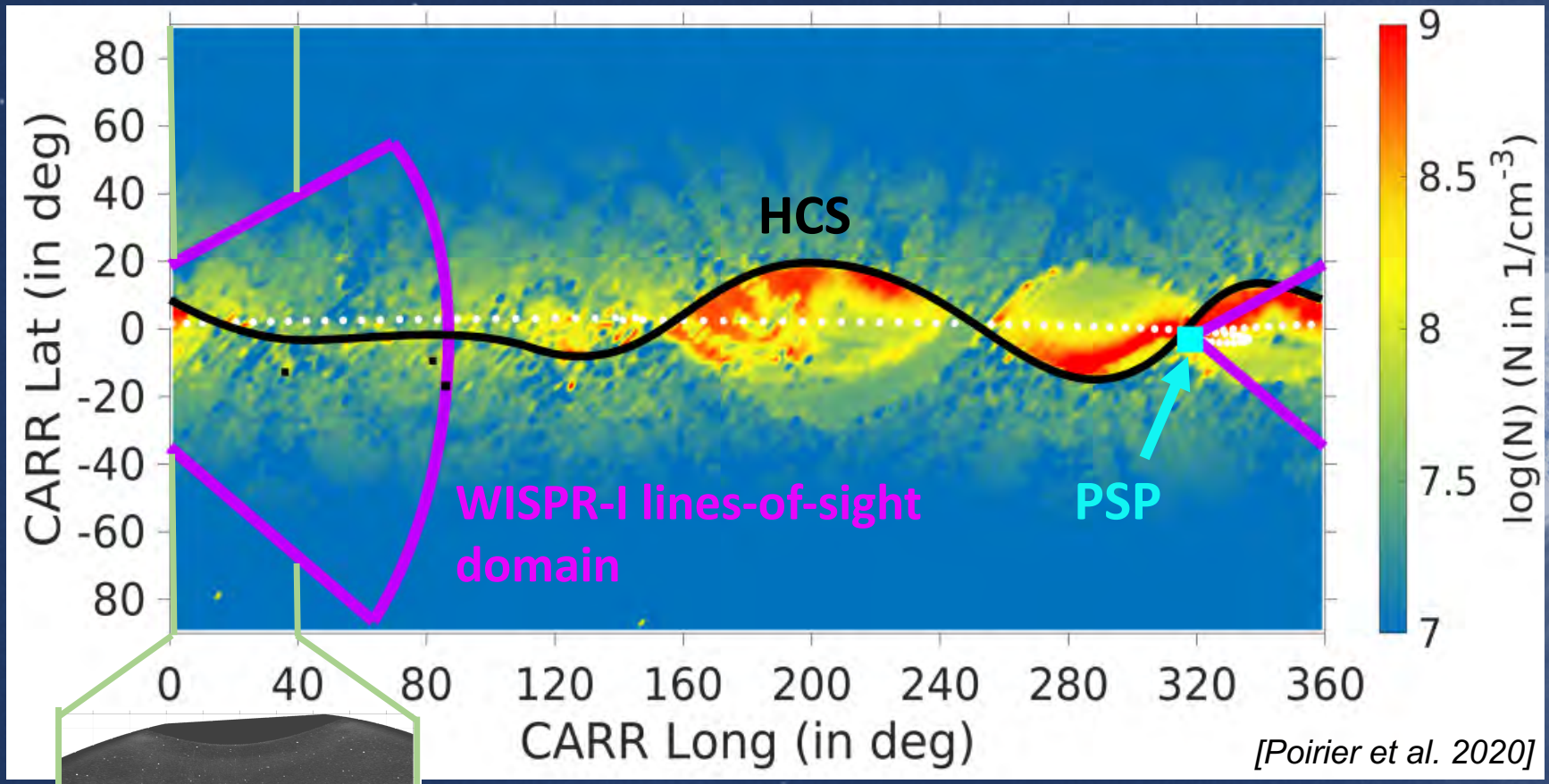


> *Moreover a model will never be perfect, here we see how WISPR observations (in this form) can be very helpful to better constrain our models of the solar corona and solar wind.*

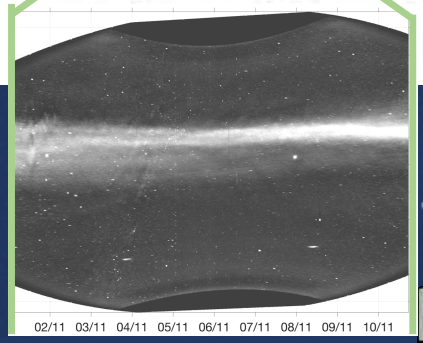
> Ok! But how these synthetic maps help the interpretation of the observations?

