

Magnetic Fields In The Shapley Supercluster: *revisited*

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Director: Shane P. O'Sullivan

1 year ago...

“No sabemos qué está pasando, **pero lo estamos viendo**” –David Alonso, 17 diciembre 2024



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→ ...What did I mean back then?

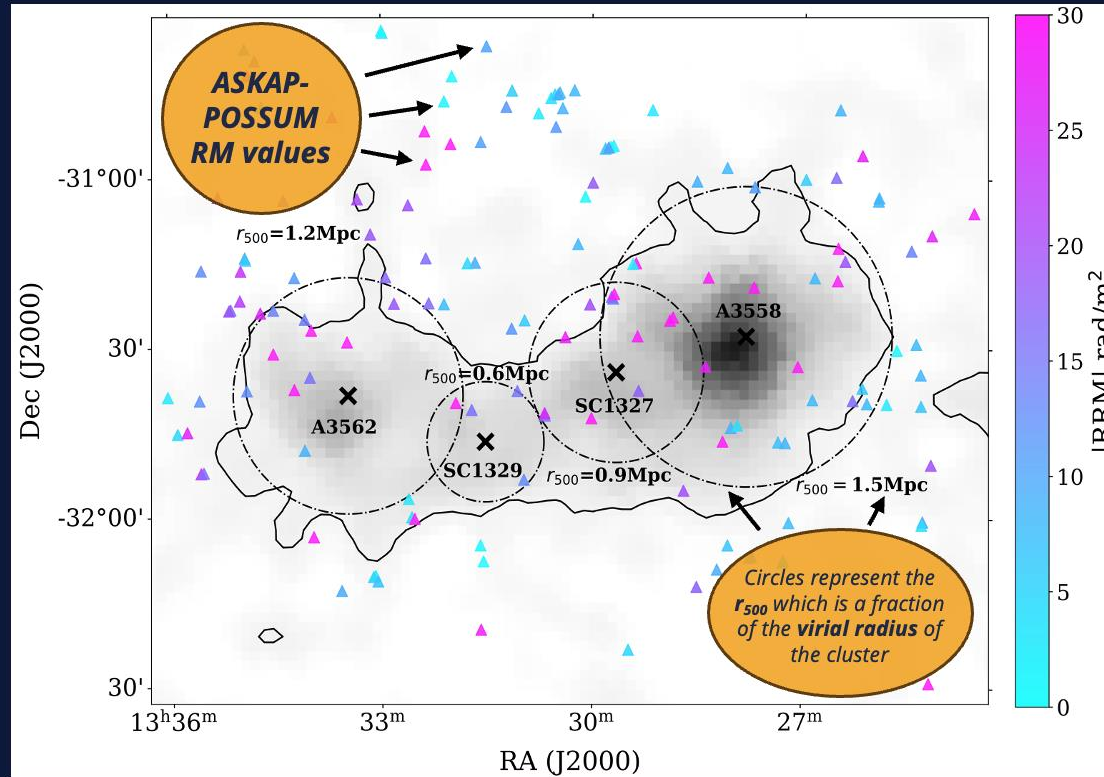
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SHAPLEY SUPERCLUSTER CORE: Abell 3558 & Abell 3562 clusters + SC 1327 & SC 1329 groups



