



Testing spin parity in galaxies, groups and clusters

Galaxy winding and projected group / cluster motions across the sky

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1 Why study spin parity across scales?

Spin and image handedness

Spin = actual physical rotation.

Handedness = how spiral arms wind outward in an image.



Clockwise (CW)



Anticlockwise (ACW)

Our images measure winding. Inferring rotation needs assumptions about the arms and viewing geometry.

What does mirror symmetry mean?

A pattern and its mirror-reversed version are equally likely. Parity violation would break this.



Original pattern



Mirror counterpart

A population rule: individual galaxies need not look symmetric, and a finite sample need not be exactly 50:50.

Alignment can preserve mirror symmetry

Gravity can correlate spin directions [3].

Correlation need not favour either handedness.

Standard LambdaCDM allows this.

Primordial chirality [1] and a rotating black-hole universe [2] motivate alternatives. We test winding and projected motions, not those specific models.

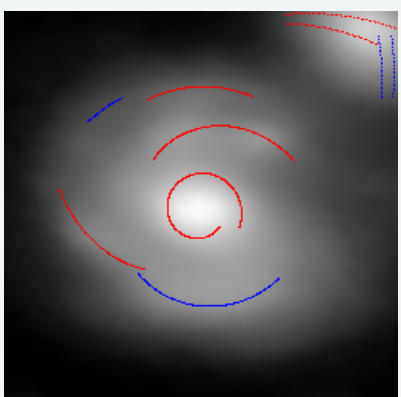
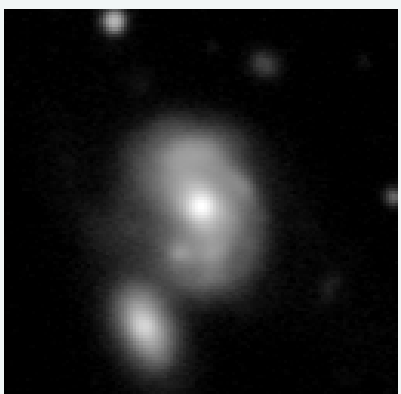
Theory: [1] Shim et al. (2025 revision), arXiv:2406.06080; [2] Poplawski (2025 revision), arXiv:1910.10819; [3] Lee & Pen (2001), ApJ 555, 106. Full references: QR.

2 Galaxy winding: dipole as the main directional test

Our galaxies: images and fitted arms

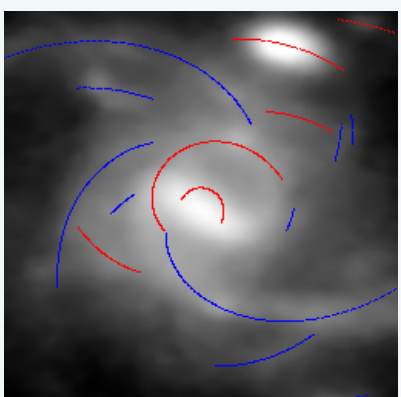
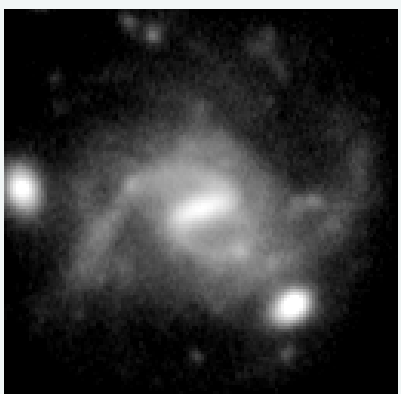
Brighter CW

r = 15.05



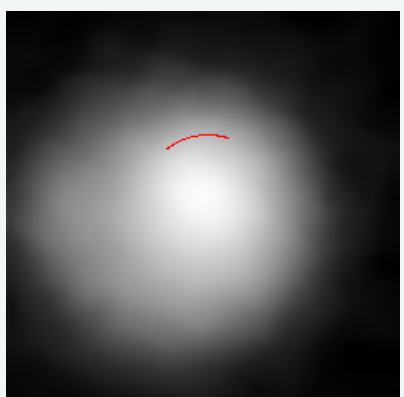
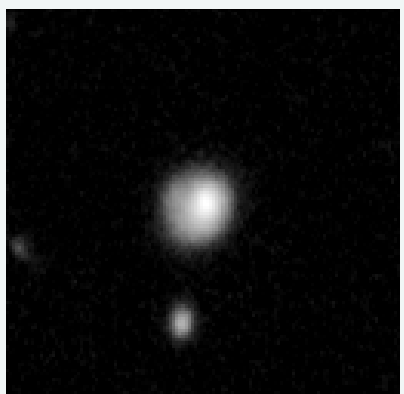
Brighter ACW

