PAPER CHECK · EXOPLANETS

Simulated stellar storms flip the field around weakly magnetized planets, but no telescope can see it yet

A 2026 simulation study hit Earth-like planets with a stellar storm whose field opposed the wind before it. Near planets with no magnetic field or a weak one, the field reversed; at Earth's strength and above it held [1 p. 1]. That contrast is real in the model, but it isn't yet a test anyone can run with a telescope.

By Fact-Checked Science · Published October 19, 2026

OUR ANALYSIS marks our own reasoning and calculations, and the verdicts are our assessment. Everything else comes from the numbered sources.

A clear result in the model, not yet a way to detect a planet's field

OUR ASSESSMENT

2 of 4

field strengths flip when the storm's field opposes the wind: none, and a tenth of Earth's [1 p. 6]

≈ 2.1 R_p

where we estimate the weak-field planet's boundary sits during the storm, inside the 2.8 R_p probe; our analysis

0

remote signals modelled: the reversal is read inside the simulation, not by anything a telescope could see [1 p. 13]

THE PAPER'S CLAIMS

TRUE

A storm whose field opposes the wind flips the field near planets with no or weak magnetism; Earth-strength fields hold

Gupta, Roy and Nandy 2026 [1 p. 6]

The paper's Fig. 2(b) shows it 2.8 planet radii out: the field turns south with no field of its own and with a tenth of Earth's, and stays north at one and two times Earth's [1 p. 7]. Finer-grid runs with no field, a tenth and twice Earth's field show the same [1 p. 15]. For the weak field the flip is probably local, not global. See section 3.

TRUE

In the model, a magnetized planet loses more atmosphere when the storm's field opposes its own

Gupta, Roy and Nandy 2026 [1 p. 1][1 p. 10]

Once the first surge has passed, a southward storm keeps a weakly magnetized planet losing atmosphere about twice as fast as one with no field, and a northward storm keeps it below that rate; without a field the orientation barely matters [1 p. 11]. The authors warn their plasma atmosphere "may overestimate" loss and aim only at qualitative behaviour [1 p. 4]. See section 4.

UNCONFIRMED

"may provide a potential diagnostic for detecting and characterizing exoplanetary magnetic fields"

The paper's abstract [1 p. 1]

The contrast is real in the model, but no radio or other remote signal is computed, the field direction of other stars' storms "remains essentially unconstrained", and where the flip stops depends on the storm's strength [1 p. 1][1 p. 8]. For now it is a potential diagnostic, as the authors say. See sections 5 and 6.

UNSUPPORTED

"it remains inside the planetary magnetosphere ... across all of the simulations, including during periods of maximum CME-induced compression"

The paper, on the 2.8 R_p probe [1 p. 6]

No boundary positions are shown. Simple pressure balance with the paper's own storm puts the weak-field planet's boundary near 2.1 planet radii, inside the probe, and in Fig. 2(b) its field there almost matches the no-field run. See section 6.

