



Testing spin parity in galaxies, groups and clusters

Galaxy winding and projected group / cluster motions across the sky

Duho Kim | Department of Astronomy and Space Science, Chungnam National University | KAS 2026 Fall



1 Why study spin parity across scales?

Does the cosmos favour a handedness?

Compare clockwise and anticlockwise outward winding across the sky.



Clockwise (CW)



Anticlockwise (ACW)

Mirror symmetry predicts no ensemble preference. Image winding is a proxy for spin, not a direct rotation measurement.

Could early physics leave a trace?

Primordial chirality -> halo spins

Simulations show that an initial handed pattern can survive in later halo spins [1].

Rotating black-hole universe (BHU)

A speculative proposal links a rotating parent black hole to a preferred axis and possible spin-direction asymmetry [2].

Rotation or an axis alone does not prove parity violation. We do not test these specific models.

Standard LambdaCDM: no preferred hand

Tidal torques can align spins [3].

Alignment can preserve mirror symmetry.

Correlated spins are allowed.

With parity-symmetric initial conditions, no ensemble handedness preference is expected. A finite sample can still be imbalanced.

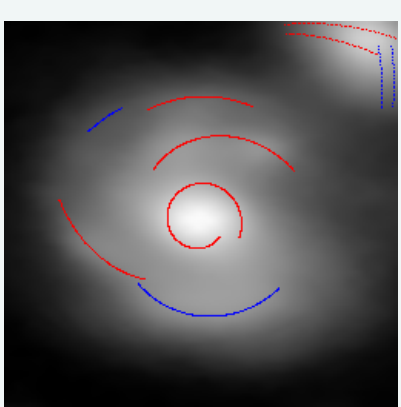
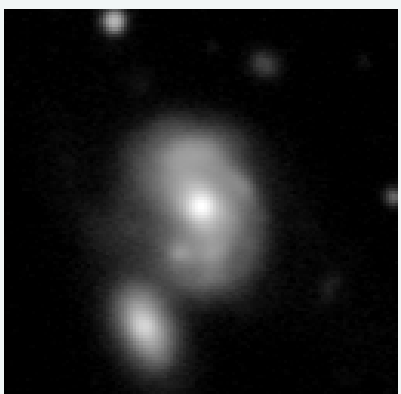
Theory: [1] Shim et al. (2025 revision), arXiv:2406.06080; [2] Poplawski (2025 revision), arXiv:1910.10819; [3] Lee & Pen (2001), ApJ 555, 106. Full references: QR.

2 Galaxy winding: dipole as the main directional test

Our galaxies: images and fitted arms

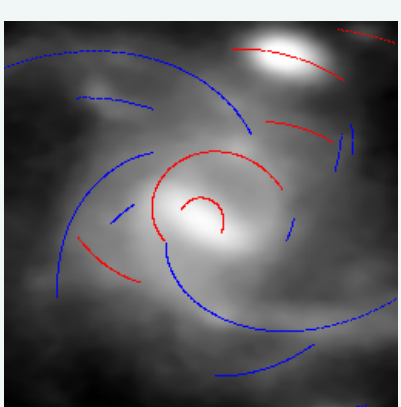
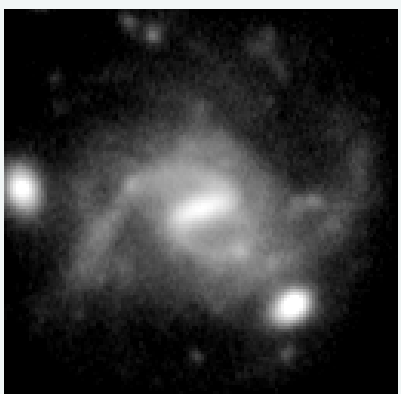
Brighter CW

