A preferential switchback orientation

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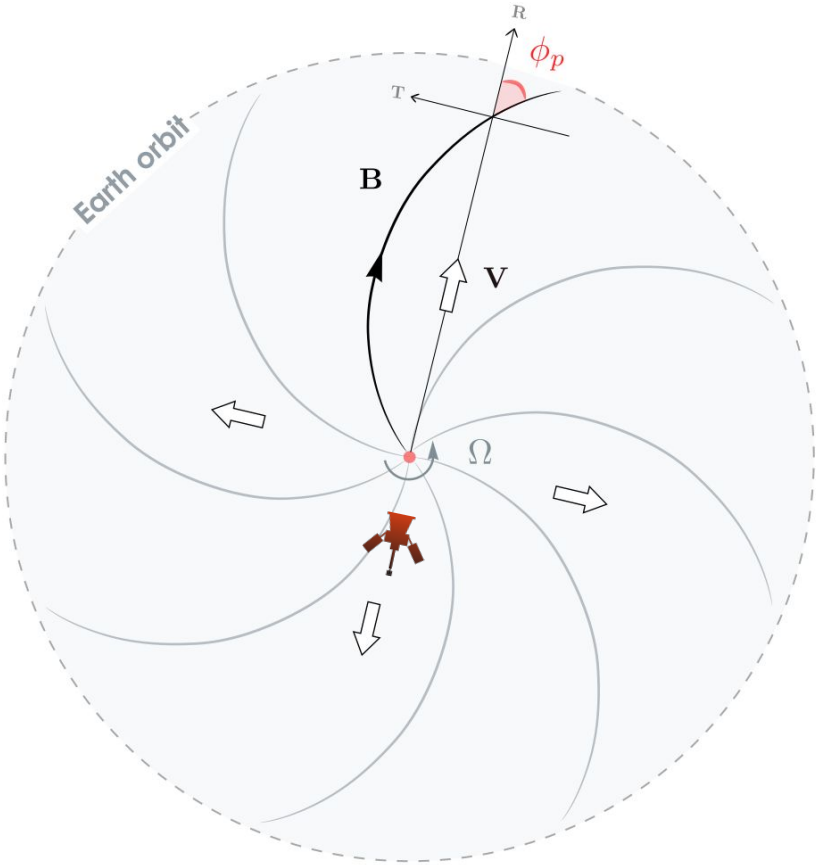
Expected B features close to the Sun

- The magnetic field is **radial**

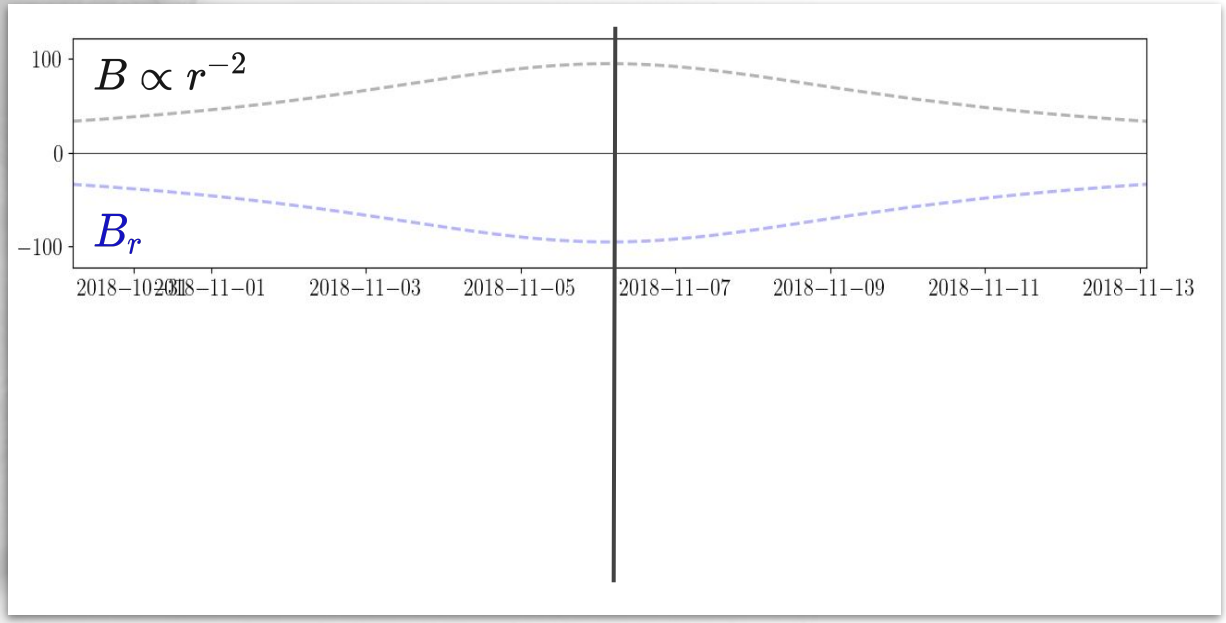
$$B \sim B_R$$

- Due to flux conservation :

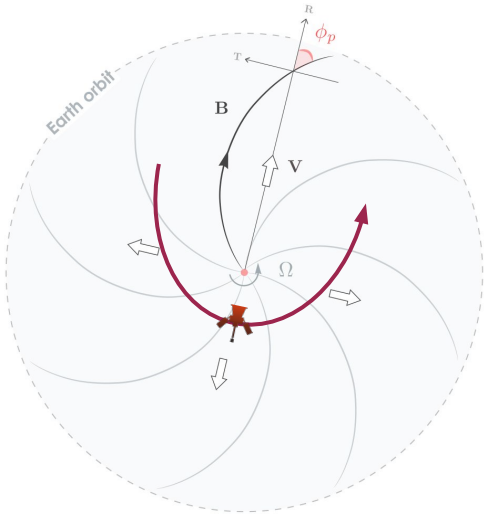
$$B_R \propto \frac{1}{r^2}$$



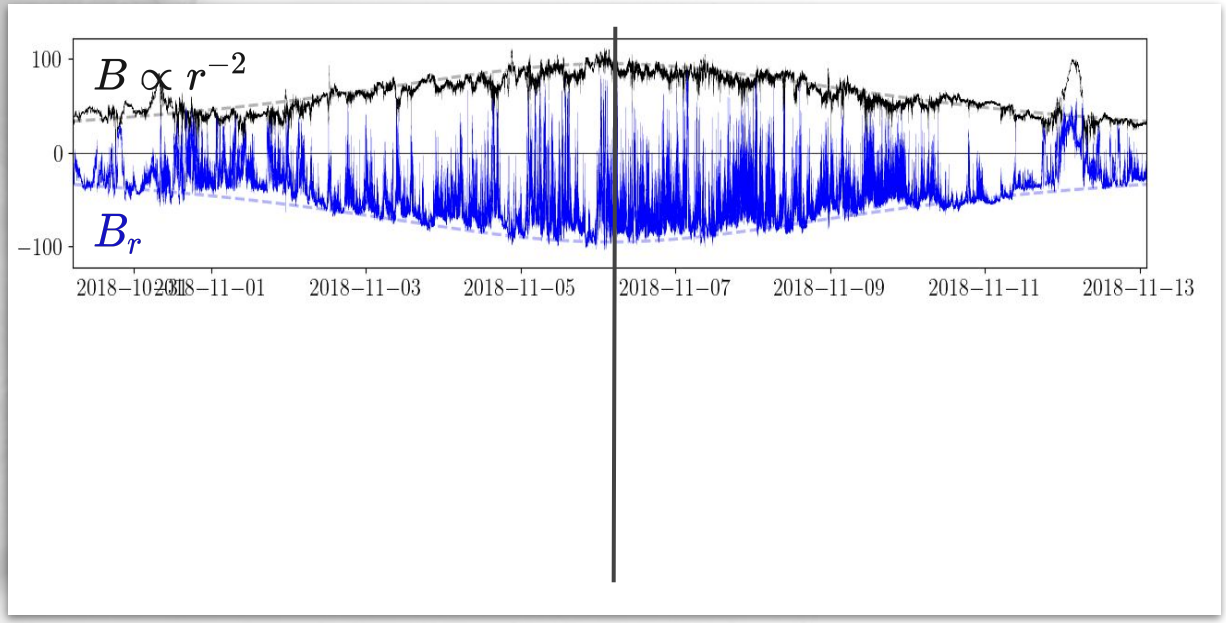
In-situ observations :