r = 15.96



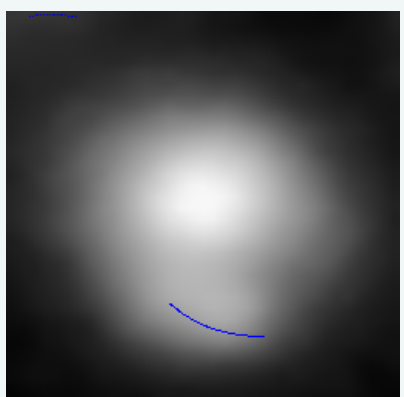
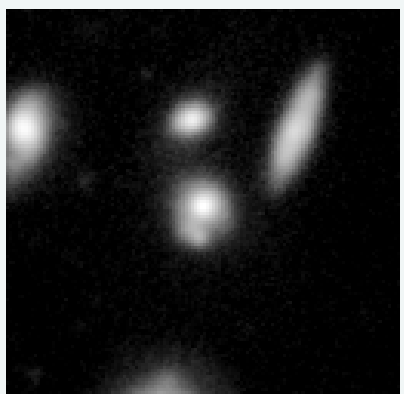
Fainter CW

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%

$A = (CW - ACW) / \text{resolved}$; 18,301 unresolved

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

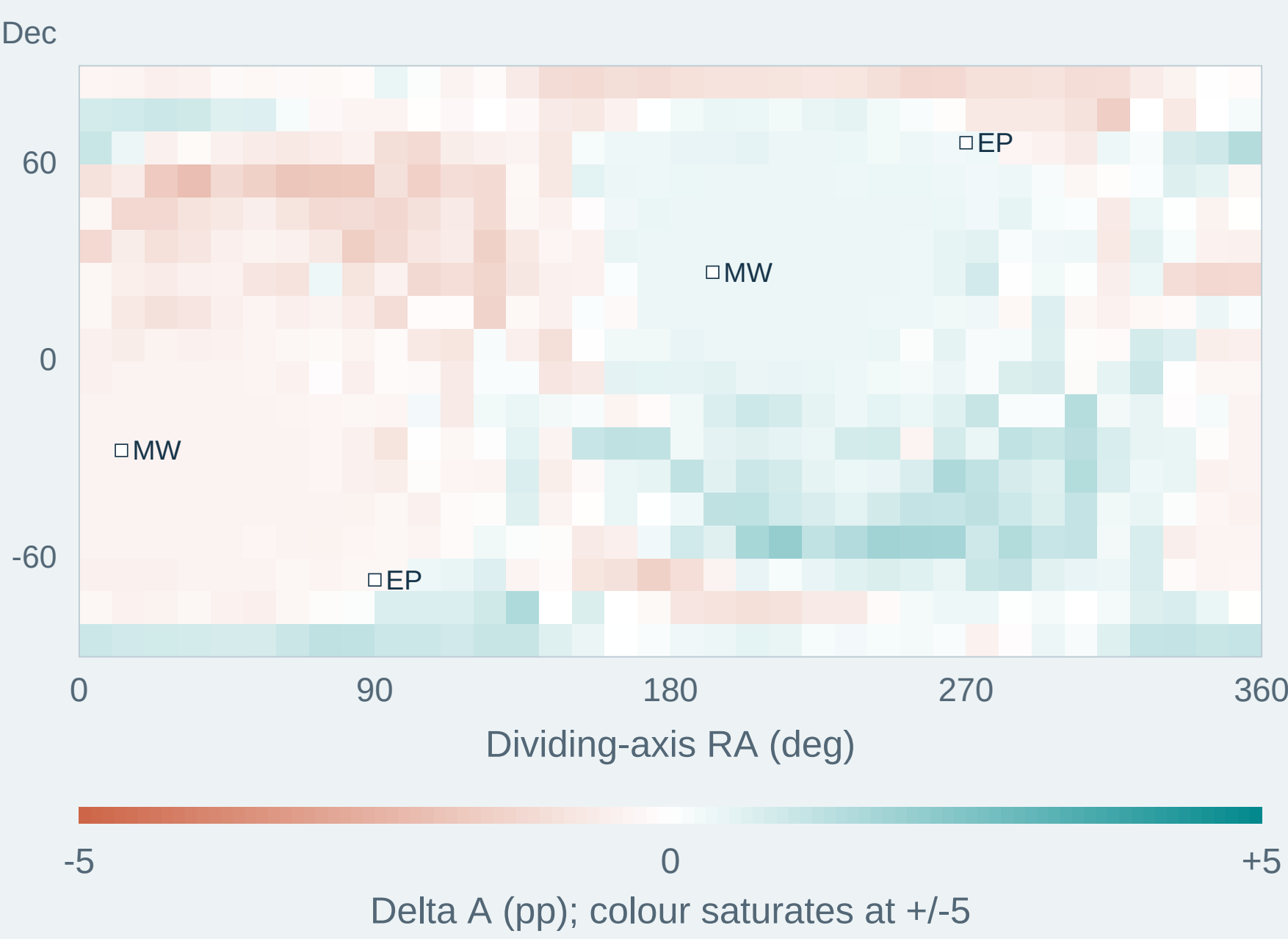
DESI: 7,905 positional matches; 4,920 also resolved.

