Solar wind speed and rotational shear at coronal hole boundaries, impacts on magnetic field inversions

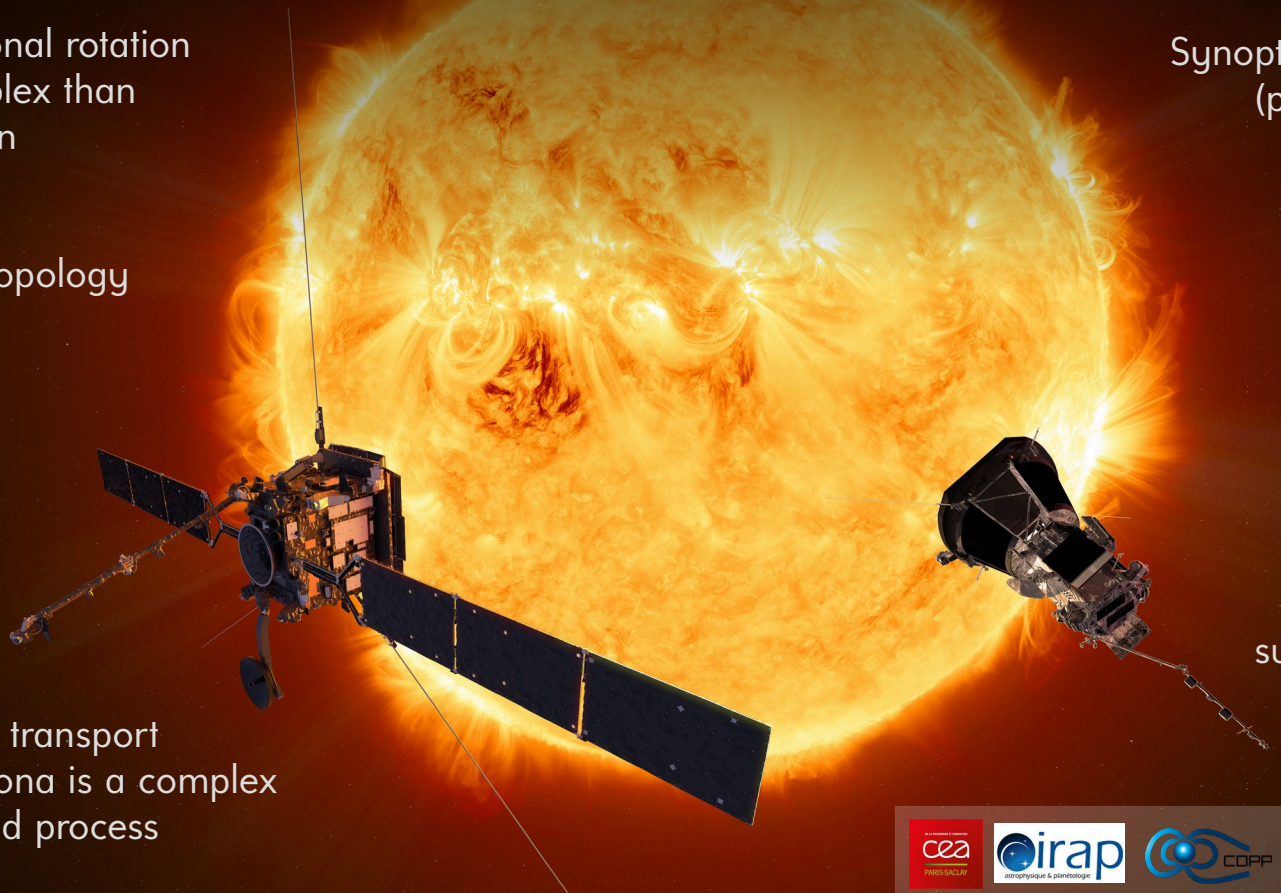
Rui F. Pinto (rui.pinto@irap.omp.eu); CEA Saclay & IRAP

Solar wind and coronal rotation more variable/complex than photospheric rotation

Solar cycle / mag. topology dependent

Coronal response to differential rotation (e.g. injecting shear)

Angular momentum transport across the solar corona is a complex but badly understood process