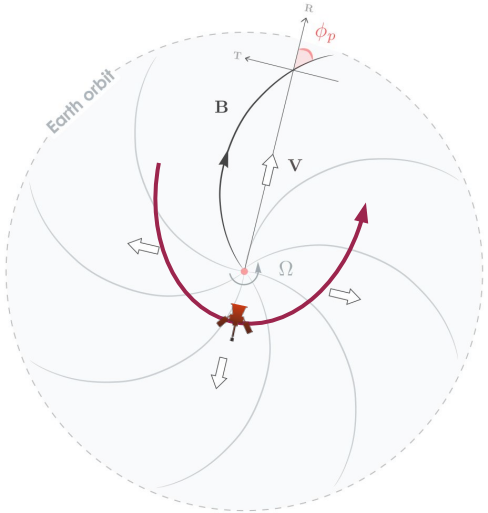
perihelion



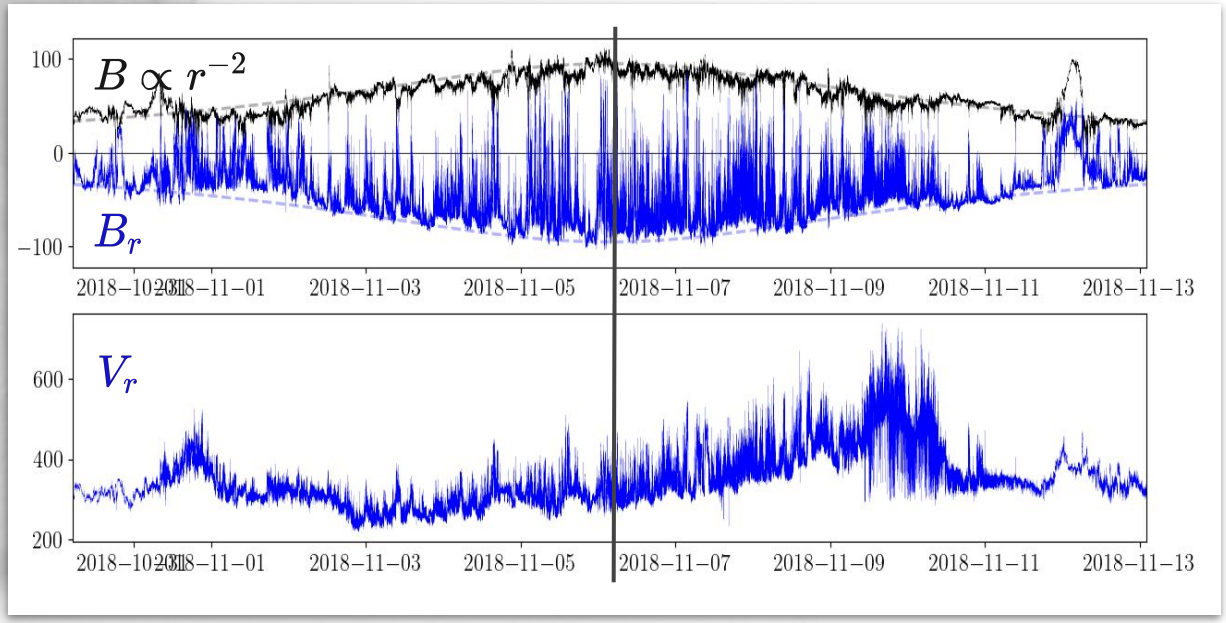
In-situ observations : magnetic switchbacks



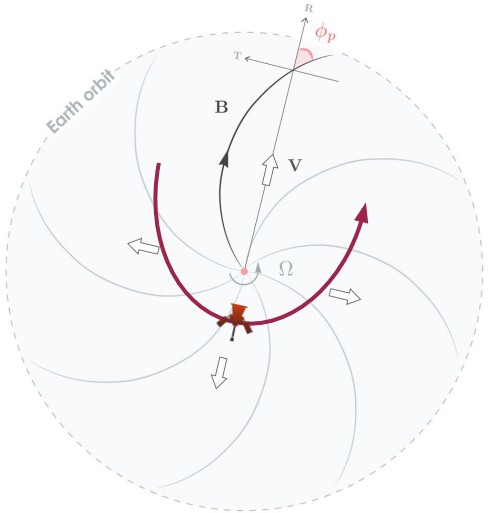
perihelion



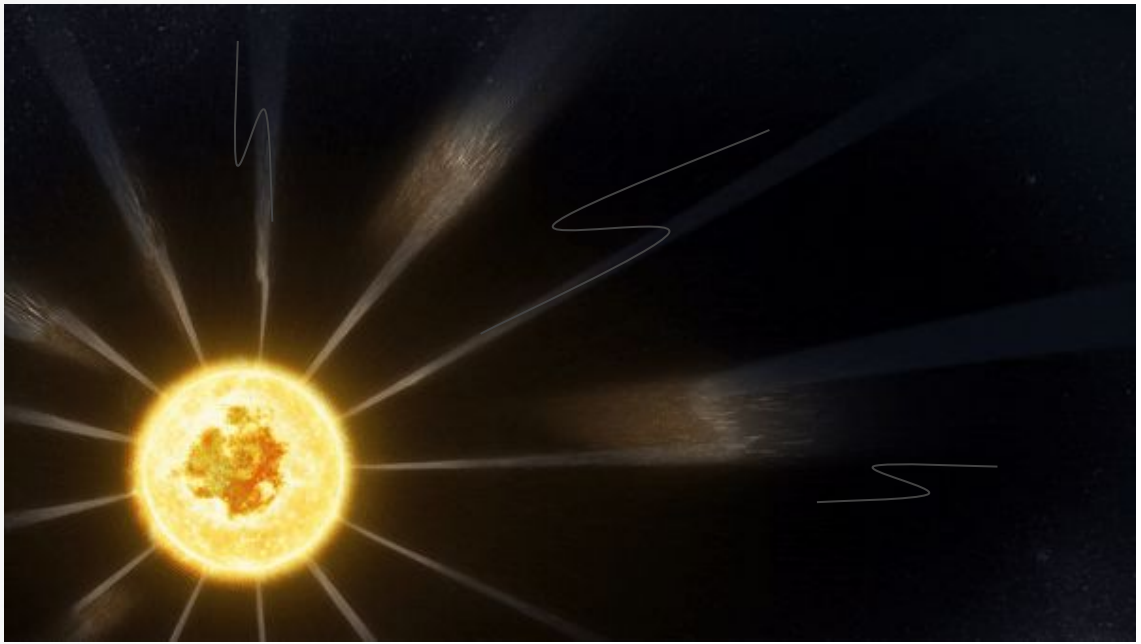
In-situ observations : magnetic switchbacks



perihelion

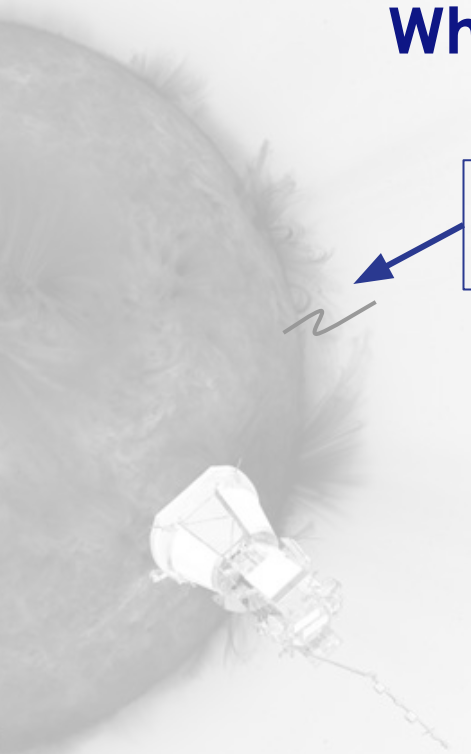


Accelerated folds in the magnetic field



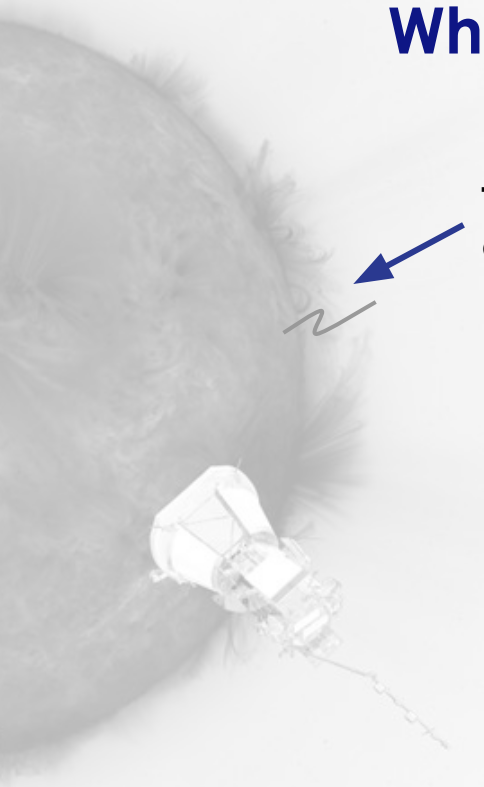
Artist's view
(NASA)

Where and how are they formed ?



Through processes in the low atmosphere ? (magnetic reconnection, alfven wave generation and steepening with expansion...)

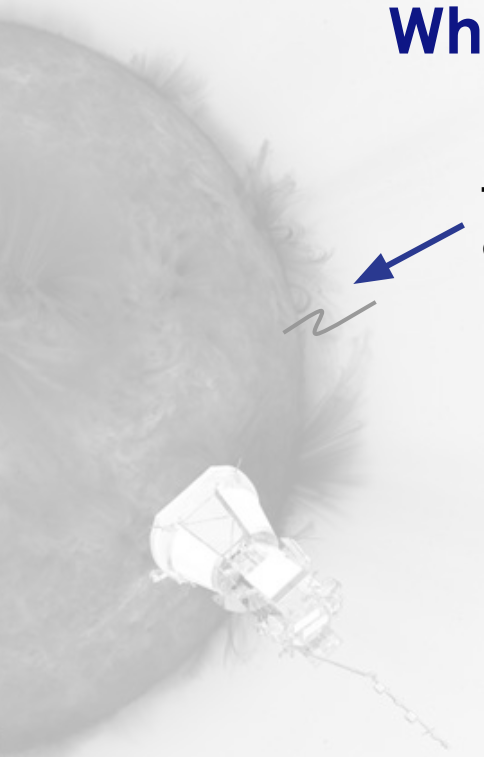
Where and how are they formed ?



Through processes in the low atmosphere ? (magnetic reconnection, alfven wave generation and steepening with expansion...)

In situ in the solar wind ? (turbulence, velocity shears..)

Where and how are they formed ?



Through processes in the low atmosphere ? (magnetic reconnection, alfven wave generation and steepening with expansion...)

In situ in the solar wind ? (turbulence, velocity shears..)