1 · THE EXPERIMENT

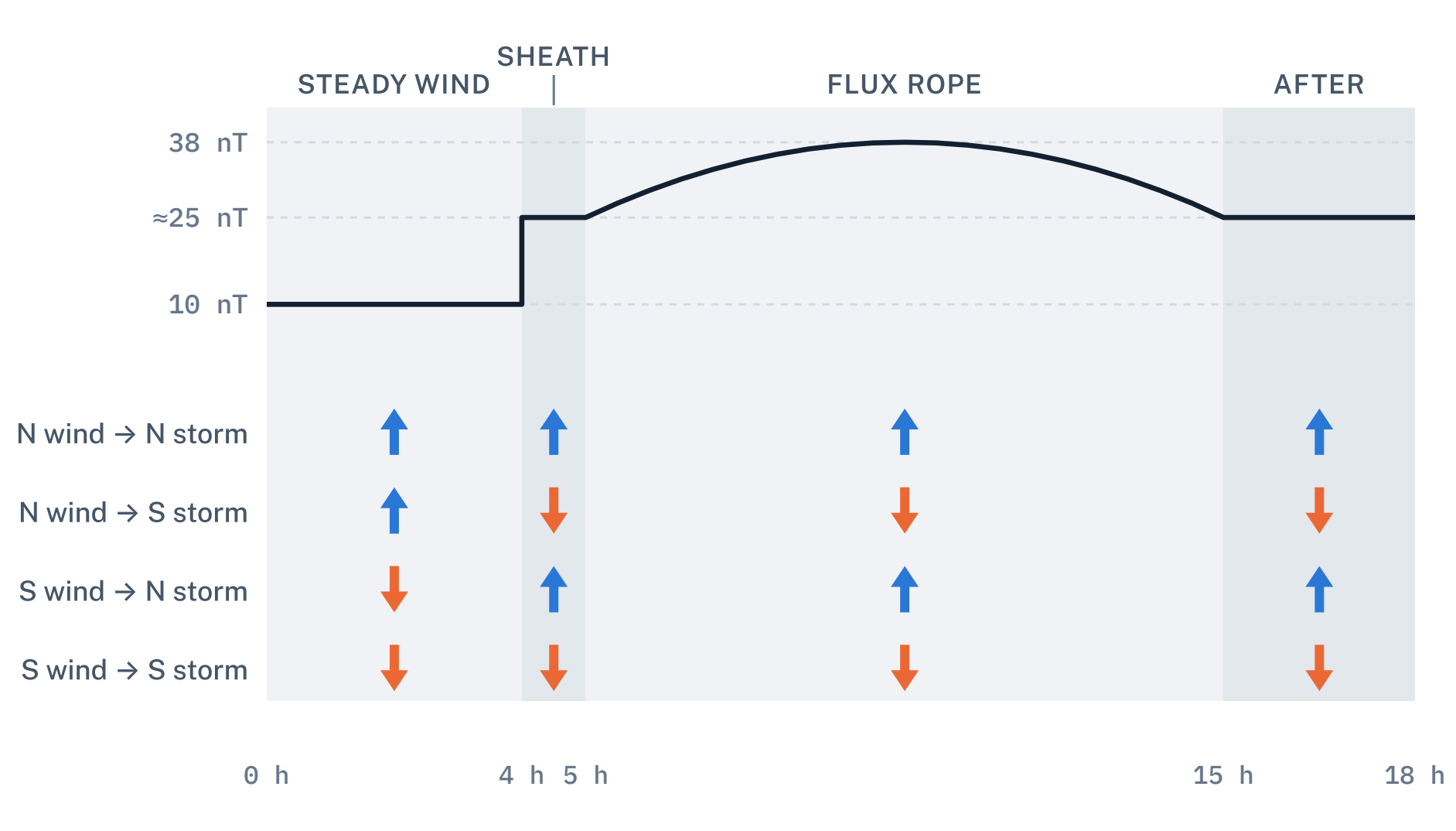
One planet, four field strengths, four storms

The authors used 3D magnetohydrodynamic simulations to hit an Earth-like planet, with no magnetic field or with 0.1, 1 or 2 times Earth's, with a coronal mass ejection whose field points either with or against the steady stellar wind before it [1 p. 1][1 p. 5].

Model setup

- **Planet:** Earth's mass and radius, its dipole tilted 11°, placed far out from its star [1 p. 3][1 p. 4].
- **Field strengths:** none, 0.1, 1 and 2 times Earth's surface equatorial field (3.1×10^4 nT) in the main runs, plus 0.3 and 0.5 in an appendix [1 p. 5][1 p. 16].
- **Steady wind:** 10 nT, pointing north or south, at 350 km/s in the text but 400 km/s in the parameter table [1 p. 4].
- **Storm:** a shock and sheath, then a Gold–Hoyle flux rope at 1,000 km/s whose field peaks at 38 nT; afterwards the field stays at about 25 nT, still pointing the storm's way [1 p. 4][1 p. 5].
- **Physics:** resistive MHD with CESSI-STORMI, built on the PLUTO code, with the same total field strength in every case so that only the orientation differs [1 p. 3][1 p. 5].
- **Atmosphere:** a conducting plasma out to 3 planet radii. The authors say it "may overestimate the atmospheric mass-loss rate" and that they aim at the "qualitative" response [1 p. 4].