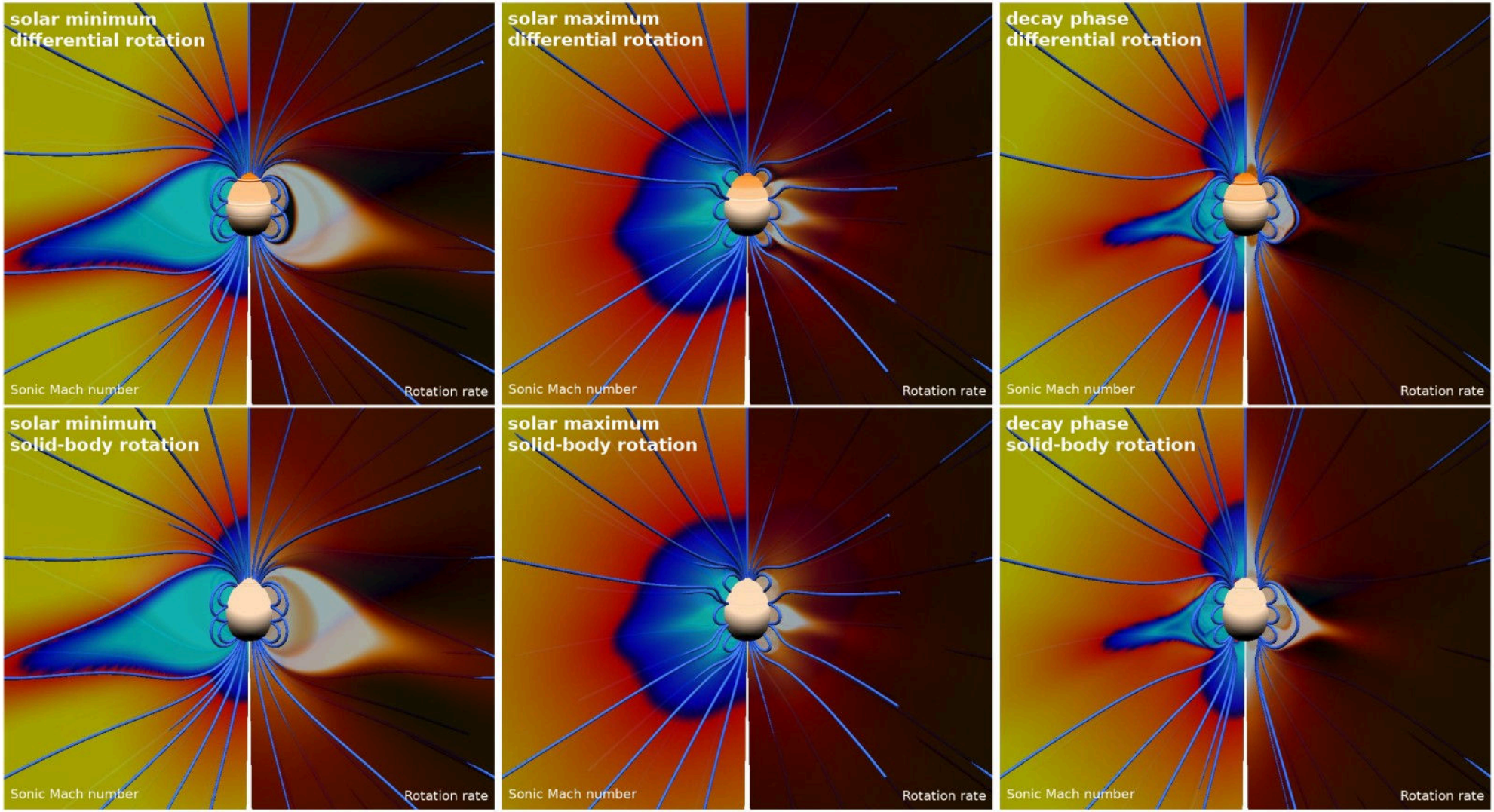


Synoptic UVCS campaings revisited (plans for SO/Metis synoptics)

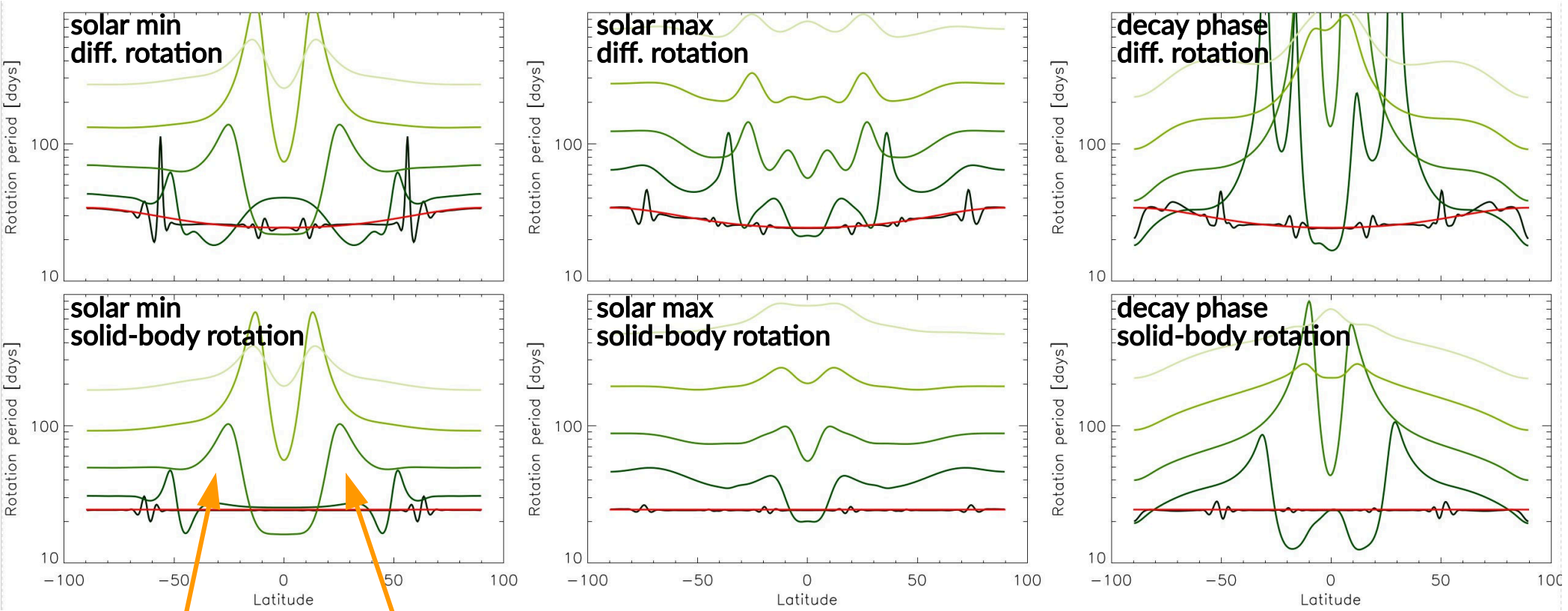
Synergies with PSP (WISPR, in-situ)