r = 15.05



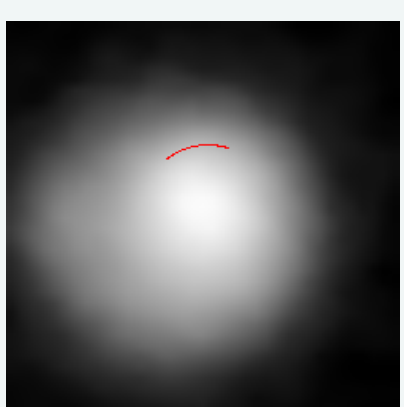
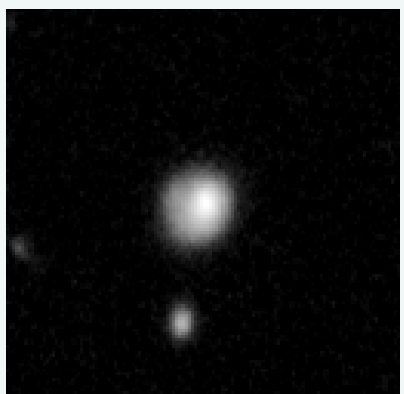
Brighter ACW

r = 15.96



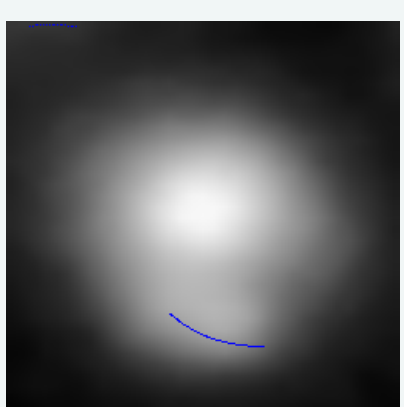
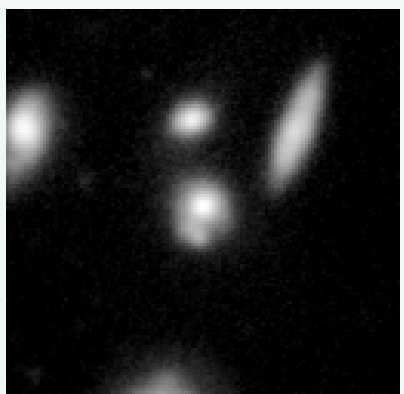
Fainter CW

r = 17.64



Fainter ACW

r = 17.69



Our input cutouts (top) and stored arm fits (bottom).

Development examples, not validation. Brighter ACW chosen for visible structure. Curves are stored fits, not proof of spin. Smaller r = brighter.

30,910 resolved / 49,211 images

CW: 15,479

ACW: 15,431

Observed imbalance +0.155%

A = (CW - ACW) / resolved; 18,301 unresolved

Selection: 46.7% of smallest vs 75.2% of largest resolve.