ASKAP radio-interferometer



800-1440 MHz

$$RM = \frac{e^3}{2\pi m_e^2 c^4} \int n_e(l) B_{\parallel}(l) dl$$

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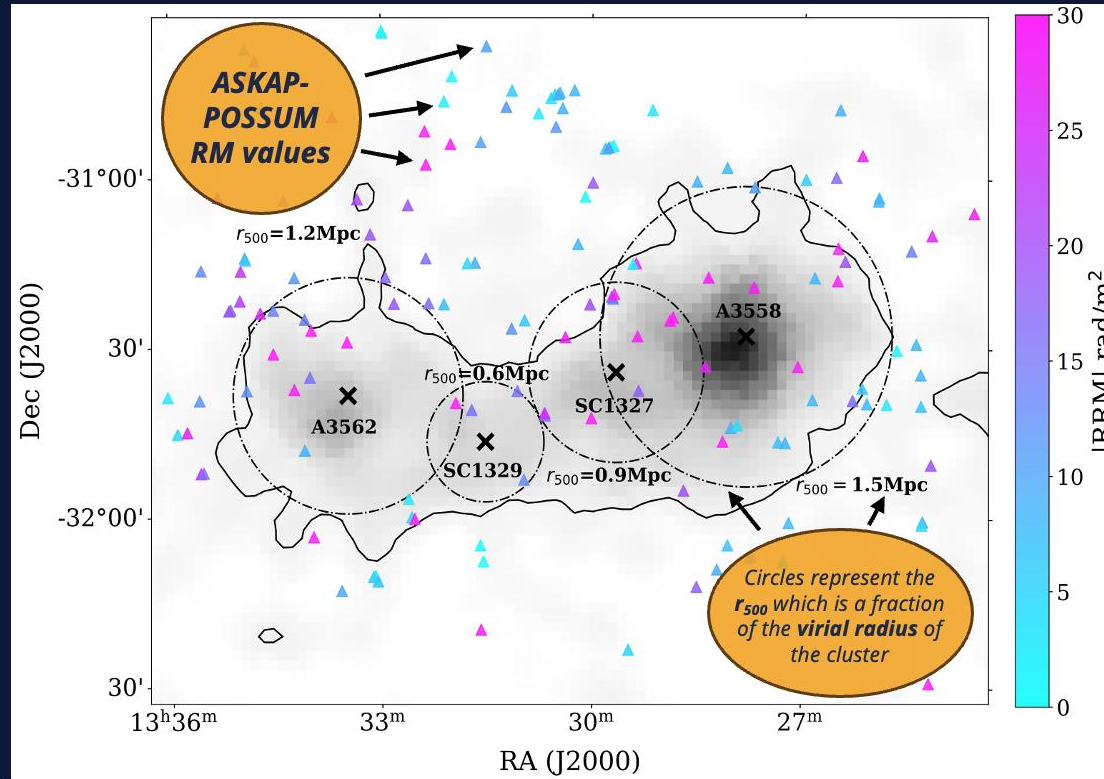
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High statistically significant **first detection** of **magnetised gas** in the SSC



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$$\sigma_{RM}^{SSC} = 30.52 \pm 4.55 \text{ rad/m}^2$$

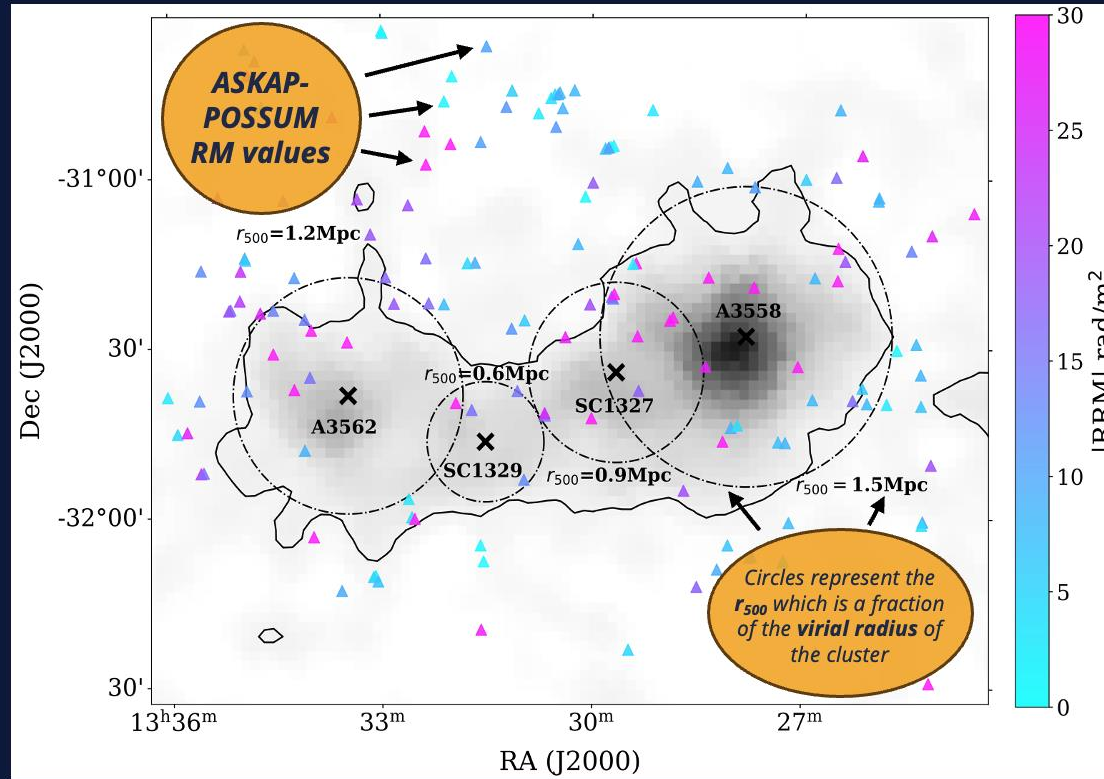
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...but, what are the **properties** of the **B field**? i.e., **amplification mechanism**?