Consequences for sun-to-spacecraft connectivity

Coronal rotation, MHD simulations, full solar cycle



Rotation period from low to high corona

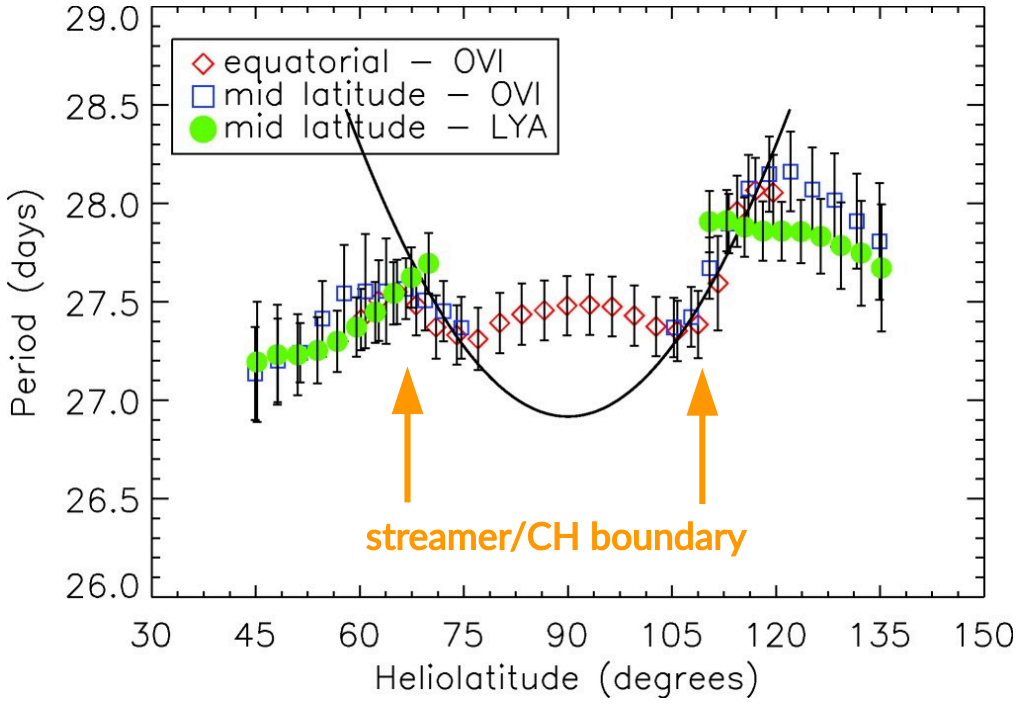


streamer/CH boundary

dark to light green: r=1.03, 2.0, 4.0, 8.0 and 16 R_{sun}
red: surface rotation profile

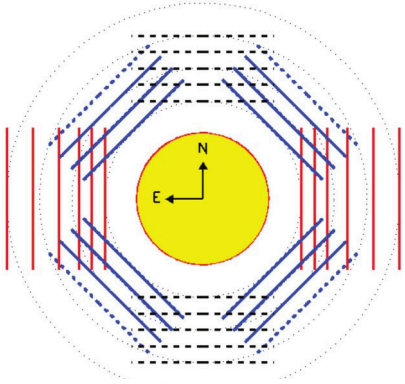
Pinto, et al, accepted (A&A); arxiv.org/abs/2104.08393

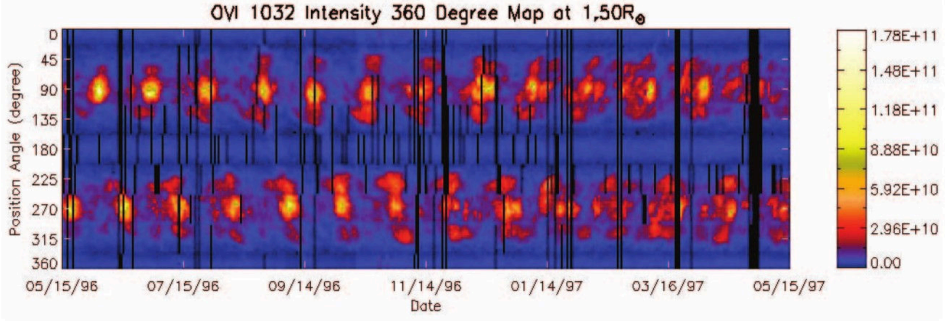
Differential rotation in the corona, observations