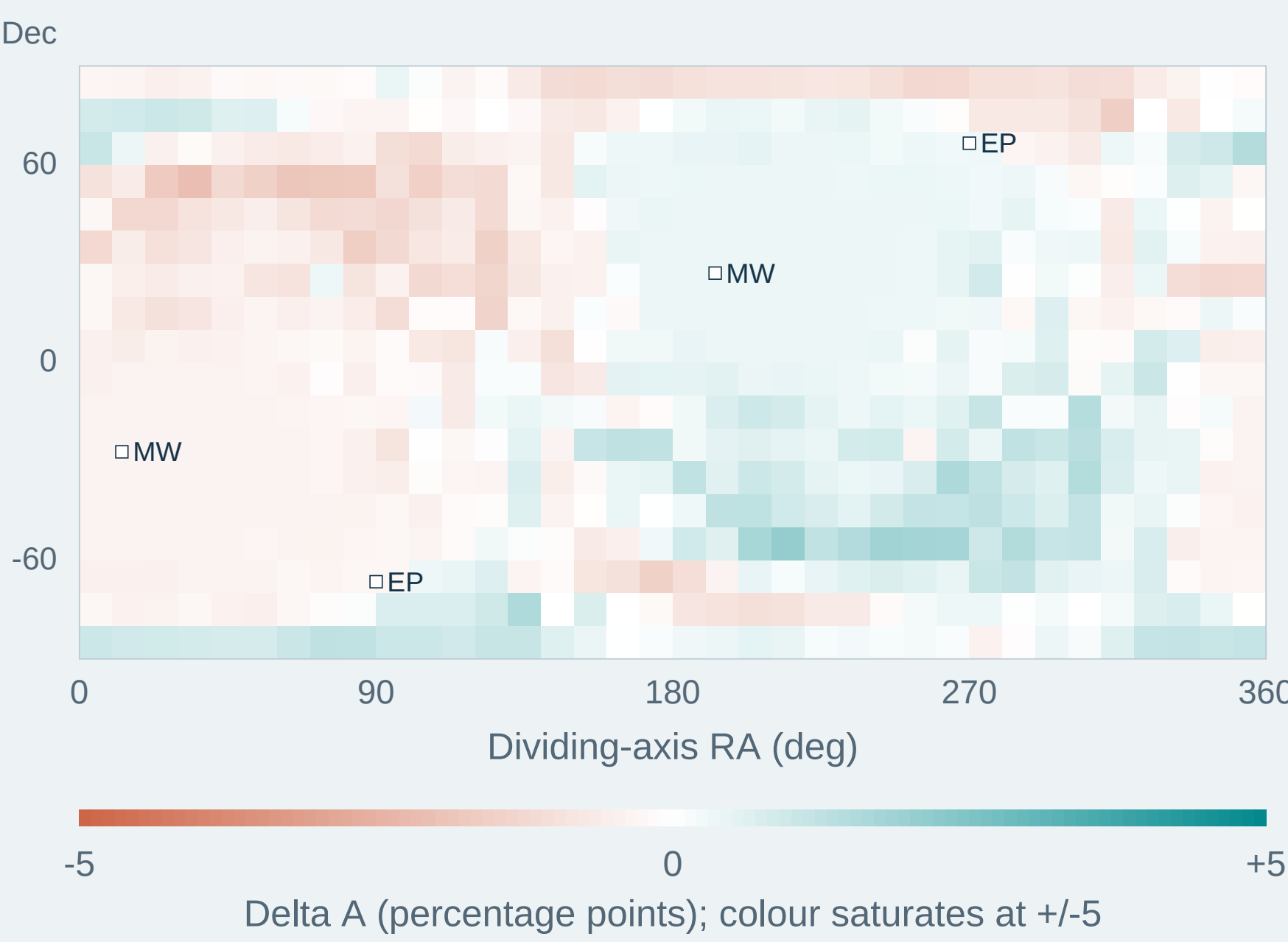
DESI: 7,905 positional matches; 4,920 also resolved.

DESI associations are provisional. Added dipole/quadrupole terms did not improve held-out prediction.

SpArcFiRe | 30,910 resolved

Stored spiral-arm fits; same 49,211 targets

Colour: imbalance toward the axis minus the opposite half.



CW 15,479 | ACW 15,431

Map cells: -2.1 to 2.1 pp (not a confidence range)