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%

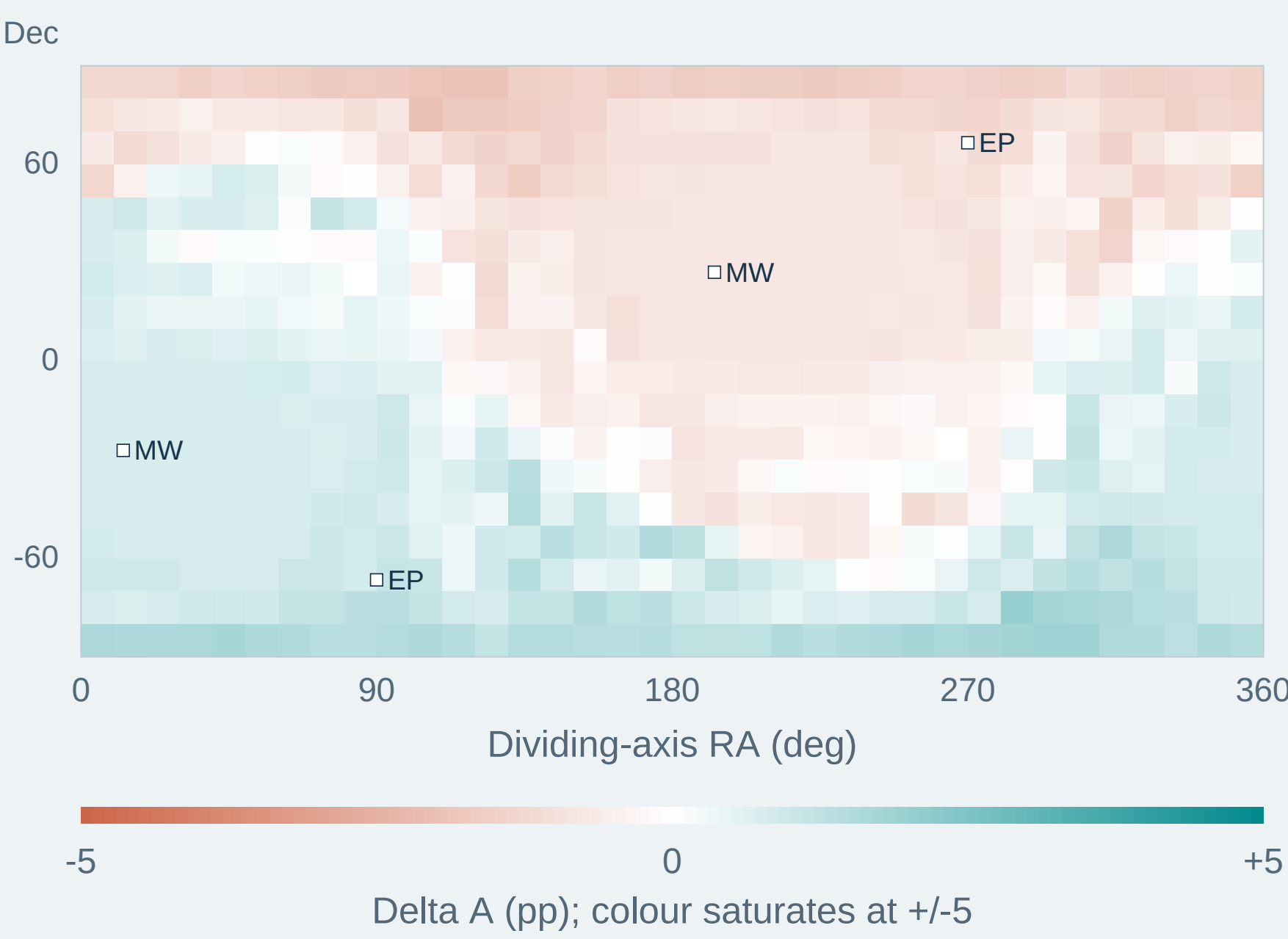
Conditional global shuffle p = 0.684

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.