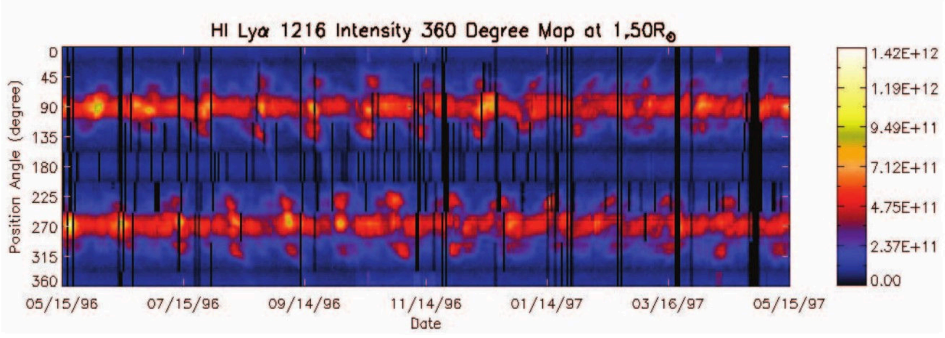


UVCS derived rotation periods (at 1.5 R_{sun}), solar minimum

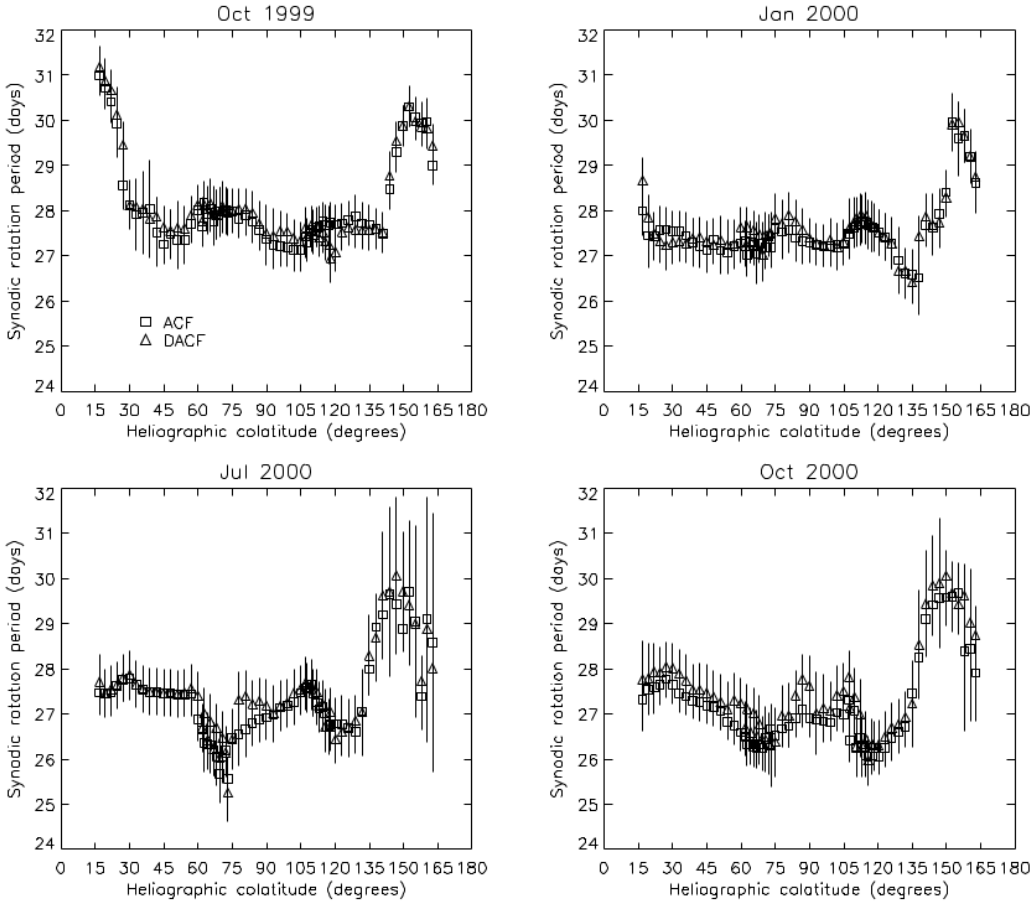
(Giordano & Mancuso, ApJ 2008)





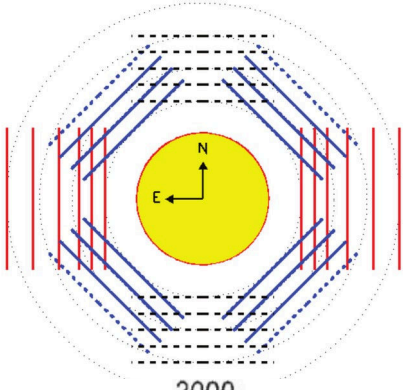


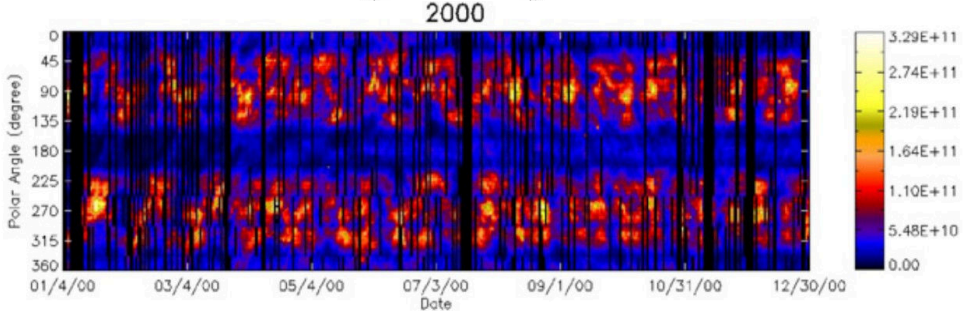
Differential rotation in the corona, observations