Historical dipole: 2.27%

Approx. 95% Wald: 0.00-7.79%

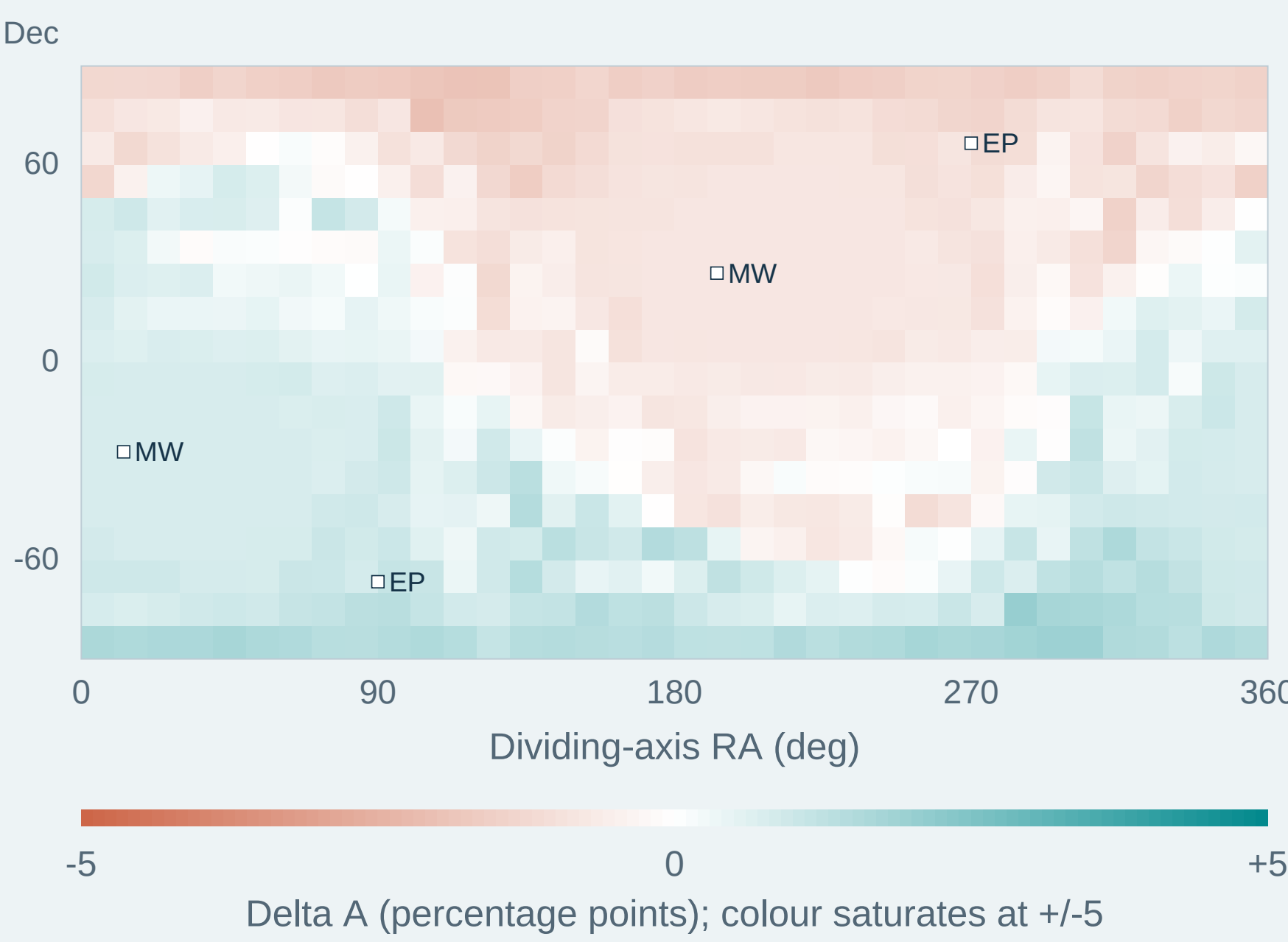
Conditional global shuffle p = 0.684

The map shows hemisphere contrast, not dipole amplitude. No preferred direction established.

Fourier | 49,007 assigned

Frozen image-pattern estimator; same targets

Colour: imbalance toward the axis minus the opposite half.



CW 24,644 | ACW 24,363

Map cells: -2.0 to 2.0 pp (not a confidence range)

Full dipole: 1.65% [0.00-6.03%]

Shared sample: 2.16% [0.00-7.68%]

Approx. 95% Wald envelopes; shared n = 30,910.

Four new tests: Bonferroni p = 1.0 each

Conditional shuffles; classification and selection biases remain. No population calibration transfer.

Shared sample: 30,910 galaxies; 18,791 labels agree. Maps above use each method's full resolved/assigned set and one display orientation. SpArcFiRe GZ/CzSL: -0.06% [-4.44%, +4.32%], assuming transferable shared class errors and equal CW/ACW resolution. Cohort-specific errors: [-19.07%, +11.10%] under a different model and joint confidence construction. Calibration details: QR.

3 Groups and clusters: exploratory motion patterns

How we measure projected motion

1 Regression

Fit member line-of-sight velocity versus position angle using a sine and cosine.