Two algorithms, one 49,211-target inventory; resolved sets differ. CW/ACW share one display orientation. Maps are observed contrasts, not detections. Both resolve 30,910 (18,791 agree). SpArcFiRe GZ/CzSL: -0.06% [-4.44%, +4.32%], assuming shared errors. Cohort differences: [-19.07%, +11.10%].

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.

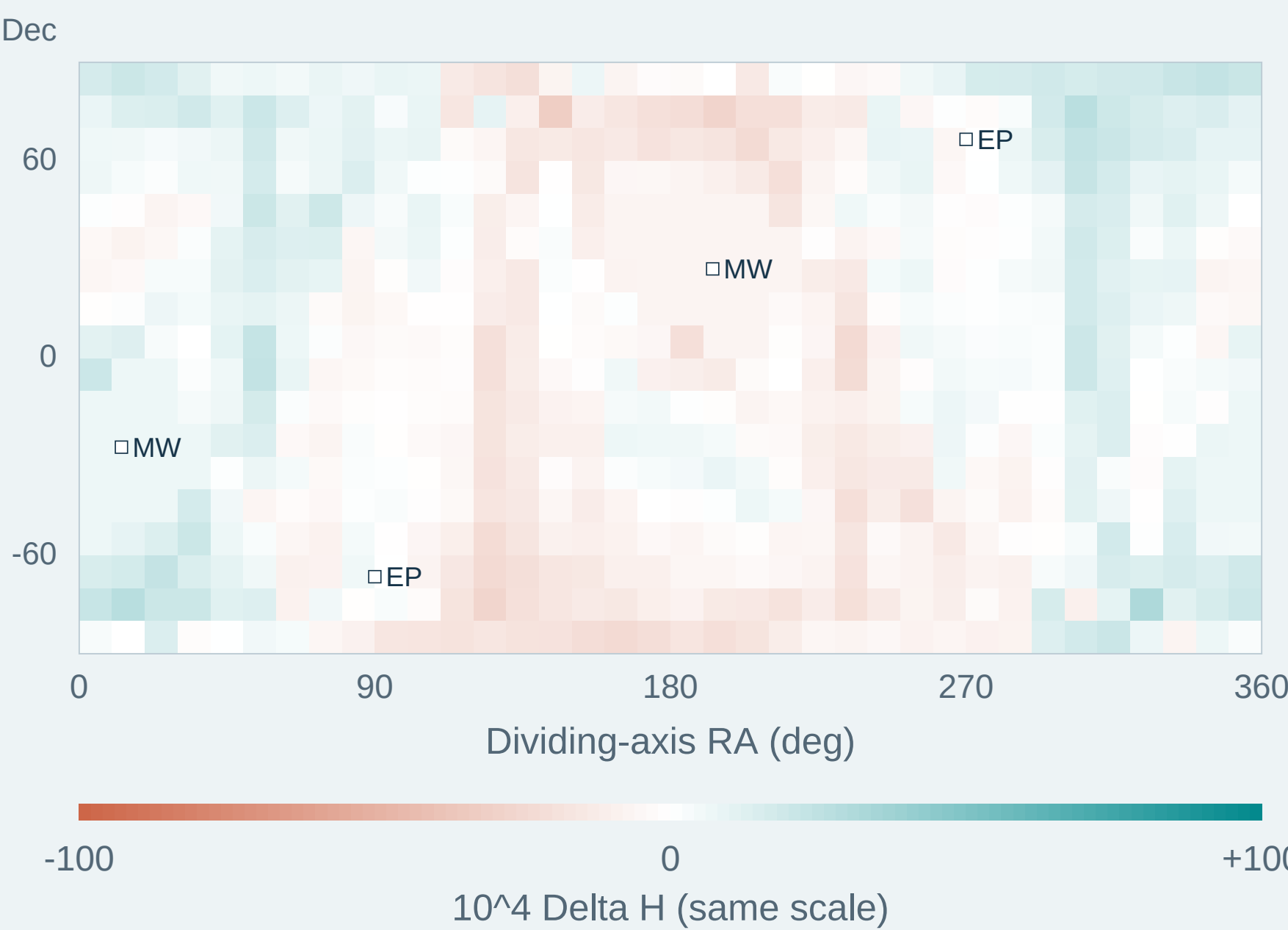
Two halves -> contrast -> direction

H summarizes pair handedness of projected directions. Map colour is H(toward) - H(opposite).

H is dimensionless, not speed or CW/ACW %.