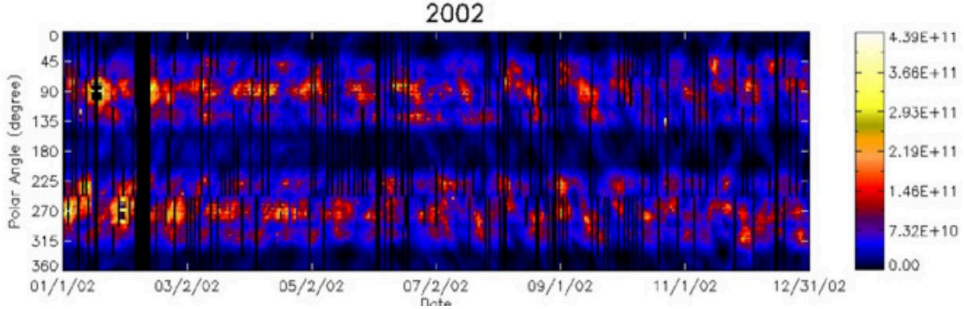


UVCS derived rotation periods (at 1.5 R_{sun}), solar maximum

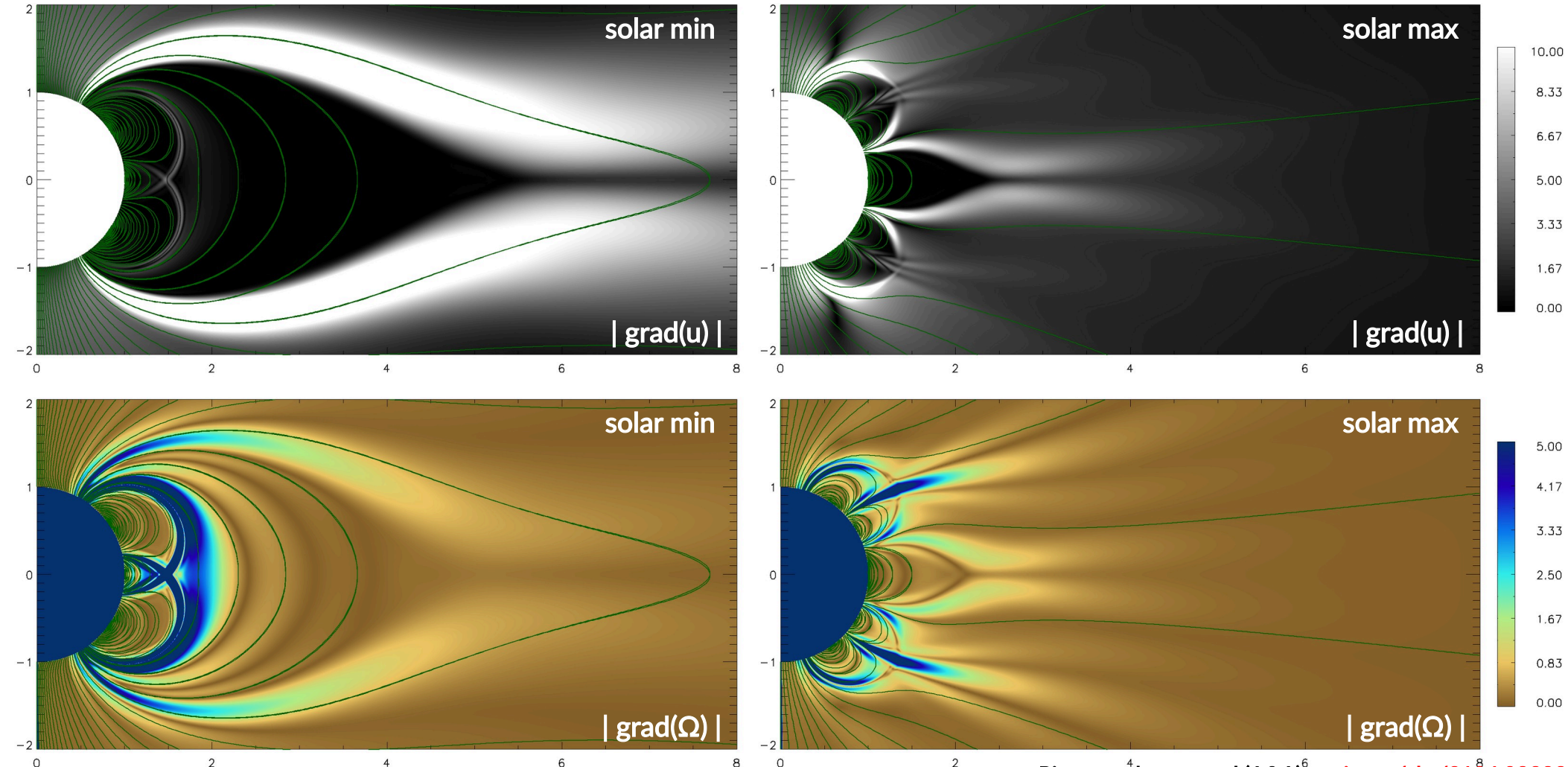
(Mancuso & Giordano, ApJ 2011)