> In fact we need to investigate one last thing: how density is distributed along the the lines-of-sight of the WISPR-I imager.

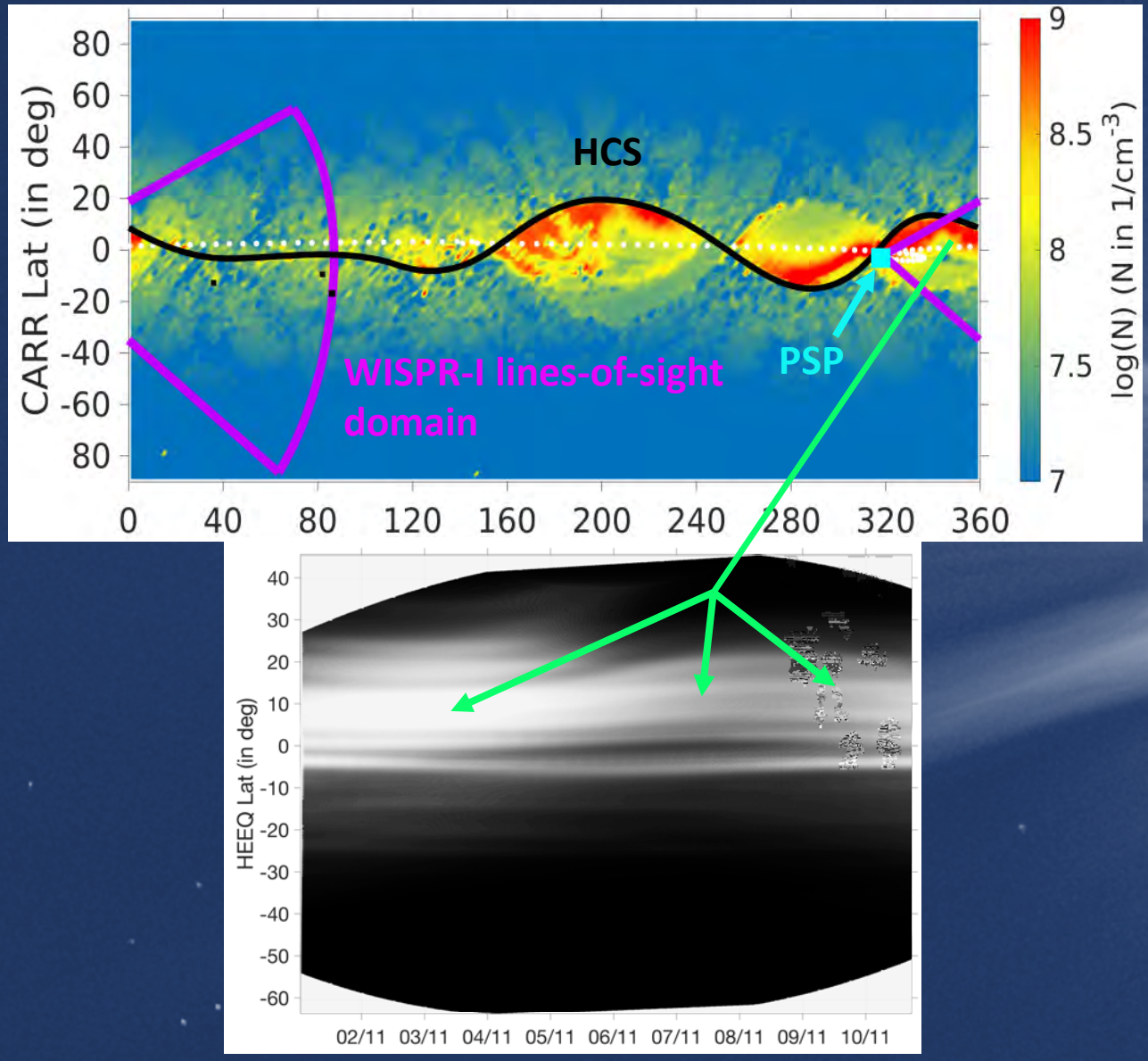
> Below is a modeled density map at 15Rsun for the full solar rotation.