What the planet meets



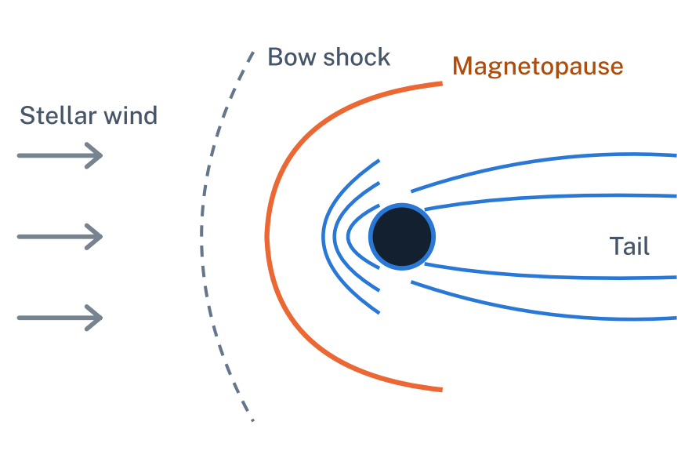
Schematic after the paper's Fig. 1, not to scale in height: the field's strength over 18 hours and its north–south direction in each of the four sequences [1 p. 5]. The two same-direction sequences are the controls; in the two flipped ones the planet's own field either matters or doesn't [1 p. 6]. Adapted from Gupta, Roy and Nandy (2026), *ApJ* 1009, 62, CC BY 4.0.

2 · TWO KINDS OF MAGNETOSPHERE

A field of the planet's own, or one borrowed from its star

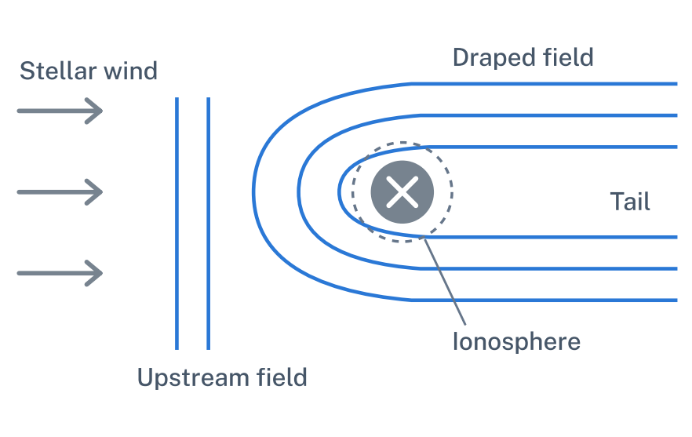
Earth's magnetic bubble comes from a field generated inside it. Venus and Mars have no such field, and the stellar wind's own field wraps around their upper atmospheres instead [1 p. 2].

Intrinsic: set by the planet



Storms compress the boundary and drive reconnection at its edges, but "the overall magnetic topology remains stable"; Earth is the example [1 p. 6]. Schematic.