Velocities -> angular fit -> direction

2 Half-plane

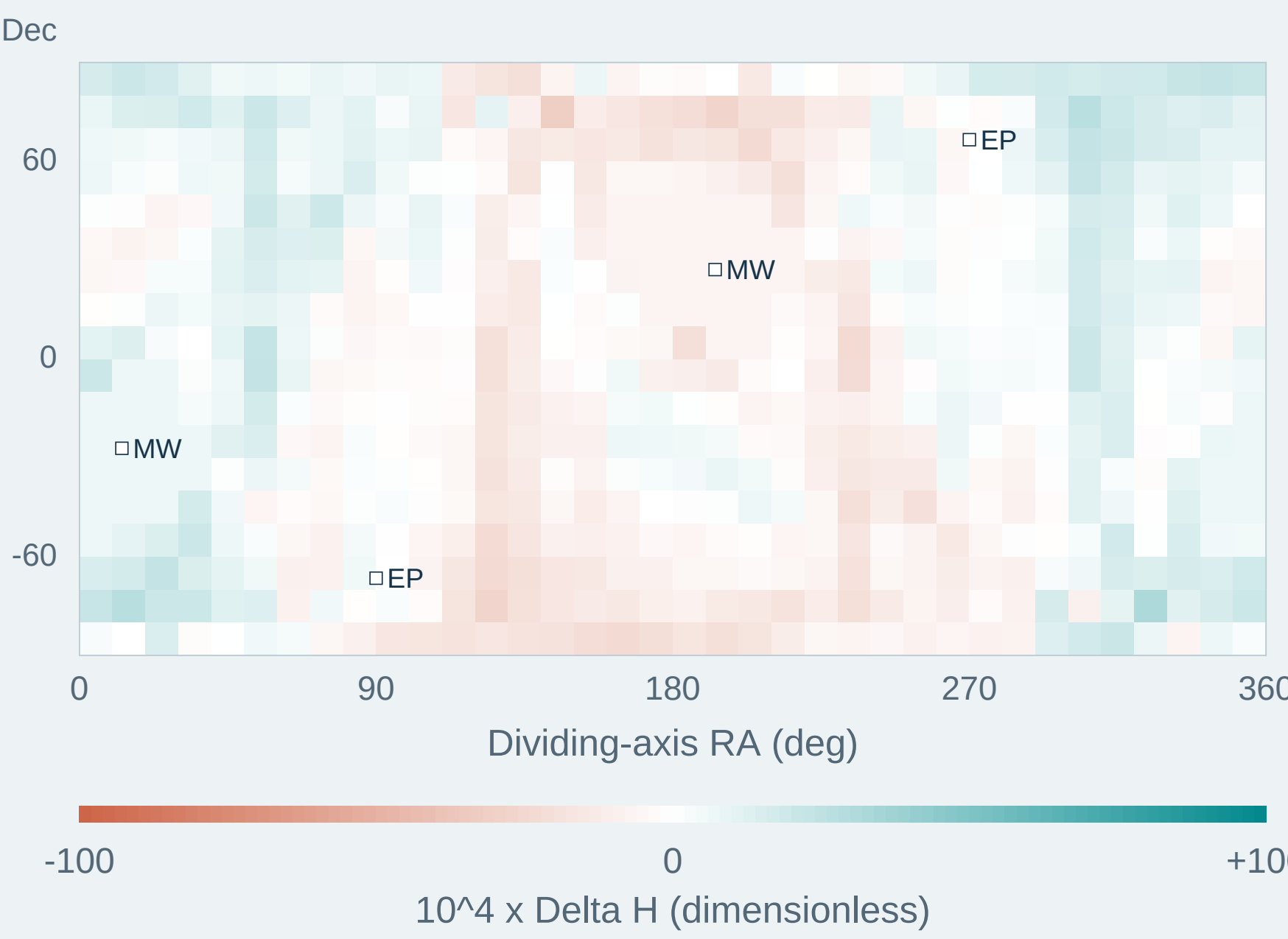
Rotate a dividing line; compare the two mean velocities and extract the first harmonic.

Two halves -> contrast -> direction

Exploratory H: fitted directions have equal weight. H is a dimensionless pair-handedness statistic. Map: $10^4 \times [H(\text{toward}) - H(\text{opposite})]$. Not speed, CW/ACW %, or % of rotating systems. Significance / measurement uncertainty: not evaluated for the displayed 1,722 systems.