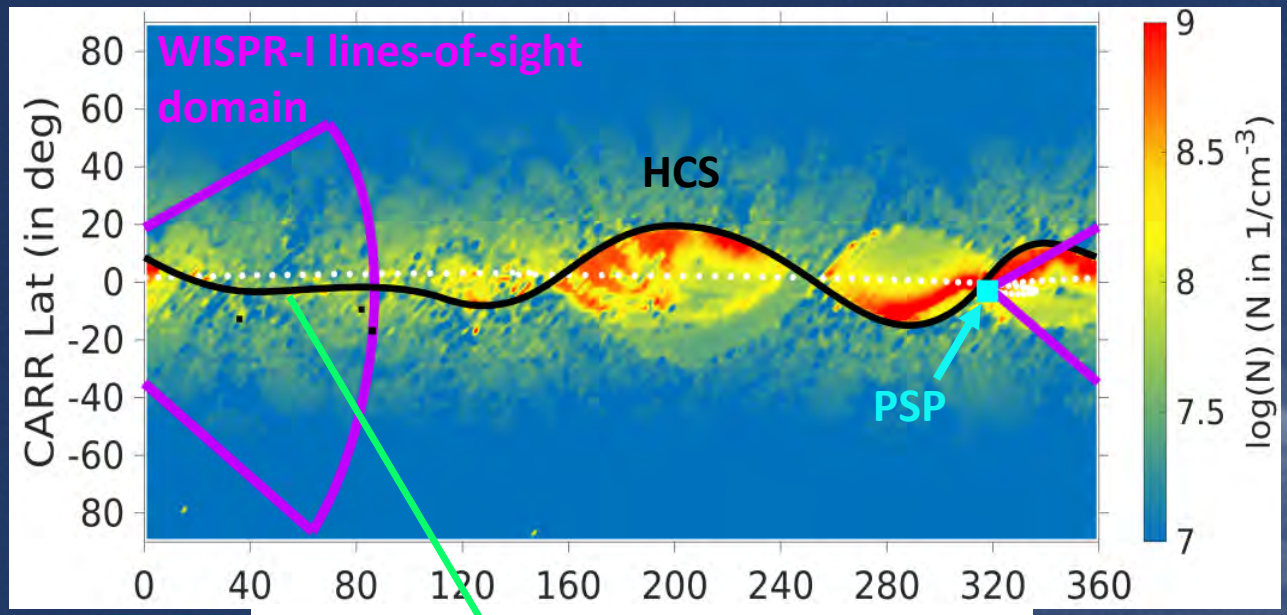
[Poirier et al. 2020]

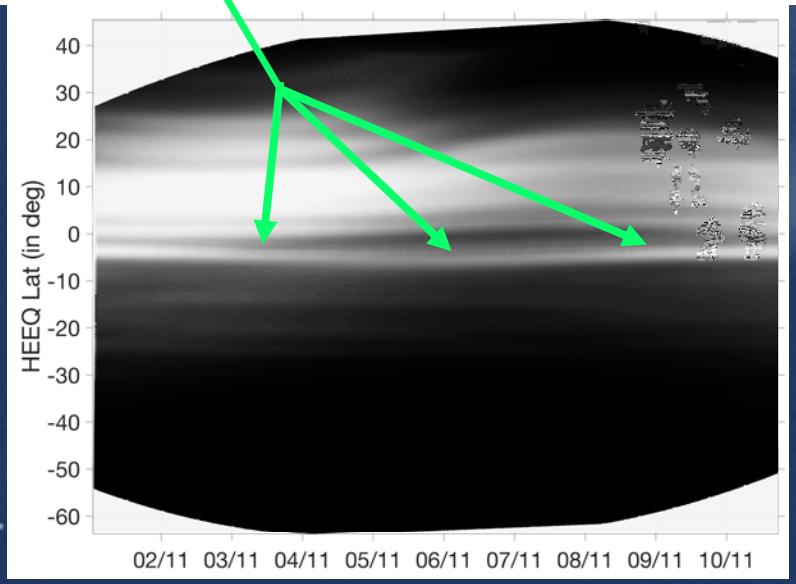


> *You can see how the dense HPS at foreground contributes to the bright northern streamer ray in the plot at bottom.*