Induced: set by the star

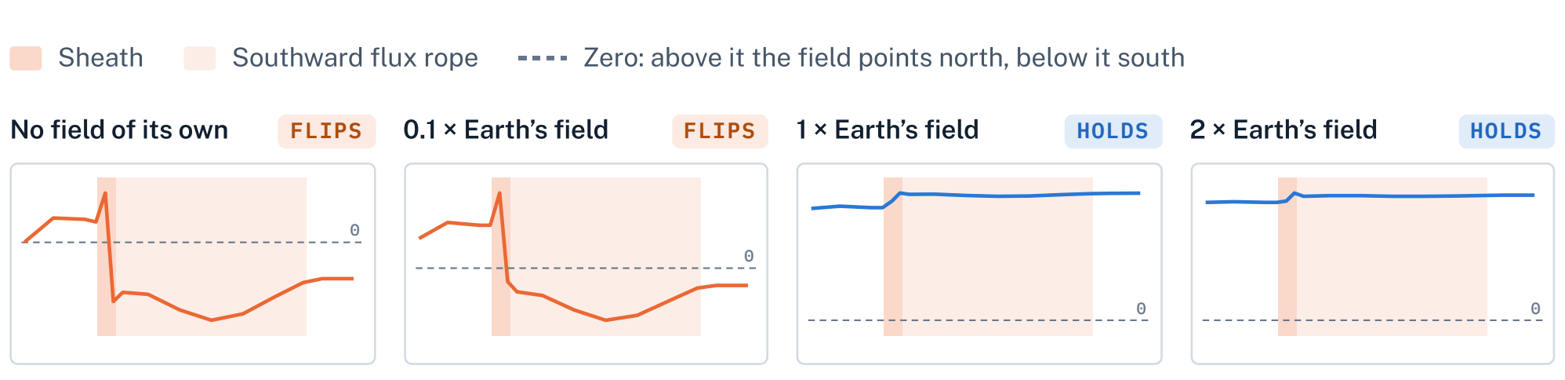


The stellar field drapes over the ionosphere, and when it reverses "the induced magnetosphere rapidly reconfigures, resulting in a global polarity reversal"; Venus and Mars are the examples [1 p. 2][1 p. 6]. Schematic.

3 · WHO FLIPS

Without a strong field, the field near the planet turns with the storm

The paper reads the north–south field 2.8 planet radii out on the side facing the star. With a northward wind followed by a southward storm, it turns south for the planets with no field or a tenth of Earth's, and stays north for the others [1 p. 6][1 p. 7].



North–south field 2.8 planet radii out over 18 hours, read from the paper's Fig. 2(b) at 15 times, so the lines are approximate; each panel has its own scale [1 p. 7]. The weak-field runs stay south after the storm, which we put down to the field afterwards keeping the storm's direction, and the strong-field runs end slightly higher than they began. Adapted from Gupta, Roy and Nandy (2026), *ApJ* 1009, 62, CC BY 4.0.

No field, or a weak one

With no field, after "a brief duration" of reconnection, "the imposed magnetosphere reconfigures and reverses, aligning with the external stellar CME magnetic-field orientation", and the same happens with a southward wind followed by a northward storm [1 p. 6]. With a weak field, "the stellar wind or a CME magnetic field can still induce polarity reversals" [1 p. 6]. The abstract calls this "global polarity reversals" for both [1 p. 1]; section 6 explains why for the weak field it is probably local.

Earth-strength and stronger

The magnetosphere is compressed and reconnects locally, but a strongly magnetized planet "maintains its intrinsic polarity for all cases" [1 p. 6]. The switch between the two behaviours "does not appear to occur at a single threshold" but over a range of field strengths set by how strong the storm is against the planet's own field [1 p. 8].

4 · TAIL CURRENTS AND ESCAPE

Two more differences: the tail's current and the atmosphere's loss

The model also tracks the electric current in the planet's magnetic tail and how fast its plasma atmosphere escapes [1 p. 8][1 p. 10].

Tail current, no field of its own

Where the field reverses, the current 1.5–5 planet radii behind the planet stays lower than in the matching run without a reversal for the first hour or two, then catches up [1 p. 8]. The authors "speculate" that this explains the drop in heavy-ion flux in Venus's tail that Venus Express saw after reversals [1 p. 13][2].

Tail current, magnetized

The current is higher when a southward storm hits the northward planetary field than when the storm points north, which the authors attribute to "enhanced magnetic reconnection" on the side facing the star [1 p. 8].

Mass-loss rate through the storm, kilograms per second

RUN	PEAK, ABOUT 5½–6 HOURS IN	AFTER THE SURGE, 500–600 MIN	LATE IN THE STORM AND AFTER, 700–1,050 MIN
0.1 × Earth's field, southward storm	about 950	about 460–470	about 375–445
No field of its own, any orientation	about 990–1,030, the highest	about 235–245	about 220
0.1 × Earth's field, northward storm	about 860–950	about 160–200	about 130–200

Read from the paper's Fig. 4(A), to about ±10 kg/s, for the planets with no field and with a tenth of Earth's; the stronger fields are described but not shown [1 p. 10][1 p. 11]. Before the storm the weak-field runs were already losing more than the no-field ones, about 90–170 against about 20 kg/s.