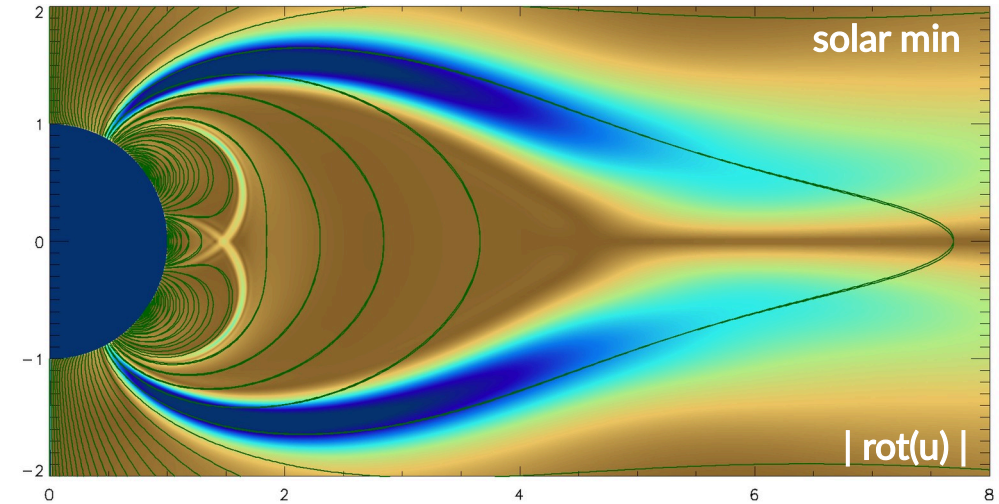


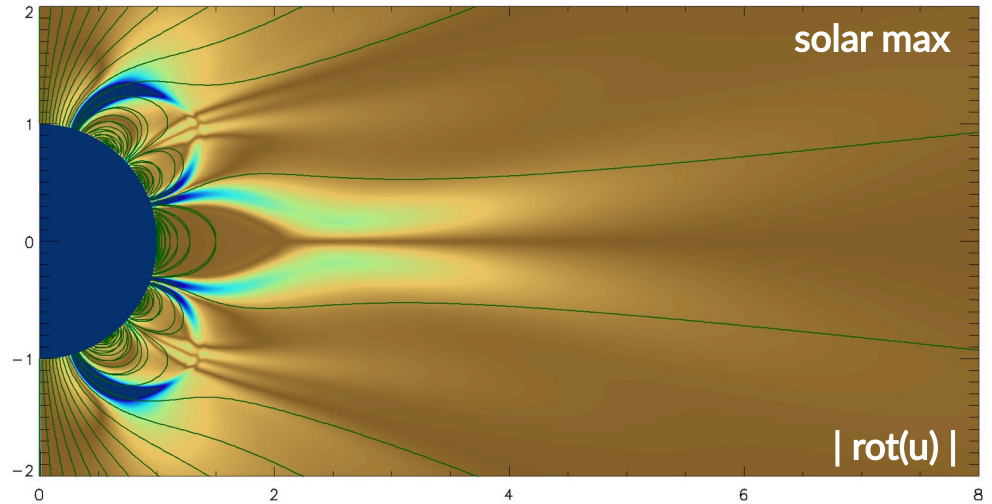
MHD: Wind speed and rotation rate gradients