- Do they **participate in heating the corona ?**
- Are they **involved in solar wind formation ?**
- Are they involved in solar wind **acceleration ?**

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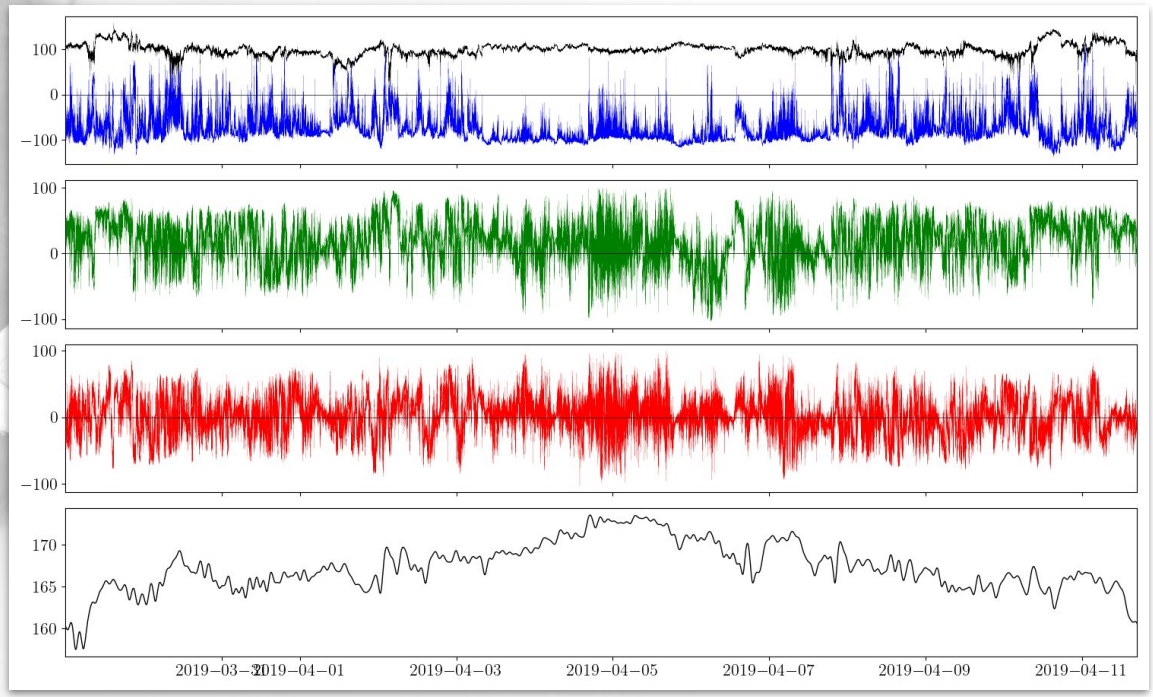
In RTN, a slight bias…

B_r

B_t

B_n

α_P



In RTN, a slight bias…

B_r

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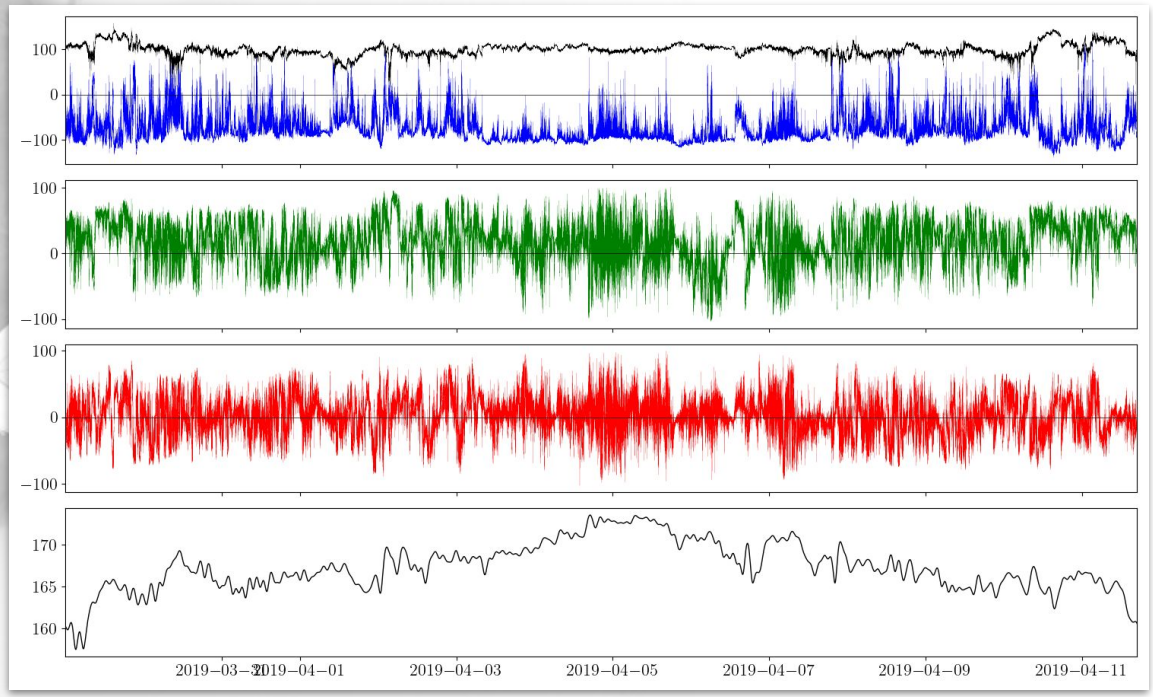
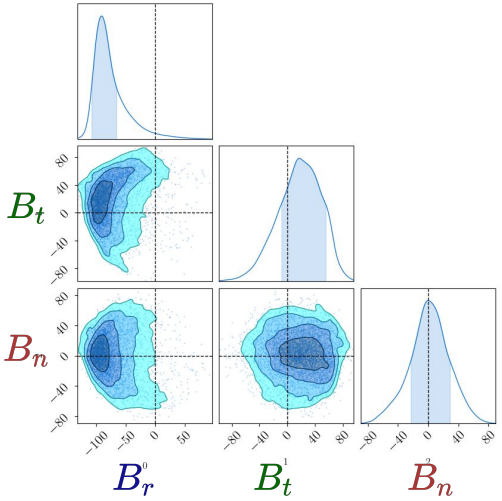
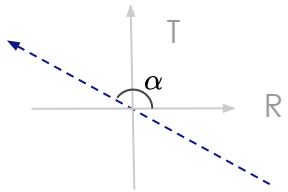






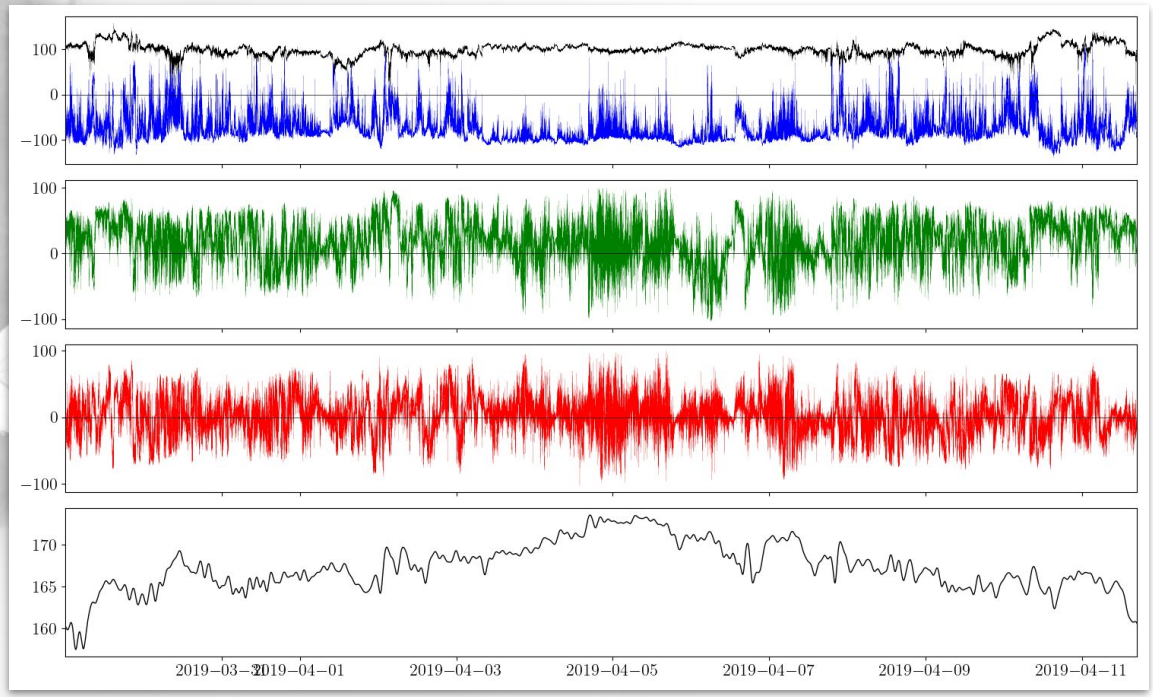
In RTN, a slight bias… due to the Parker spiral