OUR ANALYSIS

A field shields only some of the time

As the storm hits, the weak-field runs dip briefly; the paper says this happens "for all cases" [1 p. 10], but in its Fig. 4(A) the no-field runs only level off [1 p. 11]. Then compression and the reshaped field open the tail and the polar cusps to outflow, and loss surges in every run, highest without a field [1 p. 10]. After the surge, a southward storm keeps the weak-field planet losing about twice as fast as the no-field one, and a northward storm keeps it at two-thirds to four-fifths of that rate: the field shields only when it lines up with the storm's [1 p. 11]. The authors also report that "the mass-loss rate is higher for the planet with a stronger planetary magnetic field" in this plasma atmosphere [1 p. 10].

5 · WHY IT MATTERS

Why astronomers want a magnetic-field test

Whether a planet has a magnetic field bears on how its atmosphere fares and on its chances of being habitable [1 p. 2][1 p. 13], and on what its interior is like [3]; fields beyond the Solar System are hard to measure [1 p. 3].

An open problem, now shifting

When the paper was written, "direct observations of (exo)planetary magnetic fields" had not been achieved [1 p. 3]. A tentative radio signal from the τ Boötis system, reported in 2021 and possibly from its hot Jupiter, has not been confirmed by follow-up observations [4][3][5]. In September 2026 a preprint, not yet peer reviewed, reported radio bursts from the young giant planet β Pictoris b implying a field of at least 1.25 kG, which would be the first direct measurement [6]. For rocky planets there are only hints: radio bursts from the red dwarf YZ Ceti come at similar points in its innermost planet's orbit. One team infers that the planet has a magnetic field [7]; another can't rule out the star's own activity [8].

Habitability stakes

In these simulations, how much atmosphere a storm strips depends on the orientation of the fields, not just on the planet's field strength [1 p. 1]. The authors conclude that intrinsic fields "do not always protect the planet against atmospheric escape" [1 p. 12]: "magnetized means protected" is too simple.

Venus as a testbed

Venus Express saw Venus's induced magnetosphere reverse, and its tail lose heavy ions for a few hours, after the solar wind's field flipped at sector boundaries, in current-sheet crossings that take about ten minutes in the ordinary wind, not in storms [2][9][1 p. 2][1 p. 3]. A conference abstract from the same team reported more heavy ions, not fewer, when the reversal came with a coronal mass ejection or a corotating interaction region [10]. The simulations match the sector-boundary trend only "qualitatively" [1 p. 1].

A new handle, with conditions

If a storm-driven reversal could be sensed remotely, it could help tell weakly from strongly magnetized planets. We note two conditions: it would work only for a storm whose field is known to oppose the wind before it, and where the line falls depends on the storm's strength [1 p. 8]. The authors surmise that "even planets with stronger magnetic fields relative to Earth may undergo polarity reversals under extreme CME forcing" [1 p. 13].

6 · READ WITH CARE

A model reading, and a probe that may end up outside the boundary

These are our notes, not the authors' claims.