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1 year later...

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...why?

- i. 40 times more data than previous RM studies in Galaxy clusters
- ii. 10 times better RM precision
- iii. Cosmological MHD simulations → best up-to-date modeling of RMs in clusters
- iv. Bayesian model selection

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Accepted in A&A since 17 November 2025 (1 month old!): [10.48550/arXiv.2511.14377](https://arxiv.org/abs/10.48550/arXiv.2511.14377)

Magnetic fields in the Shapley Supercluster core with POSSUM: Challenging model predictions

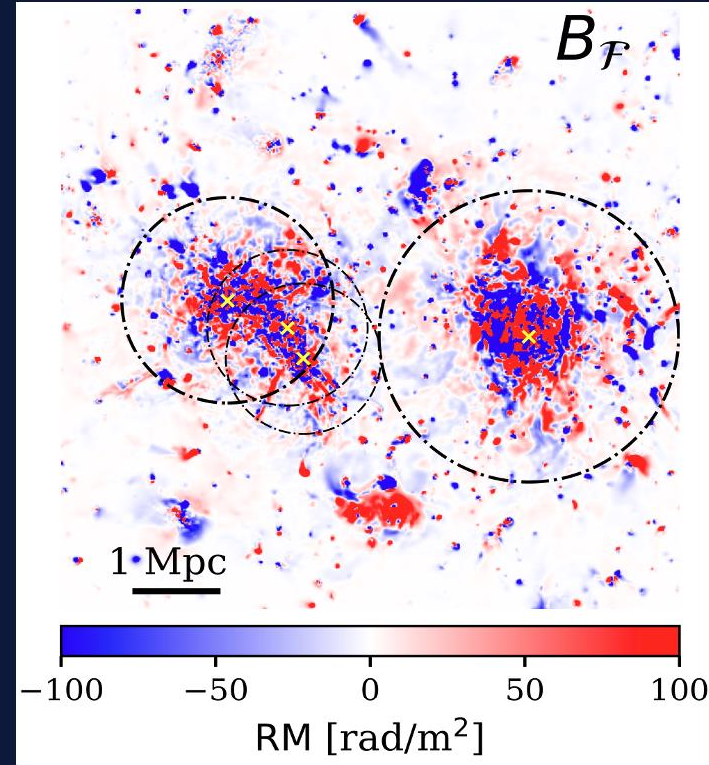
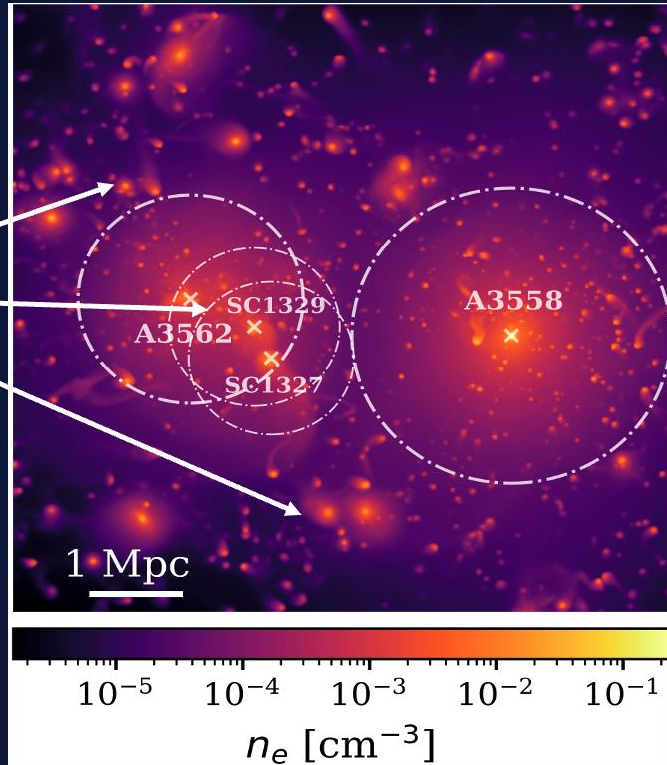
D. Alonso-López ¹, S. P. O’Sullivan ¹, A. Bonafede ^{2,3}, L. M. Böss ⁴, C. Stuardi ³, E. Osinga ⁵, C. S. Anderson ⁶, C. L. Van Eck ⁶, E. Carretti ³, J. L. West ⁷, T. Akahori⁸, K. Dolag^{9,10}, S. Giacintucci¹¹, A. Khadir ^{12,5}, Y. K. Ma ¹³, S. Malik ¹, N. McClure-Griffiths ⁶, L. Rudnick¹⁴, B. A. Seidel ⁹, S. Tiwari¹⁵, and T. Venturi³