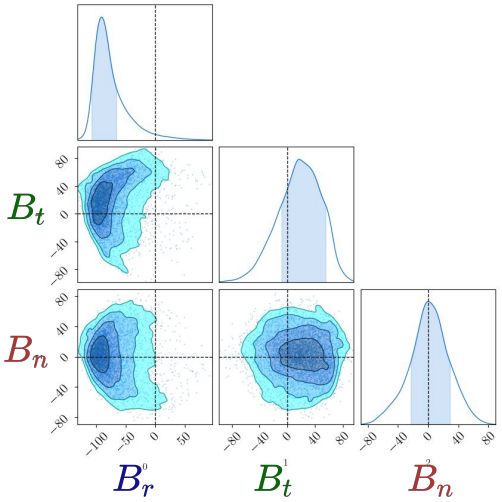
B_r

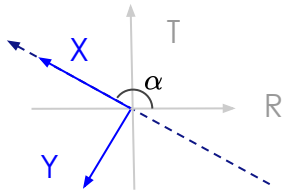
B_t

B_n

α_P







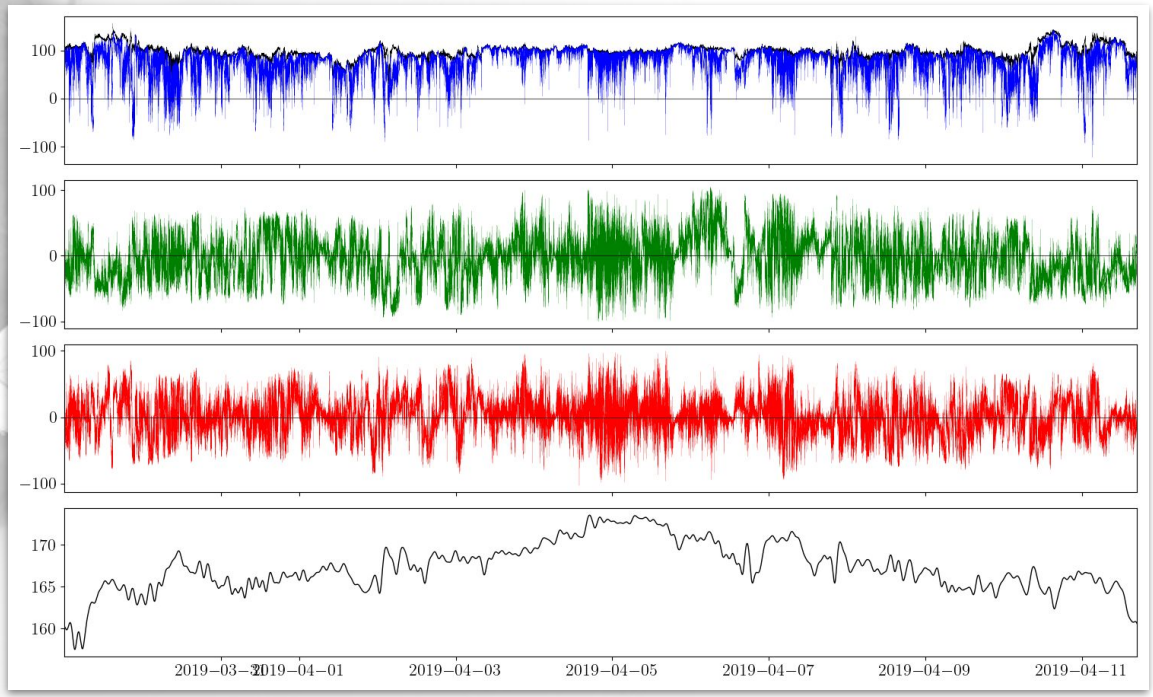
Let us rotate to the local Parker frame (xyz)

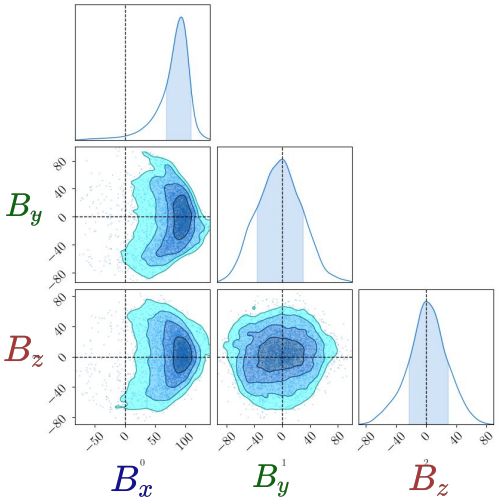
B_x

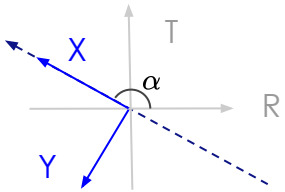
B_y

B_z

α_P







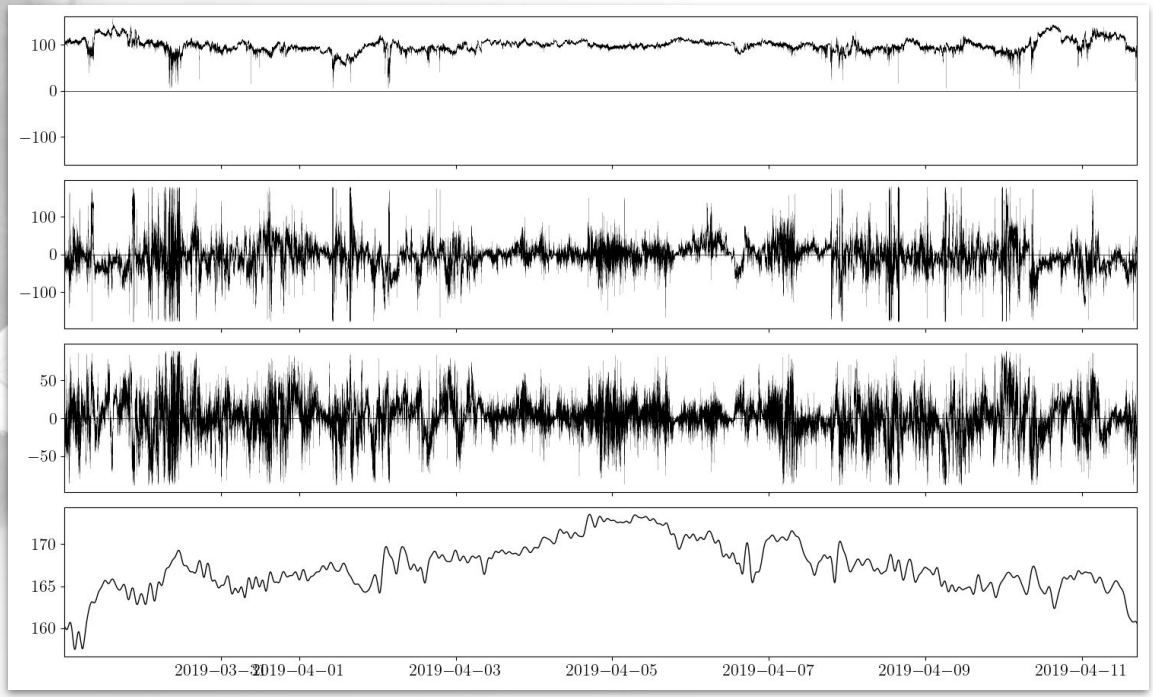
and consider the orientation angles in xyz

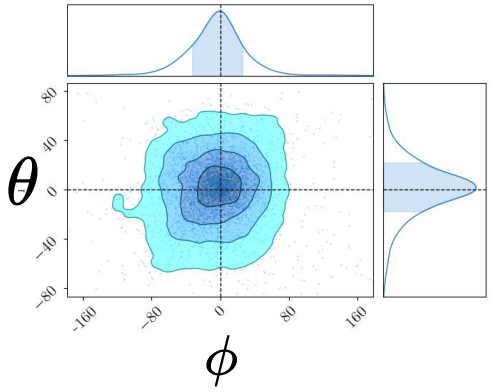
B

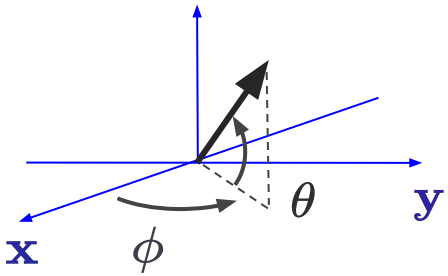
ϕ

θ

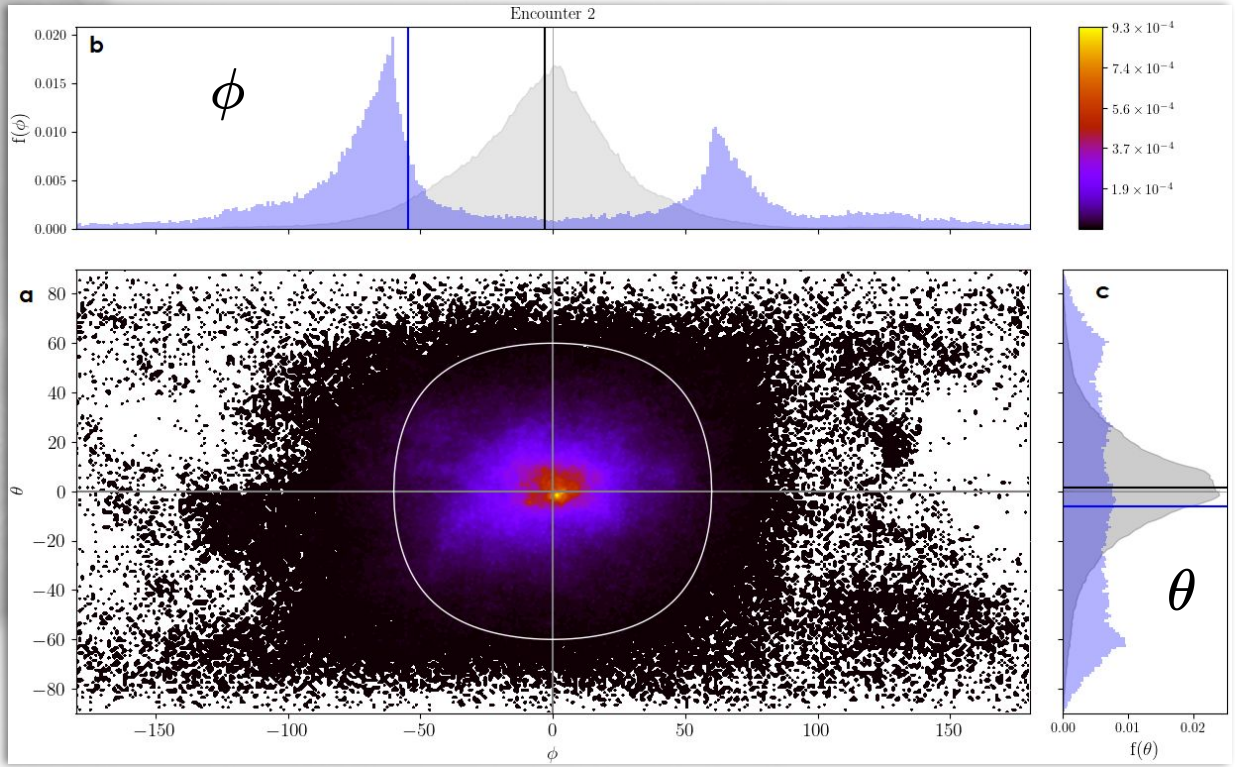
α_P







Orientation angle distribution



A threshold approach is possible but:

- **Threshold is arbitrary**
- **The phenomenon is not completely captured**
- **Hard to characterise the resulting distributions**

A modeling approach :

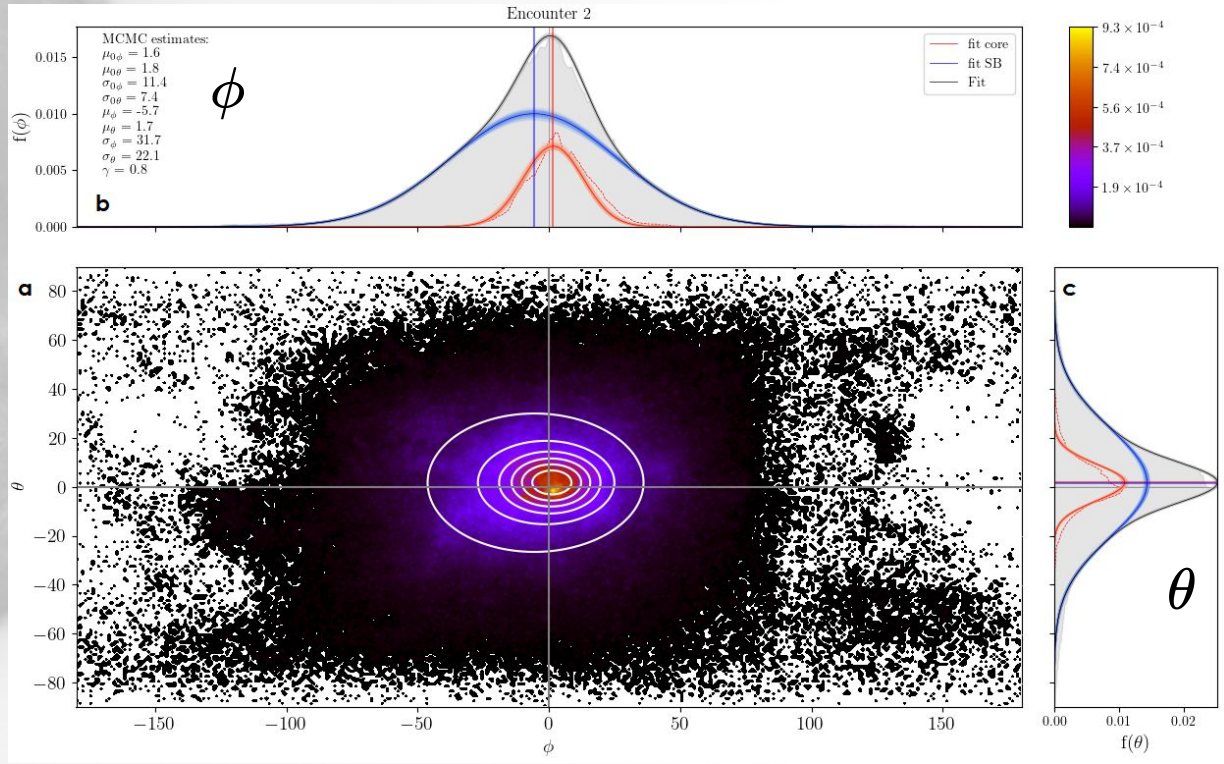
We assume that the solar wind is composed of **two populations**, and that **the deflection angles follow a normal distribution** for each population

- **The background solar wind** $\mu \sim [0, 0]$ $\sigma \leq 30^o$
- **The perturbed (SB) solar wind** μ, σ

The total distribution we observe is the weighted sum of two 2D gaussians with different means and variances

$$(1-\gamma)\,\mathcal{G}(\mu_0, \Sigma_0) + \gamma\,\mathcal{G}(\mu, \Sigma)$$

We fit for the best parameters :



$\mu_\phi = 1.6^o$
$\mu_\theta = 1.8^o$
$\sigma_\phi = 11.7^o$
$\sigma_\theta = 7.6^o$

$\mu_\phi = -5.9^o$
$\mu_\theta = 1.5^o$
$\sigma_\phi = 31.8^o$
$\sigma_\theta = 22.2^o$

The switchback population has a biased mean

$\gamma = 0.8$

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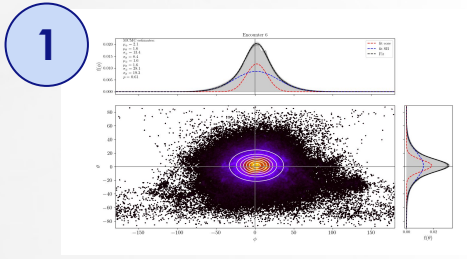
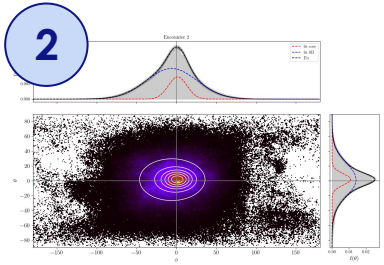
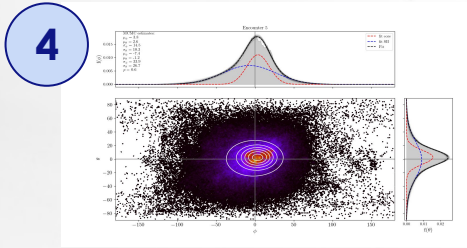
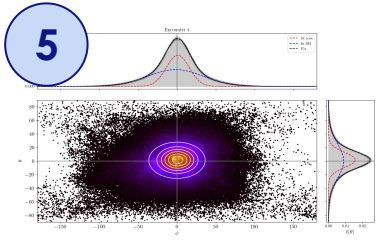
Fitting all encounters

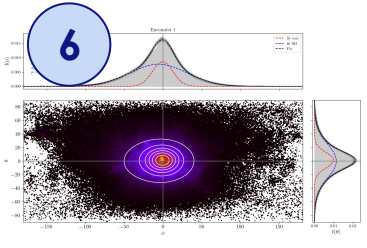


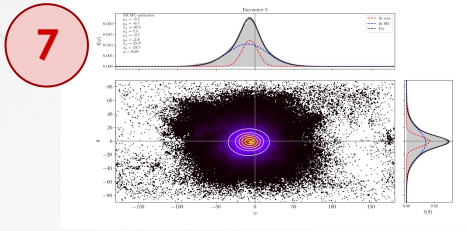


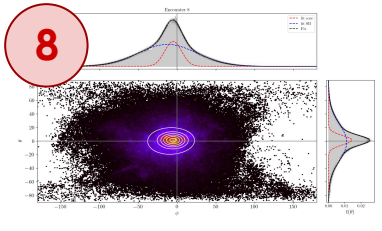
We consider the main polarity of each encounters