OUR ANALYSIS

A diagnostic without an observable, so far

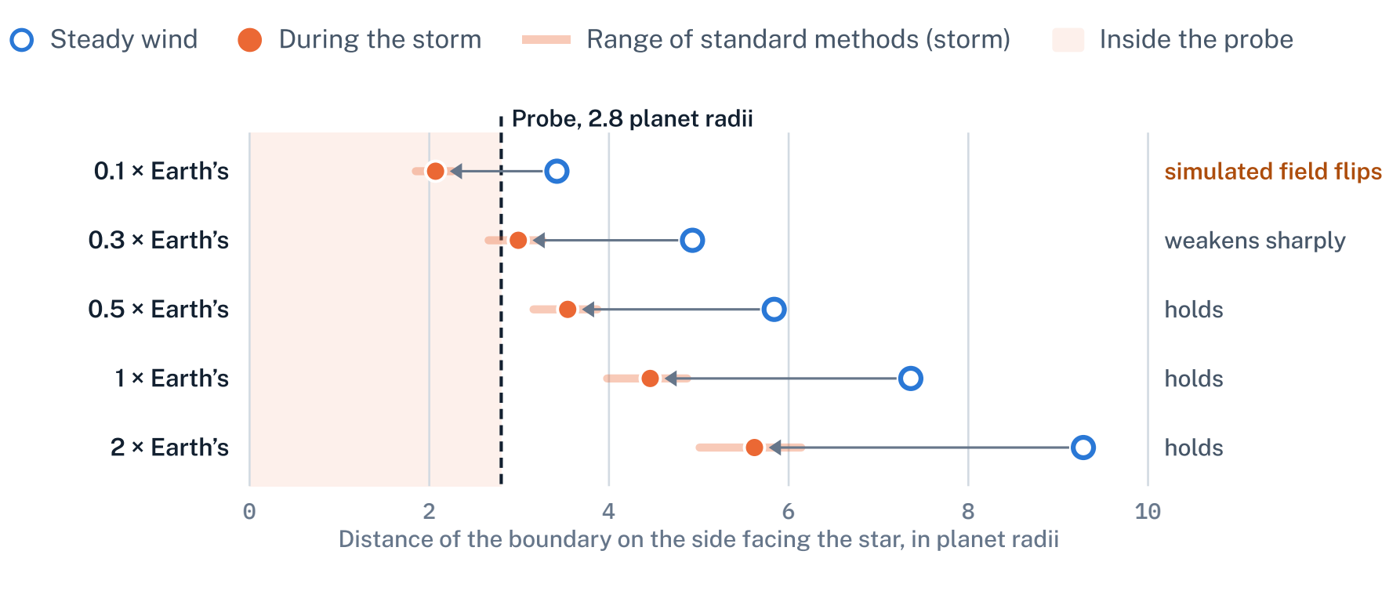
The reversal is read as one field component 2.8 planet radii out, a quantity inside the model. No synthetic radio or ultraviolet signal is computed, so nothing here can yet be pointed at a telescope. The authors acknowledge that "immediate observational tests may not be possible" [1 p. 13]. The word "potential" is new since the 2025 preprint, which said the reversals "can distinguish" the two kinds of planet [11 p. 1].

OUR ANALYSIS

Qualitative by design

The atmosphere is a conducting plasma, and the authors write that their "MHD simulation approach cannot capture microscale physics" [1 p. 8]. The Venus comparison is a match of trends, and in finer-grid runs "the absolute values of the mass-loss rate are lower than in the baseline simulations" [1 p. 16], so the loss rates and the "stronger field, more loss" result are best read as trends, not numbers. One small inconsistency: the text gives the steady wind 350 km/s and the parameter table 400 km/s [1 p. 4].

Where each planet's boundary sits, by simple pressure balance



OUR ANALYSIS The boundary sits where the planet's compressed field pushes back as hard as the wind or storm presses on it, using the paper's own densities, speeds and field strengths [1 p. 4][1 p. 5]. Dots use the textbook form; bars span the standard variants of the calculation. Right: what the paper's runs show at the probe [1 p. 8].

OUR ANALYSIS

The weak-field flip is probably the boundary moving inward

The authors state that the probe "remains inside the planetary magnetosphere ... across all of the simulations, including during periods of maximum CME-induced compression" [1 p. 6], but they show no boundary positions. With the paper's own parameters, the weak-field planet's boundary sits near 3.4 planet radii in the steady wind and about 2.1 during the storm, whose pressure is twenty times the wind's; the probe would then sit outside, in the storm's draped field. The paper's Fig. 2(b) fits this: during the storm the weak-field trace almost matches the no-field one, instead of the 140 nT or more its own dipole would give there [1 p. 7]. The simulated switch from flipping to holding also falls where the boundary crosses the probe: 0.1 flips, 0.3 weakens sharply, 0.5 holds [1 p. 8]. The planet's own dipole never reverses, and the paper doesn't say it does; closer in, the weak field should still hold, so its reversal is local rather than global. The estimate ignores reconnection, which erodes the boundary further, and the model's smeared boundary, but it puts the weak-field boundary inside the probe under every method we tried: 0.5–1 planet radii inside with the paper's storm density, and just inside even if the storm were no denser than the wind.