Comparison with *SLOW* cosmological MHD simulations

Best modeling of RM in clusters up to date

Implementation of 6 different magnetic field amplification mechanisms

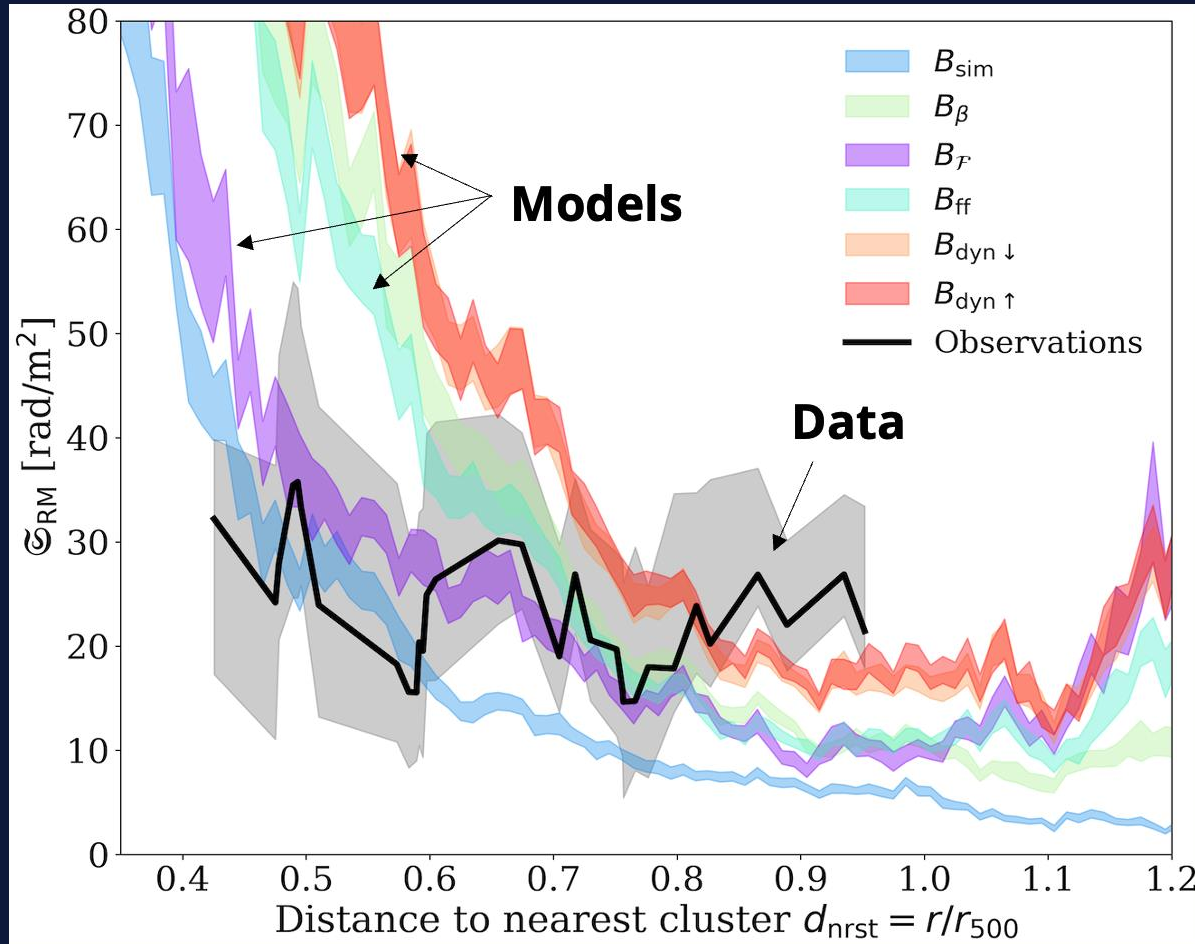
Outstanding level of *detail* in the ICM dynamics