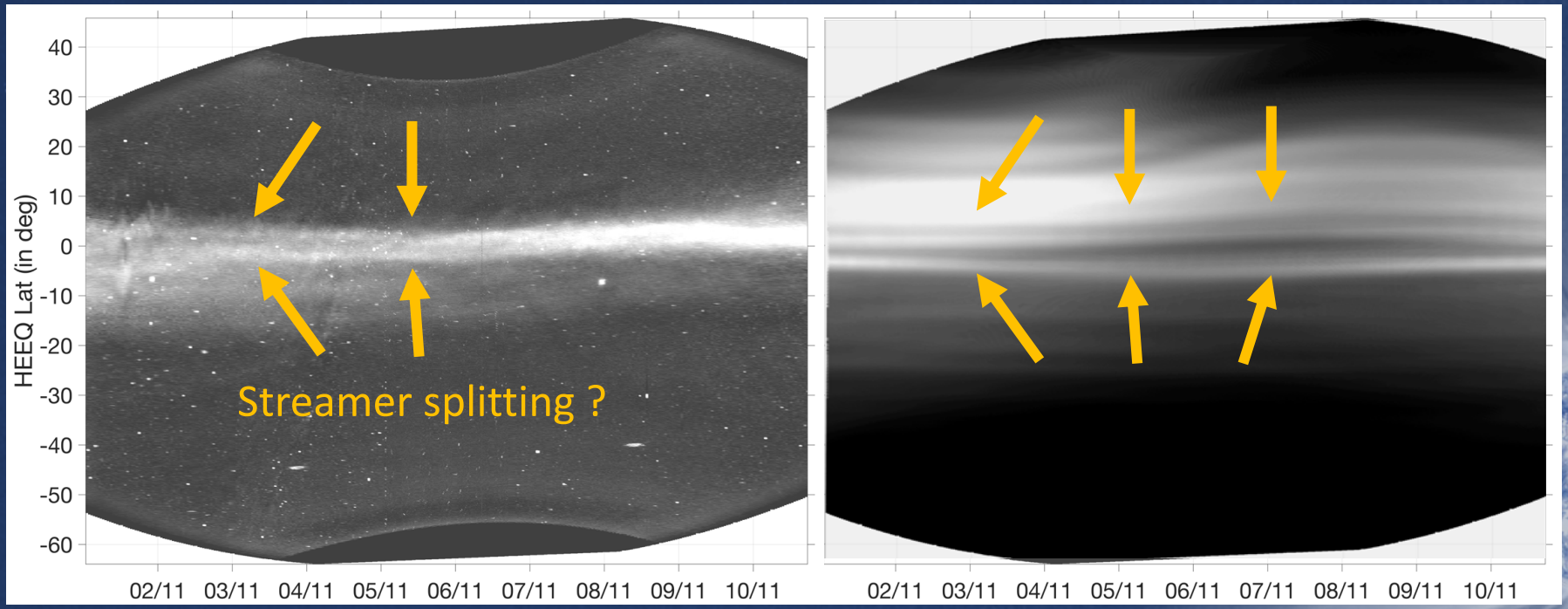


>In contrast, the much thinner and less dense HPS, which is nearly flat at background, contributes to the very thin and detached southern ray.





> *By comparing the synthetic map to the real one, we can finally get a clue.*



> *The apparent splitting of the northern streamer ray in the observations is in fact due to a small folding of the heliospheric plasma sheet (HPS) along the line-of-sight.*

> **Yes but we already saw folds of the HPS from 1 AU observations.**

> *For larger folding angles! Here WISPR captured a folding of ≈5 deg!*

Conclusion

- **WISPR-I unveils very fine structures unresolved at 1 AU:**
  - Small corrugations in the slow solar wind
  - The thin HPS (≈3×10^5 km)
  - A HPS fold of ~5deg

- **A detailed synthetic imaging of coronal rays:**
  - Consistent with the large-scale observed features

- **Synthetic + WISPR images** ➔ strict constraints on coronal model

- **PSP closest approach at ~8.86$R_\odot$ (in 2024) will provide even better insights of the slow solar wind.**

➔ Poirier et al. 2020, published in ApJS

> Thank you for following this (hopefully) interactive presentation!

> Any feedback will be highly appreciated!

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