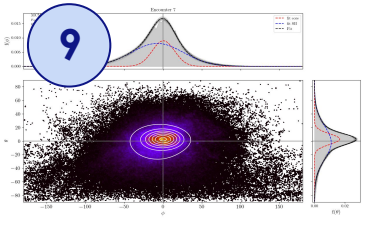




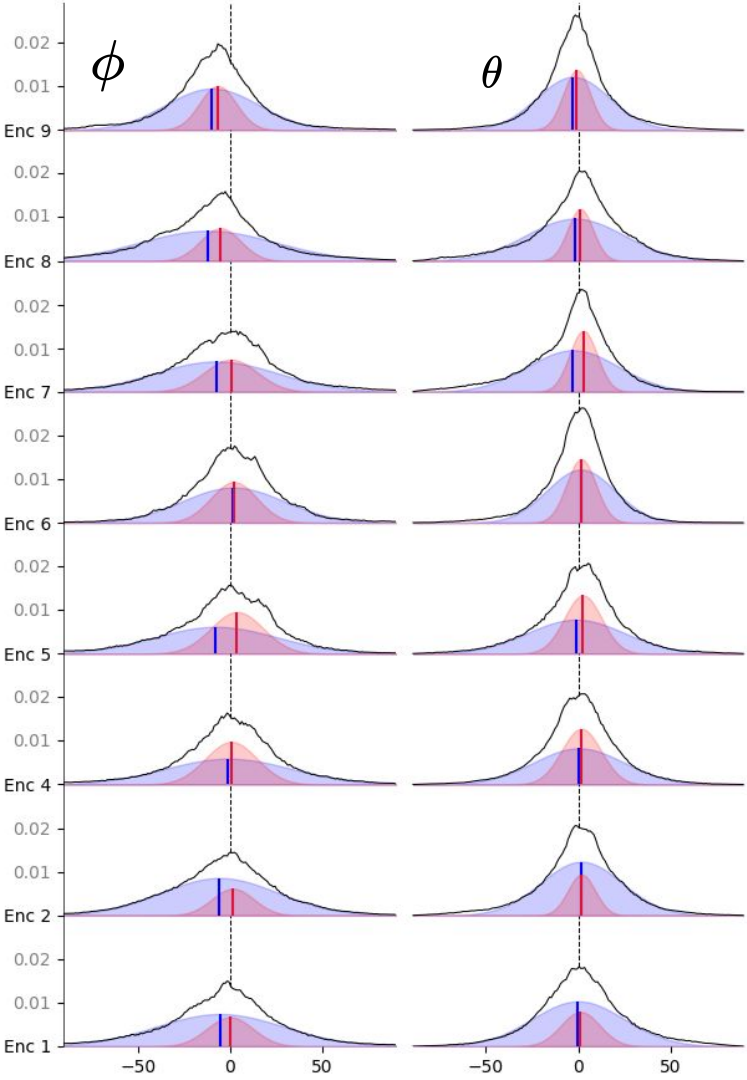






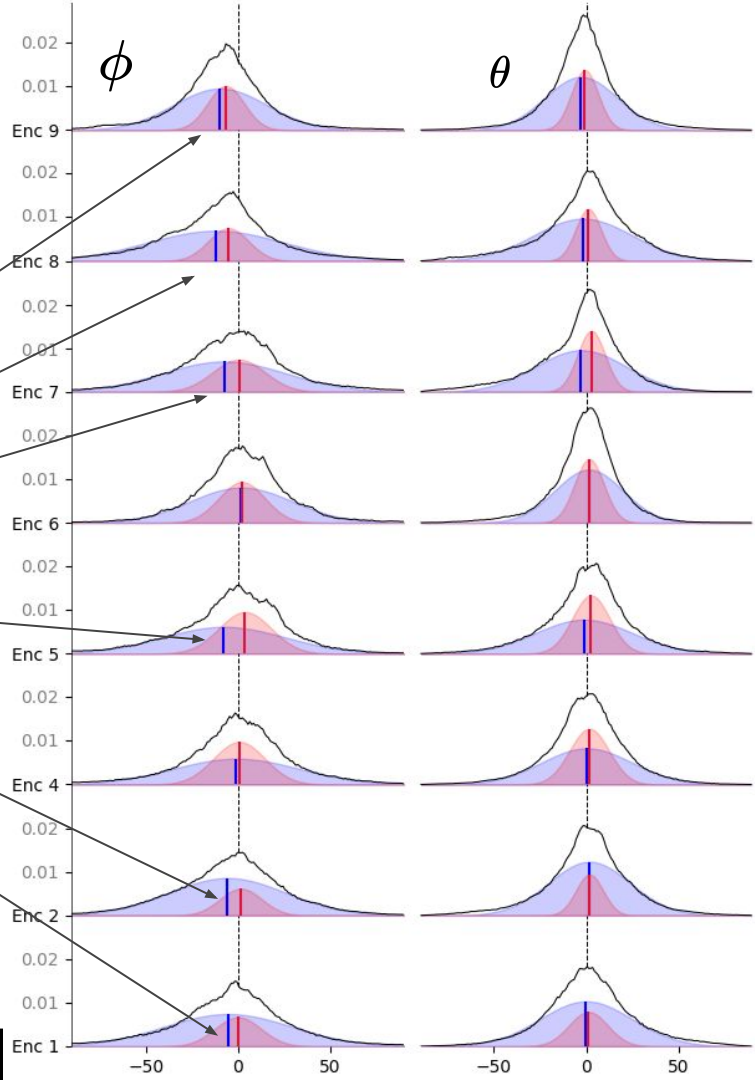


Fitting all encounters



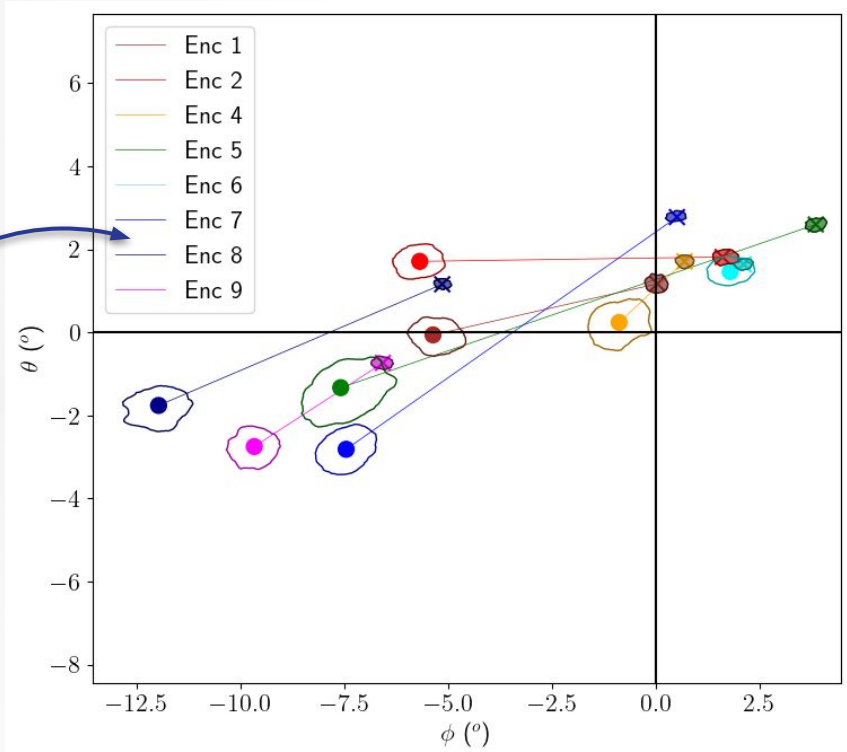
Fitting all encounters

The switchback population has a biased mean



Bias is consistent over all encounters

Regardless of the polarity



- \+ Mean of Parker spiral distribution
- • Mean of SB distribution

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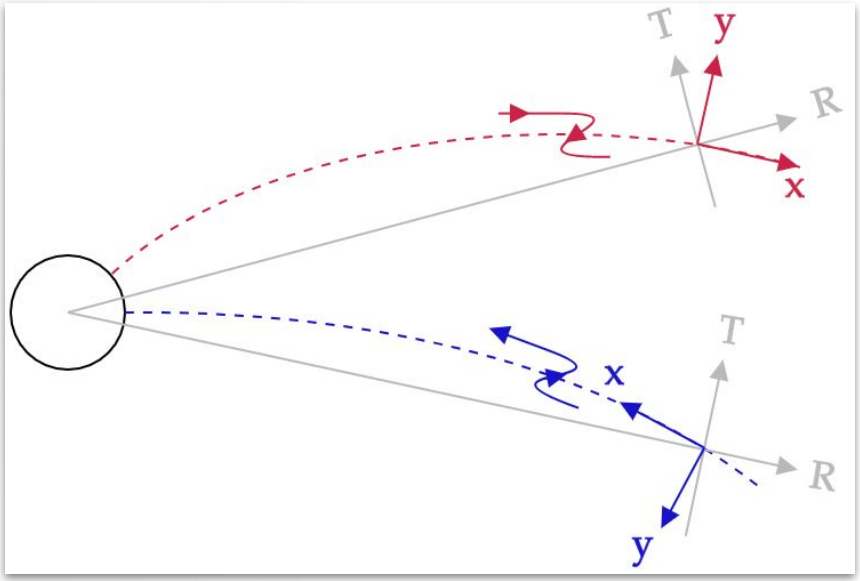
A polarity-invariant prefered geometry