RM maps for each model provide the best tool for comparison with observations

D. Alonso-López et al. 2025

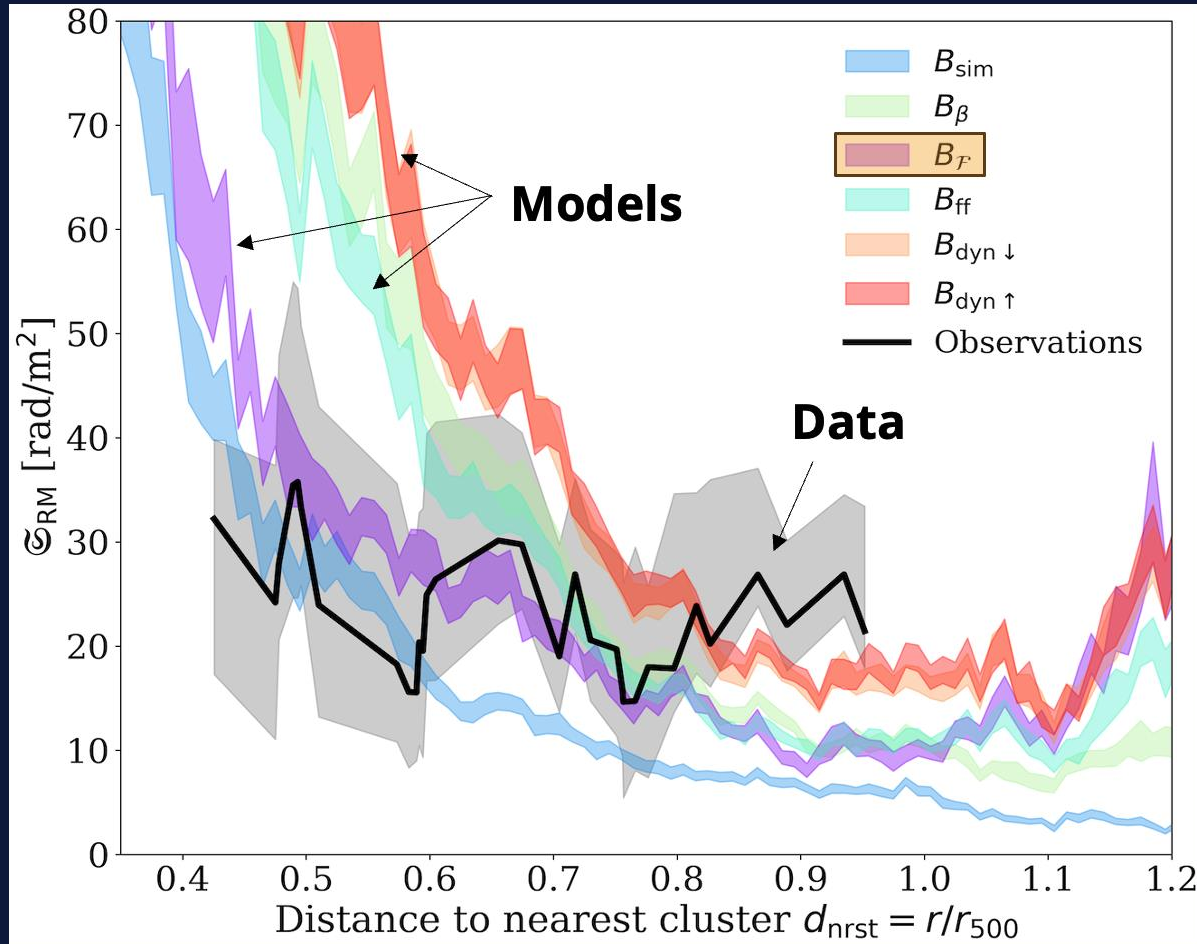
Magnetic fields beyond the core: **radial dependence**



How does the excess RM signal behave **beyond the center** of the clusters?