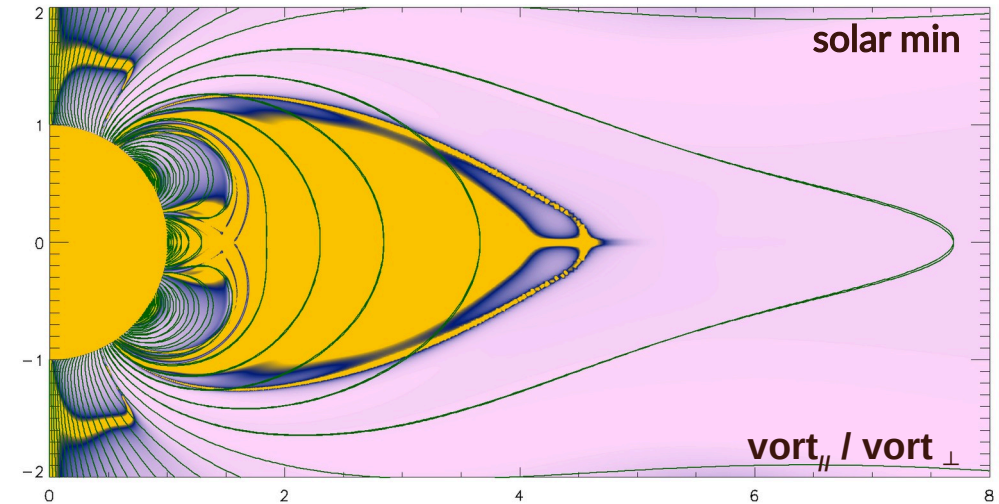


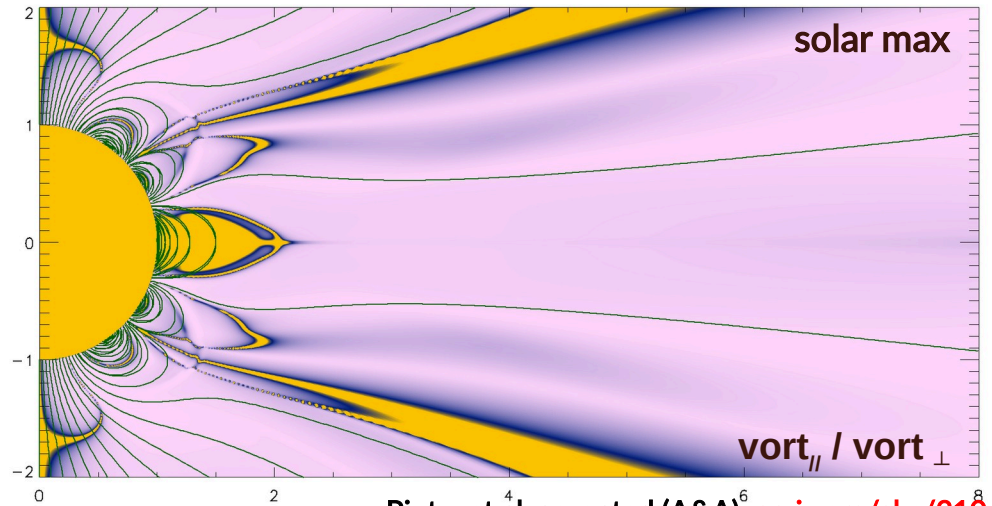
Pinto, et al, accepted (A&A); arxiv.org/abs/2104.08393