OUR ANALYSIS

Bottom line: a clear contrast in a model, not yet a measurement anyone can make.

The headline result holds in the paper's own figures, and the warning that a magnetic field doesn't always protect an atmosphere is well made. But the reversal is read inside the simulation, its line shifts with the storm, and for the weak-field planet it probably reflects a compressed boundary rather than a global flip. The authors' own word, "potential", is the right one.

Related checks

MISLEADING Venus and Mars The Disaster Cycle, Fact-Checked

Sources

Bracketed numbers refer to this list; p. gives a page of the published paper's PDF (for the preprint, of its PDF). Links checked October 19, 2026.

1 Gupta, S., Roy, S., and Nandy, D. (2026). Stellar magnetic storm induced magnetospheric polarity reversals: a potential diagnostic for distinguishing unmagnetized and magnetized (exo)planets. *The Astrophysical Journal* 1009(1), 62. Published September 16, 2026. CC BY 4.0. p. gives a page of the published PDF.

2 Vech, D., Stenberg, G., Nilsson, H., Edberg, N. J. T., Opitz, A., Szegő, K., Zhang, T., and Futaana, Y. (2016). Statistical features of the global polarity reversal of the Venusian induced magnetosphere in response to the polarity change in interplanetary magnetic field. *Journal of Geophysical Research: Space Physics* 121(5), 3951–3962. We read the abstract.

3 Turner, J. D., Grießmeier, J.-M., Zarka, P., Zhang, X., and Mauduit, E. (2024). Follow-up LOFAR observations of the τ Boötis exoplanetary system. *Astronomy & Astrophysics* 688, A66. We read the abstract.

4 Turner, J. D., Zarka, P., Grießmeier, J.-M., et al. (2021). The search for radio emission from the exoplanetary systems 55 Cancri, υ Andromedae, and τ Boötis using LOFAR beam-formed observations. *Astronomy & Astrophysics* 645, A59. We read the abstract.

5 Cordun, C. M., Vedantham, H. K., Brentjens, M. A., and van der Tak, F. F. S. (2025). Deep radio interferometric search for decametre radio emission from the exoplanet Tau Boötis b. *Astronomy & Astrophysics* 693, A162. CC BY 4.0. We read the abstract (arXiv:2501.06301).

6 Ortiz Ceballos, K. N., Berger, E., and Cendes, Y. (2026). Discovery of radio emission from the exoplanet β Pictoris b. arXiv:2609.16720, September 15, 2026, submitted for publication and not yet peer reviewed. We read the abstract.

7 Trigilio, C., Biswas, A., Leto, P., Umana, G., et al. (2023). Star–planet interaction at radio wavelengths in YZ Ceti: inferring planetary magnetic field. arXiv:2305.00809, a preprint submitted to *The Astrophysical Journal Letters*; we found no published version, so it may not be peer reviewed. We read the abstract.

8 Pineda, J. S., and Villadsen, J. (2023). Coherent radio bursts from known M-dwarf planet-host YZ Ceti. *Nature Astronomy* 7(5), 569–578. CC BY 4.0. We read the abstract (arXiv:2304.00031).

9 Higginson, A. K. (2016). Solar wind disconnects Venus's magnetotail. *Eos* 97. Published June 27, 2016; a research spotlight on Vech et al. (2016).

10 Vech, D., Stenberg, G., Nilsson, H., Edberg, N., Opitz, A., Szegő, K., Zhang, T., and Futaana, Y. (2016). On the global polarity reversal of the induced magnetosphere of Venus: a statistical study. *Geophysical Research Abstracts* 18, EGU2016-116-1, a conference abstract. CC BY 3.0.