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Magnetic fields beyond the core: **radial dependence**



How does the excess **RM signal** behave **beyond the center** of the clusters?

Bayesian model selection analysis

Favors amplification by **turbulence** in the ICM

$$B_{\mathcal{F}} \propto n_e^{1/2} v_{\text{turb}}$$

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Conclusions

First detection of an excess RM signal from the SSC is consistent with **$\sim\mu\text{G}$ magnetic field strengths** $\leftrightarrow$ agreement with previous studies of other clusters of galaxies.

The **data favors models** in which magnetic field in the intercluster regions is **amplified by the turbulent pressure** of the ICM.

However, the **trend** of the SSC RM signal **with distance** to the clusters is **flatter** than current most accurate modelling

→ Observational bias? Better modelling?

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- PID2022-138621NB-I00, funded by MCIN/AEI/10.13039/501100011033/FEDER, EU



THANKS!!

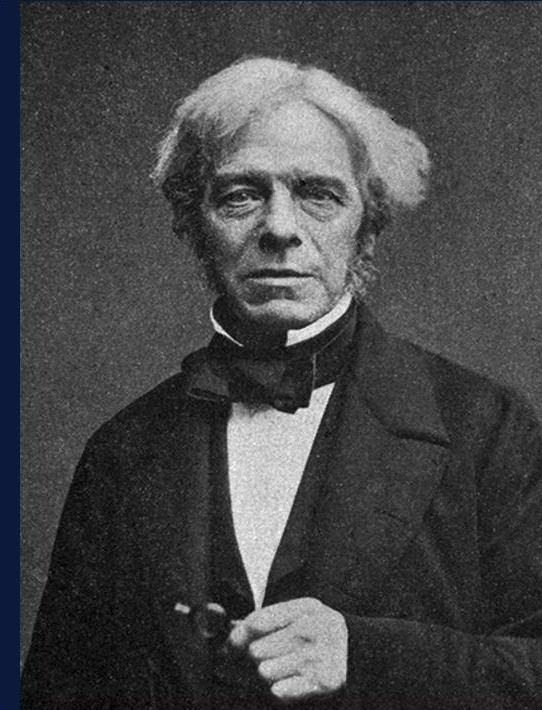
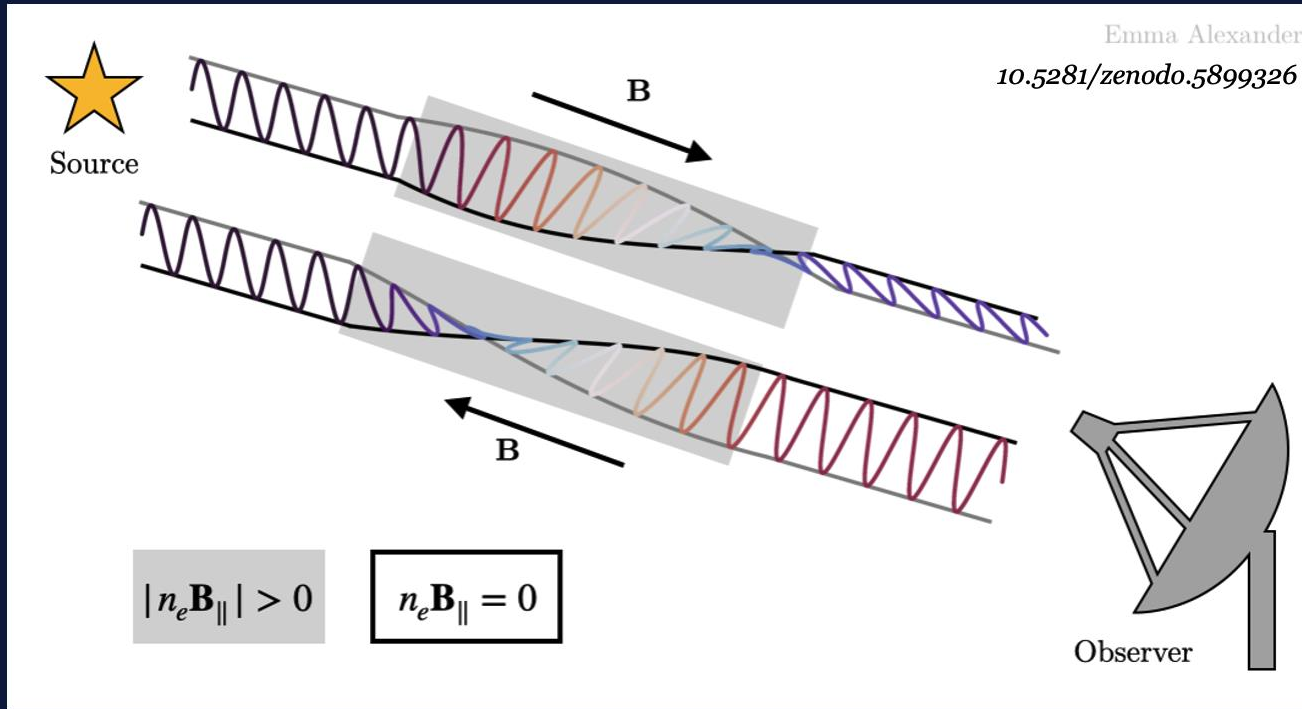