1 Regression

1,713 groups + 9 clusters after screening



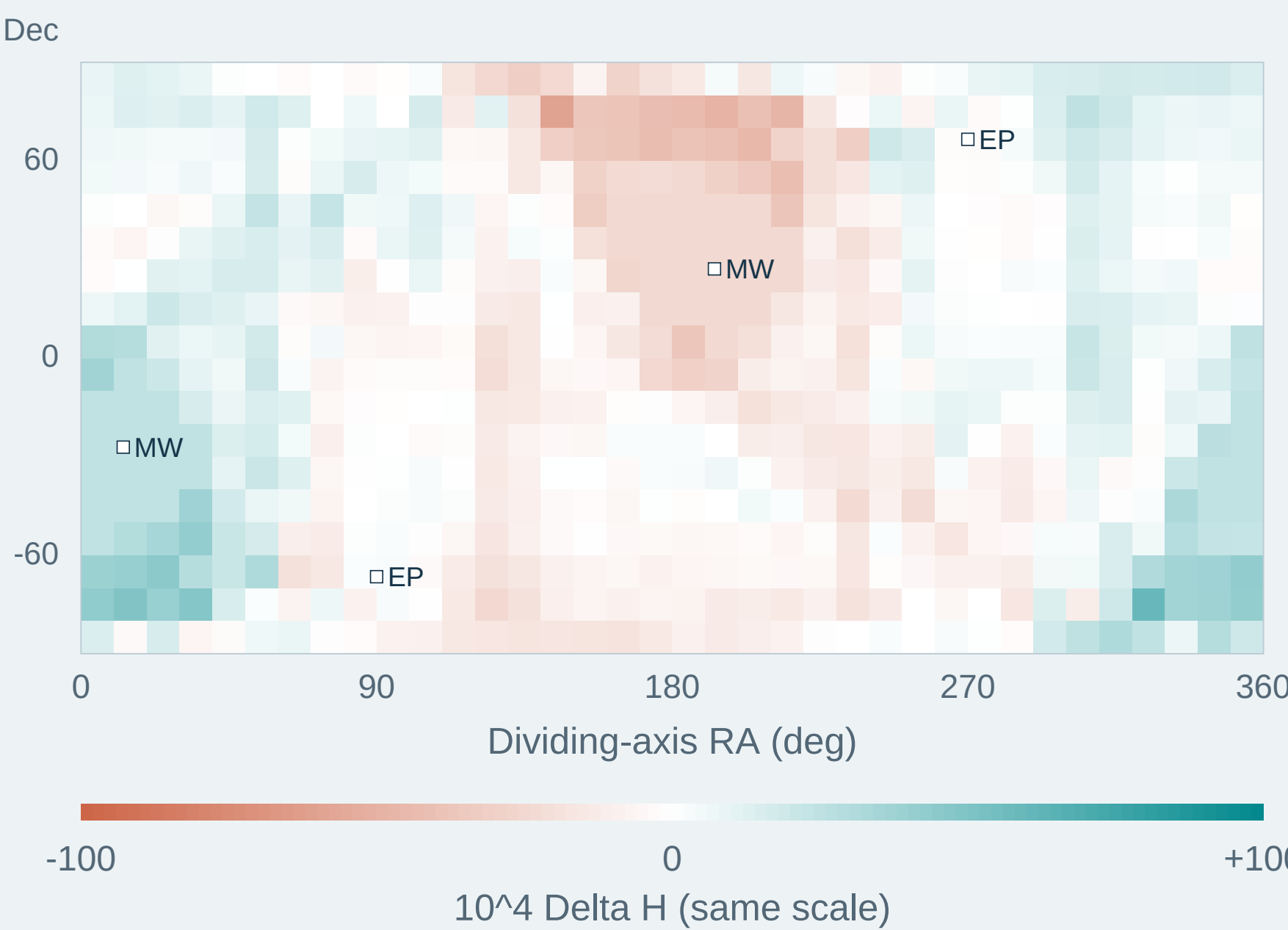
All-system 10^4 H = +0.674

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

No statistically significant directional winding pattern: all four new Fourier tests have Bonferroni p = 1.0.

The maps still show how observed imbalance changes with the choice of sky-dividing axis.

Reference calibration is sample-dependent. Overlapping targets and methods are not independent evidence.

Groups / clusters: descriptive motion patterns; no new global test or confirmed physical spin.



Research details

NebulaMind

Research details and references: nebulamind.net/studies/spin-parity-2026.html

Duho Kim | KAS 2026 Fall | v59, 10 Oct 2026 | Physical spin, image handedness and mirror symmetry explained; measurements unchanged.