11 Gupta, S., Roy, S., and Nandy, D. (2025). Stellar magnetic storm induced magnetospheric polarity reversals: distinguishing between unmagnetised and magnetised exoplanets. arXiv:2506.02886v1, the preprint, June 3, 2025; p. gives a page of its PDF.

METHOD

How this was checked

On October 19, 2026, we checked every statement, number and diagram on the original infographic, 60 items, against the published paper, its figures and appendices, the 2025 preprint, the Venus Express study it cites and the recent radio searches for planetary fields. We read values off the paper's figures, compared the infographic's diagrams with them, and re-ran the infographic's pressure-balance estimate with several standard methods. The check corrected several statements; the change log lists them.

The verdicts and the items tagged "Our analysis" are our own assessment, built on the cited sources: the readings of the paper's figures, the pressure-balance estimate and our reading of the paper's claims. The paper is open access under CC BY 4.0 [1]; the upstream schematic and the four small panels are adapted from its Figs. 1 and 2(b), and the other charts are our own.

After the page was built, a second reviewer who hadn't seen the drafting re-read the paper and its figures, read values off Figs. 2(b), 4(A) and B1 again, redid the pressure balance and checked every quotation and reference. The changes that followed: the title now says the field around weakly magnetized planets flips, not the planets' own fields; the diagnostic claim is rated Unconfirmed rather than Unsupported, because it rests on a real contrast in the model that no observation has tested yet; the finer-grid check is described as the paper gives it, with no field, a tenth and twice Earth's field; Venus's reversals followed current-sheet crossings lasting about ten minutes; Cordun et al. is cited as published in A&A; the YZ Ceti radio bursts are mentioned; and several smaller corrections, including page numbers for Fig. 4(A) and a larger upstream chart.

This page was researched and written with Claude, an AI assistant made by Anthropic, and then re-checked against its sources in a separate verification pass.

The verdicts on this page

UNSUPPORTED	No evidence we could find backs it up, though it hasn't been strictly disproven.
UNCONFIRMED	Rests on a preliminary result that hasn't been confirmed.
TRUE	The evidence supports the claim.

All ten verdicts, and how we check

CORRECTIONS

Corrections and changes

If we get something wrong, we fix it and record the change below with the date. If a correction changes a verdict, the log says what the old verdict was.

Change log

Oct 19, 2026 Published on factchecked.science after a full check against the sources. Changes from the infographic: added our verdicts on four of the paper's claims. The 2.8 R_p probe was described with the preprint's reasoning; the published paper says it was chosen to stay inside the magnetosphere in every run, which section 6 now disputes for the weak-field planet. The field strengths include the appendix runs at 0.3 and 0.5 times Earth's. The upstream diagram is redrawn after the paper's Fig. 1: the sheath is about 25 nT, not 38, and the sheath and the field after the storm point the storm's way, so the steady wind doesn't simply return. The four "who flips" panels are redrawn from Fig. 2(b): the weak-field runs stay south after the storm, and the strong-field runs rise slightly rather than dip. The mass-loss sketch is replaced by values read from Fig. 4(A): the no-field runs peak highest and only the weak-field runs dip at impact; "viscous coupling", the preprint's phrase, gave way to the published explanation, and the plasma atmosphere "may" overestimate loss. The tail-current drop is relative to the matching run without a reversal, and the Venus link is the authors' speculation. "No exoplanet's magnetic field has been measured directly" and "radio emission ... has not yet been detected from any exoplanet" now mention the unconfirmed τ Boötis signal, a September 2026 preprint on β Pictoris b and the debated radio bursts from YZ Ceti. "Field orientation, not just strength, governs how much atmosphere a storm strips" became "depends on", as the paper puts it. Venus's reversals followed sector-boundary crossings, not storms, so "the same behaviour the simulations reproduce" became a qualitative match, and "in one event" now carries the paper's conditions. In section 6, "a dipole cannot reverse" (the paper doesn't say it does) and "only the no-field case is a true reversal" became a reversal that is local rather than global, and the MHD caveat is quoted in the authors' words. The image was cut off before its footer; the full reference is in the source list. The title and the three key numbers are new.

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Last updated Oct 19, 2026