How do we measure them?

Faraday Rotation



Rotation Measures (RM)



Credit: CSIRO/Dragonfly Media

ASKAP radiotelescope

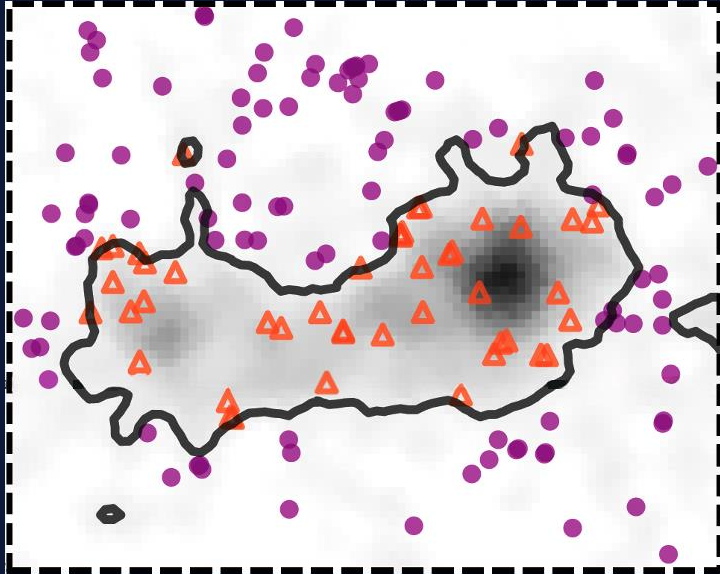


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Spain is a full member of the SKA!

Detecting the magnetic field in the SSC

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On-target RMs



Sightlines
through the
SSC



Off-target RMs



Sightlines
outside SSC



Higher RM
dispersion on
vs off?



$$\sigma_{\text{RM}}^{\text{SSC}} = 30.52 \pm 4.55 \text{ rad/m}^2$$



7 σ statistical
significance!



Yes! → First detection

Bayesian model selection

$$\mathcal{L}_k = \frac{1}{\sqrt{(2\pi)^N \prod_{i=1}^N \sigma_{\text{tot},i,k}^2}} \exp \left(-\frac{1}{2} \sum_{i=1}^N \frac{(\mathfrak{S}_{\text{RM},i}^k - \mathfrak{S}_{\text{RM},i}^{\text{Obs}})^2}{\sigma_{\text{tot},i,k}^2} \right)$$

Largest Bayesian Evidence → Best model $\ln \mathcal{L}_k$

Bayes Factors → Comparison between models $\mathcal{B}_{jk} = \mathcal{L}_j / \mathcal{L}_k$

Mechanism	$B_{\mathcal{F}}$	B_{sim}	B_{ff}	B_{β}	$B_{\text{dyn},\downarrow}$	$B_{\text{dyn},\uparrow}$
$\ln \mathcal{L}_k$	-116	-121	-176	-206	-266	-269
$\ln \mathcal{B}$	...	5.3	60	90	151	153
K&R	...	V. strong	V. strong	V. strong	V. strong	V. strong

Kass & Raftery (1995) scale