1 Regression

1,713 groups + 9 clusters after screening



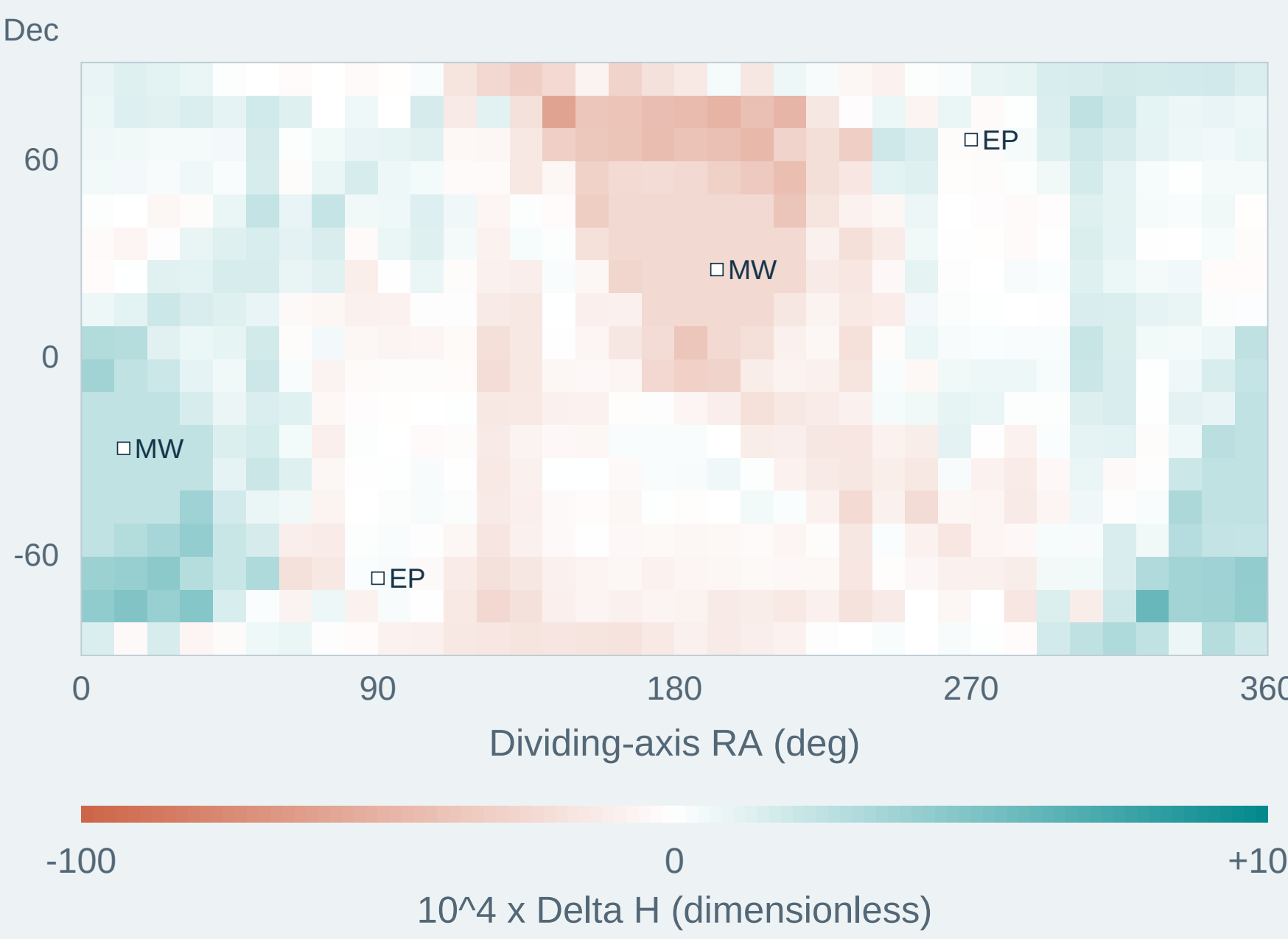
All-system $10^4 H = +0.674$

Leave-one range: +0.023 to +1.319

Sensitivity, not a confidence interval.

2 Half-plane

1,713 groups + 9 clusters after screening



All-system $10^4 H = +0.211$

Leave-one range: -0.416 to +0.839

Sensitivity, not a confidence interval.

Take away

- Galaxy spin imbalance depends on method, including in a separate comparison of the same 30,910 galaxies.
- Neither galaxy method establishes a statistically significant preferred sky direction.
- The full fitted-group sample has negative H; the displayed screened groups + clusters have positive H. Omitting one system can reverse the half-plane sign.
- The maps show hemisphere contrast across axis choices; opposite axes reverse sign by construction.

Original idea and supervision: Duho Kim.
Implementation, analysis, validation, figures and writing: Codex, with other AI models.
Research details and references: nebulamind.net/studies/spin-parity-2026.html

Duho Kim | KAS 2026 Fall | v68, 11 Oct 2026 | Sample scope and calibration assumptions clarified; audit details via QR.



Research details
NebulaMind