MHD: Vorticity amplitude and orientation



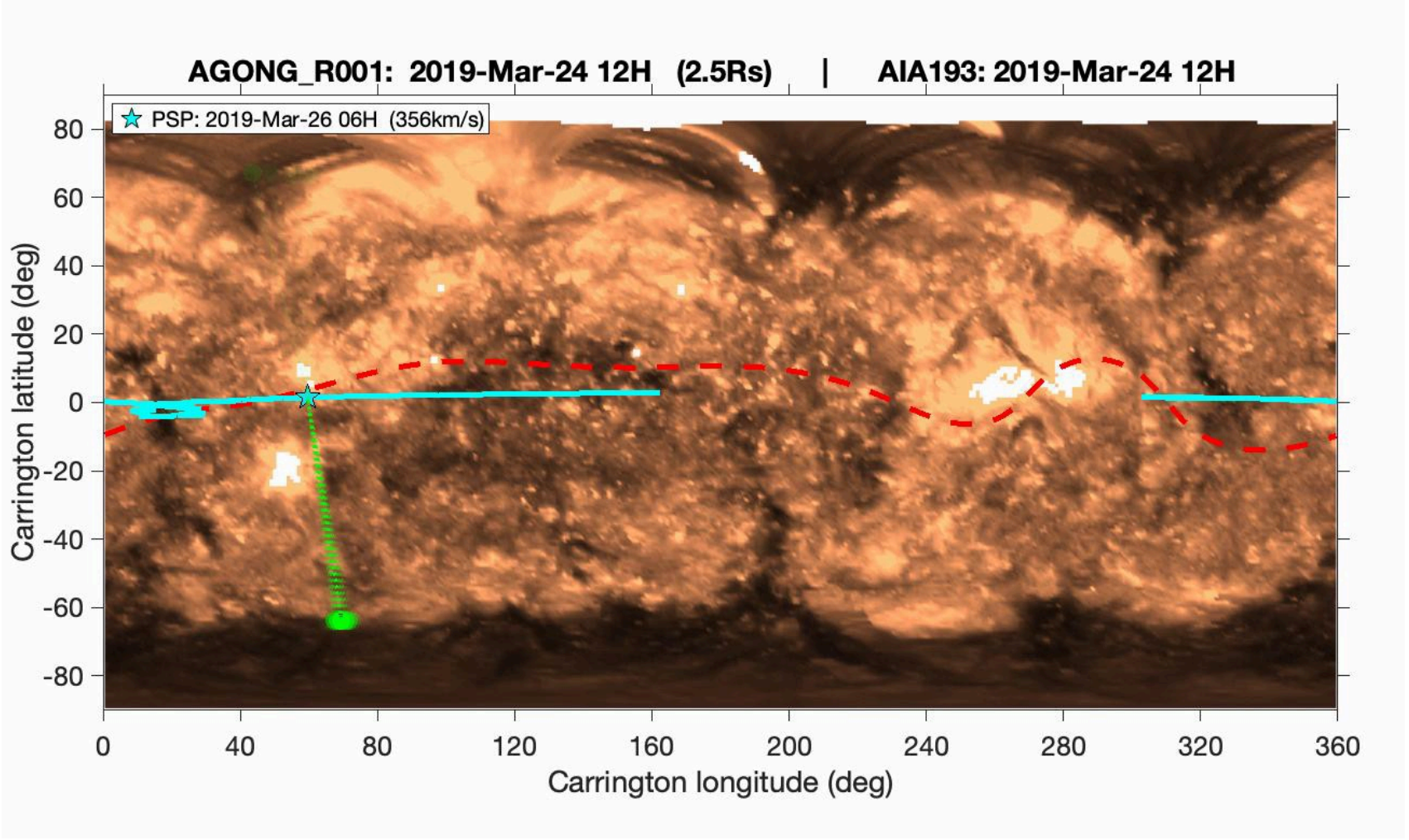






Pinto, et al, accepted (A&A); arxiv.org/abs/2104.08393

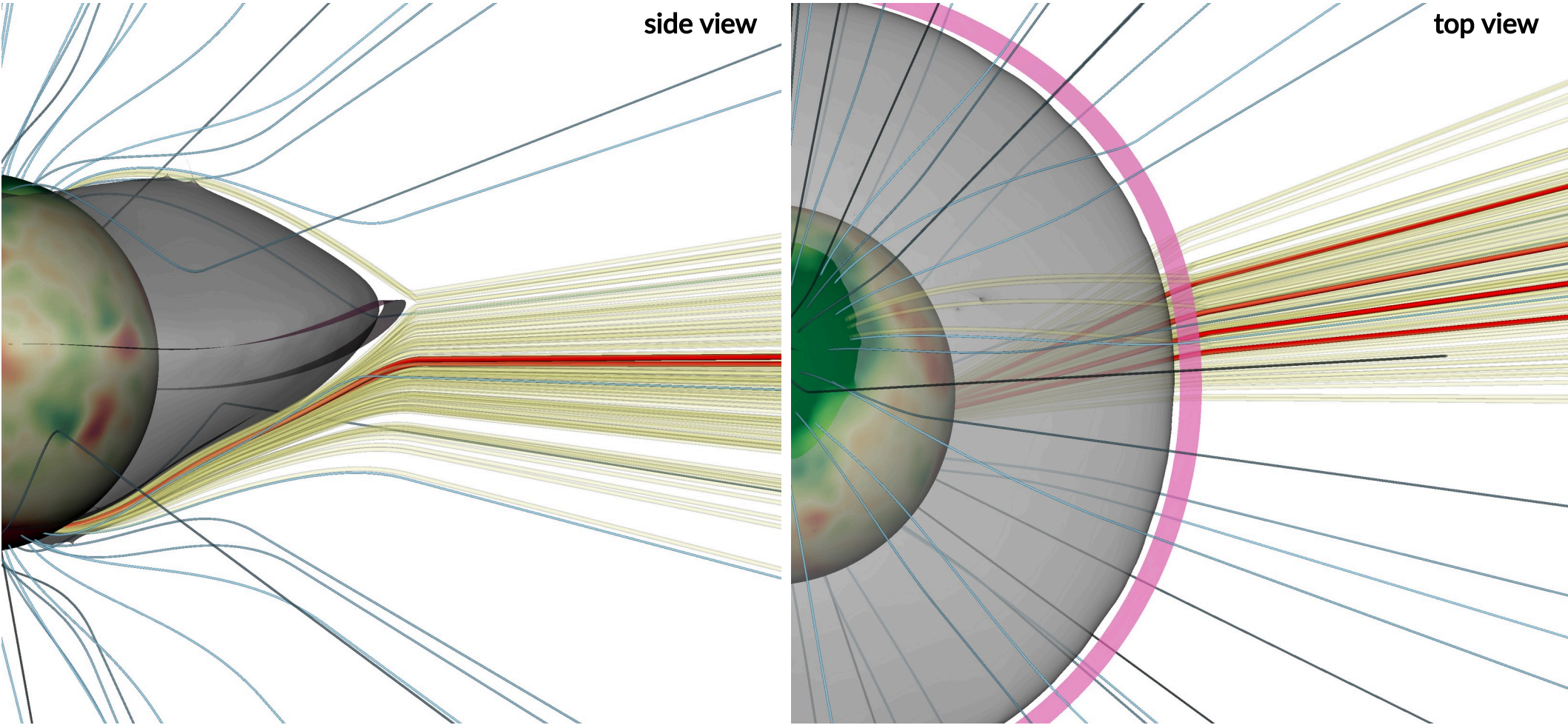
Connectivity: PSP, March 2019 (E02)



Connectivity Tool www.connect-tool.irap.omp.eu

Surface layer: AIA 193 Å

Connectivity: PSP, 23 March 2019



yellow lines: uncertainty ellipse
red lines: highest connectivity probability

Connectivity Tool www.connect-tool.irap.omp.eu

Global rotation of the corona and solar wind

Key for many science problems, but largely understudied:

- **enhanced shear forced at streamer/pseudo-streamer boundaries**, at all moments of the activity cycle
- rotation periods peak at the outside of streamer boundaries, **as observed by SoHO/UVCS**
- overall, **rotation rate of the corona is very structured** in these regions **(high and low rotation rates co-exist)**
- streamer and pseudo-streamer stalks support **radially elongated shearing zones** (up to high heliocentric distances)
- magnetic pitch angles can be high at some locations (even in low corona), **shearing in blob/flux-rope formation zones**
- **affects connectivity science** (remote to in-situ / Sun to spacecraft).
- important for angular momentum balance (solar/stellar evolution)

Remote sensing diagnostics:

- SolO/Metis synoptics: distribution of obs. windows (use LLD?), SolO orbits, non-uniform solar longitude scanning,

  Lyα less appropriate than OVI for Lomb-Scargle periograms

- WISPR: crossings of HPS/streamer belt, connect transients to shear sources

Synergies with in-situ:

- SolO/SWA, PSP, BepiColombo – several quadrature / quasi-quadrature configurations expected

Modelling support

- Numerical models (daily SWiFT/MULTI-VP, per-event full MHD), IRAP's connectity tool
- Tomography