$B_r > 0$

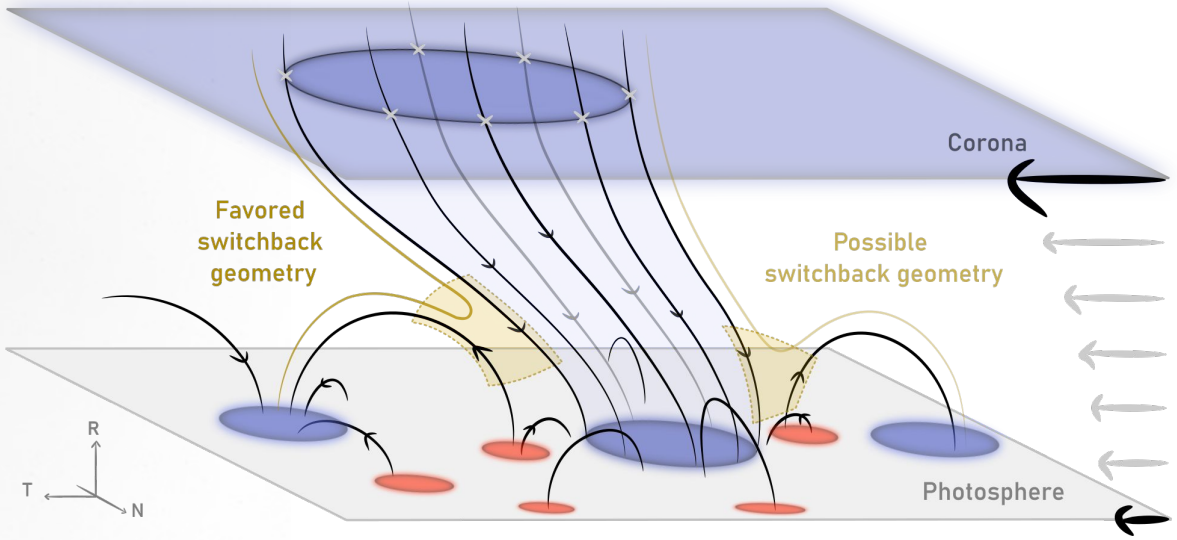
-T direction

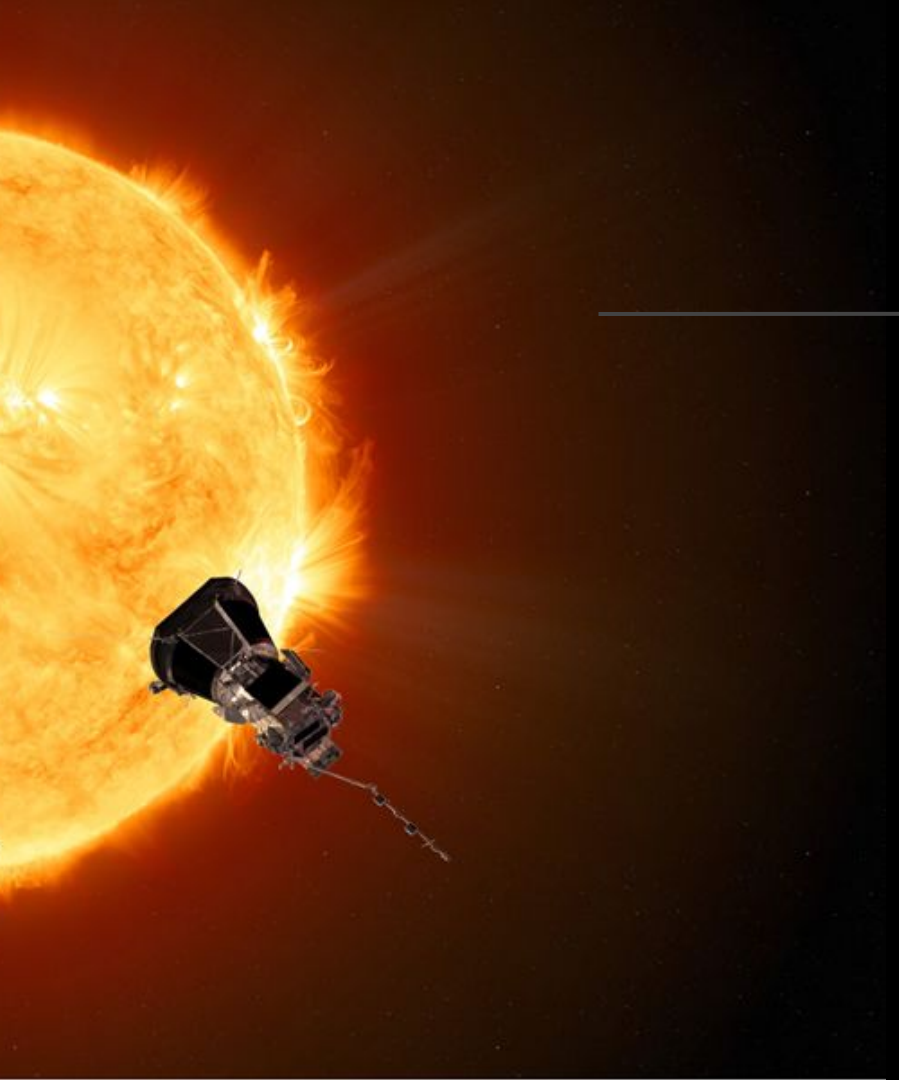
$B_r < 0$

+T direction

Consistent with interchange reconnection

Differential rotation should favor magnetic reconnection in a prefered direction



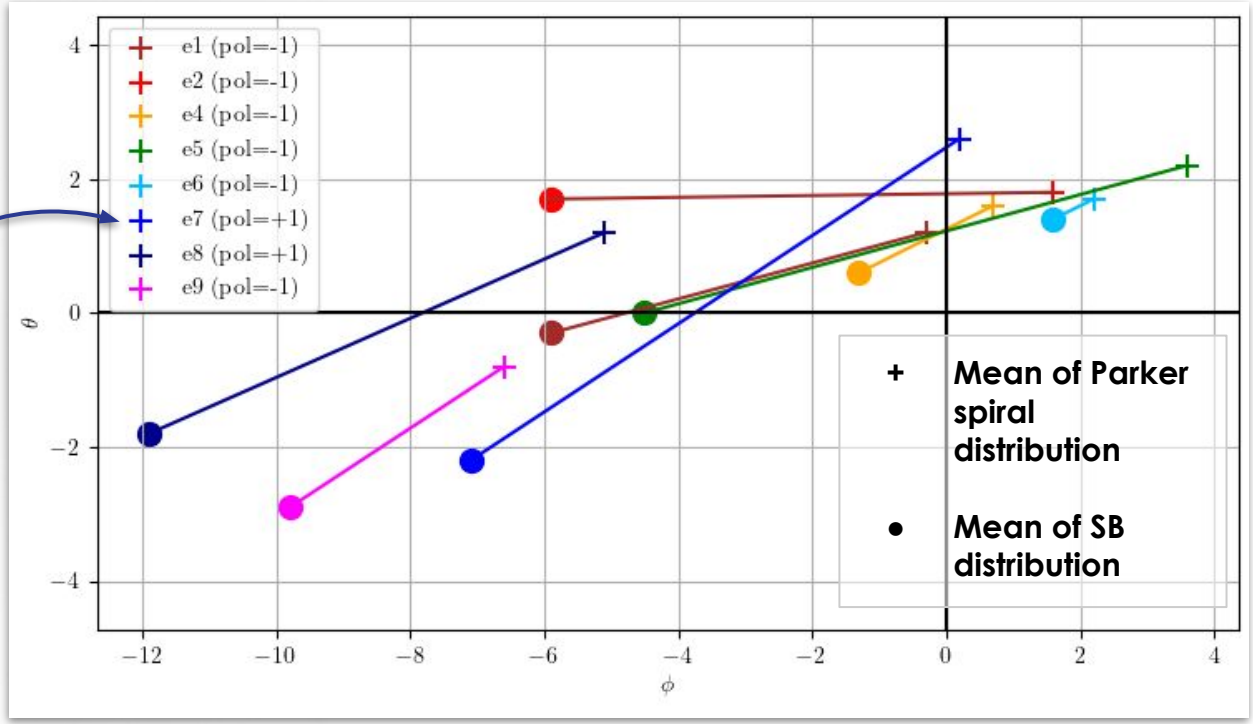


Thank you !

Any questions ?

Bias is consistent over all encounters

Regardless of the polarity

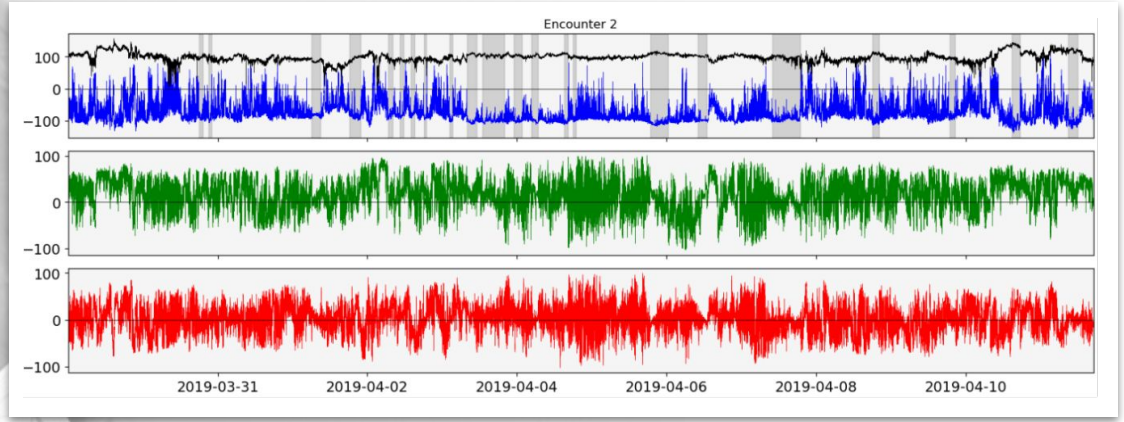


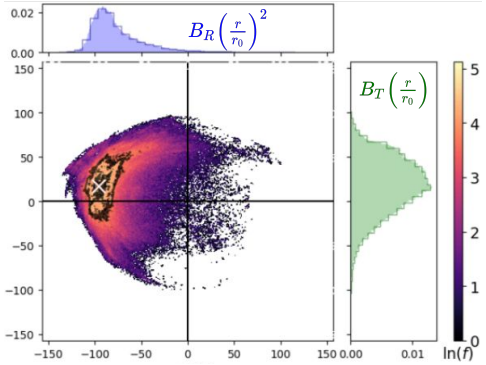
A perturbation compared to...

$B_R\left(\frac{r}{r_0}\right)^2$

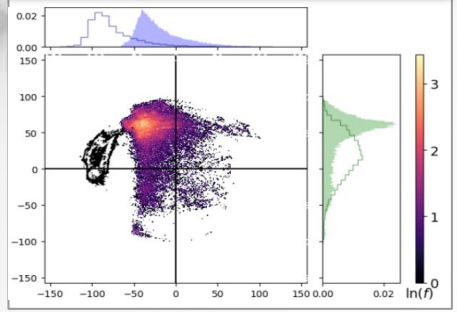
$B_T\left(\frac{r}{r_0}\right)$

$B_N\left(\frac{r}{r_0}\right)$

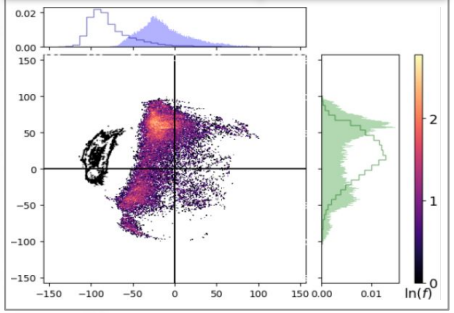




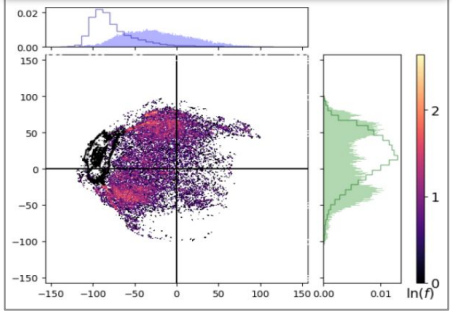
Radial



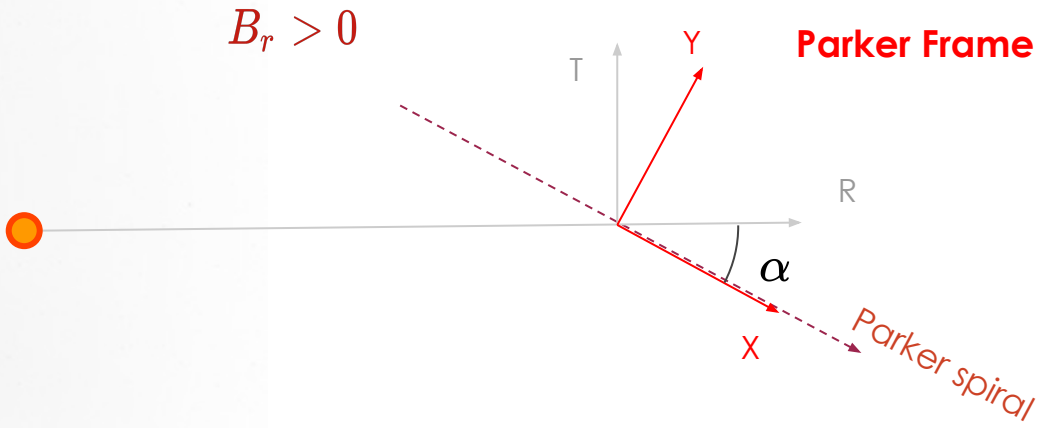
Parker spiral



6h mode



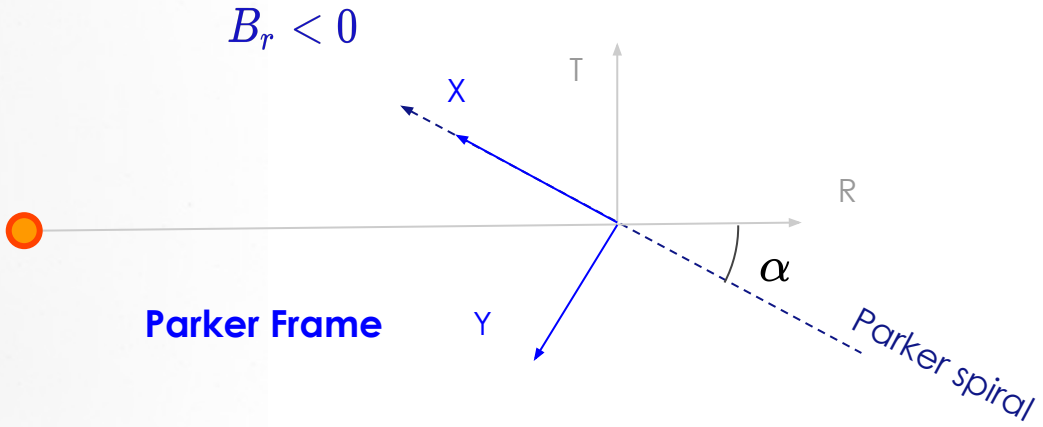
Parker spiral modeling



$$\tan\alpha = \frac{-\Omega(r-r_0)}{V_R}$$

R0 = 10 Rs
Vr treated with low pass filter (tc = 2h)

Parker spiral modeling



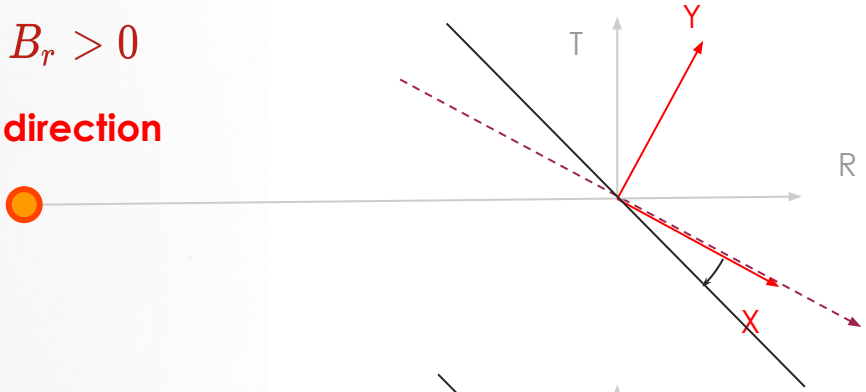
$$\tan\alpha = \frac{-\Omega(r-r_0)}{V_R}$$

R0 = 10 Rs
Vr treated with low pass filter (tc = 2h)

Invariant geometry

$B_r > 0$

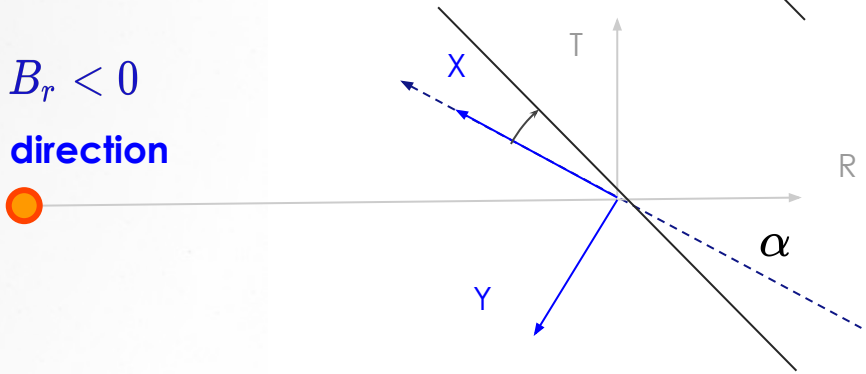
-T direction



$d\phi < 0$

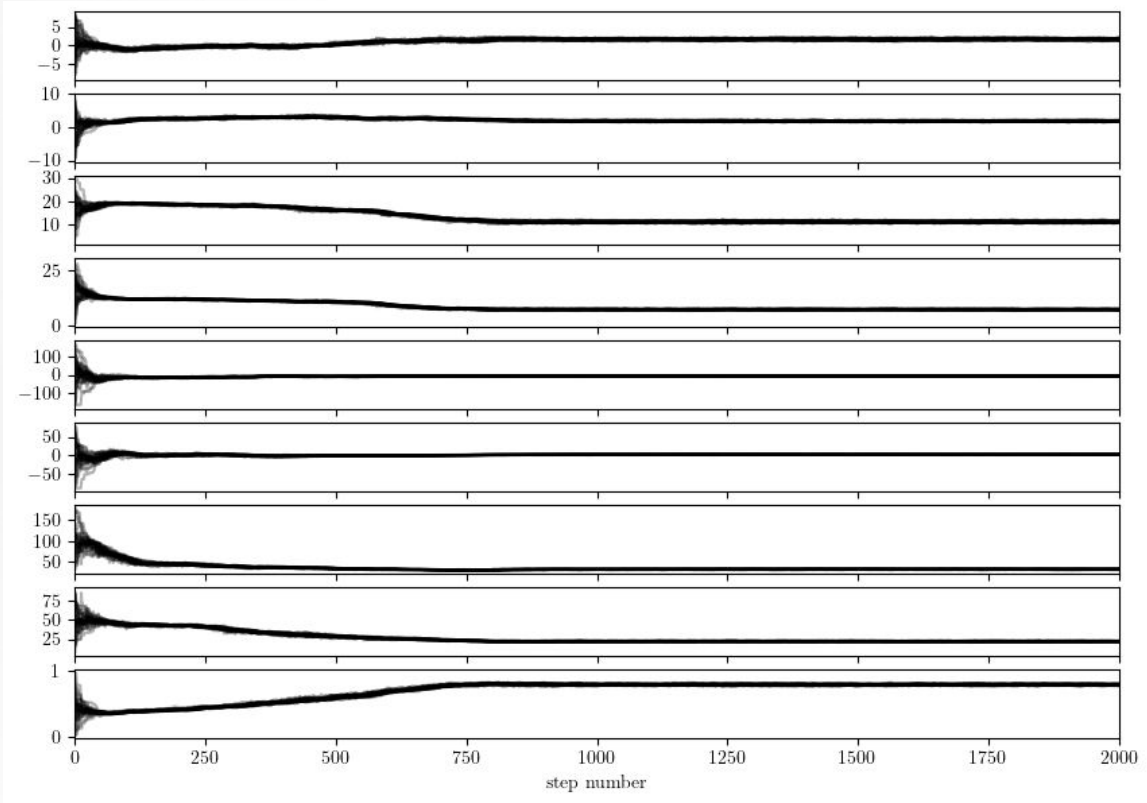
$B_r < 0$

+T direction



$d\phi < 0$

Fitting convergence



Posterior distribution