Fact-Checked Science

PAPER CHECK · ANIMAL NAVIGATION

# Bats kept their migration heading in total darkness; the paper never mentions pole shifts

Researchers from the University of Oldenburg and the Bat Research Society of Latvia, with colleagues in Brandenburg and Riga, tested 81 wild Nathusius' pipistrelles, one at a time, inside a darkened yurt on the Baltic coast and read the take-off heading of 72 [1 pp. 9–12]. Bats released in verified total darkness kept the south-westerly heading of their autumn migration, which the authors read as evidence against a compass that needs light at the moment the field is read [1 p. 1][1 p. 8]. S0 News presented the preprint, which is not yet peer reviewed, as confirmation of navigational failures during a magnetic pole shift [2 00:02:02]. We checked what the paper shows and what the episode made of it.

By Fact-Checked Science · Published October 21, 2026

OUR ANALYSIS marks our own reasoning and calculations, and the verdicts are our assessment. Everything else comes from the numbered sources; for the preprint [1], p. gives the page of its PDF and ll. the line numbers printed in its margin, Fig. a figure and Table S1 the table in its first supplementary file.

## A careful test of light, read by the episode as a verdict on the pole shift

OUR ASSESSMENT

**234°**

Mean heading of 24 bats released in verified total darkness: south-west, 11° from the 223° of controls under starlight, and significantly clustered (p = 0.02) [1 p. 5, ll. 147–150]

**5–8 min**

Time since their last photon when those bats took off, against the one-to-five-microsecond life of the only cryptochrome radical pair shown to sense a magnetic field [1 p. 7, ll. 217–221]

**0**

Mentions of pole shifts, excursions, reversals or a weakening field in the preprint. The magnetic field was never changed: every bat was released in "the local geomagnetic field" [1 Fig. 2]

THE CLAIMS

**TRUE**

*Migratory bats kept their migration heading in total darkness*

The preprint's abstract [1 p. 1, ll. 31–32]

Controls released under starlight headed south-west (223°, 23 bats, p = 0.01), and so did bats released in verified total darkness after starlight acclimation (234°, 24 bats, p = 0.02); the two groups did not differ in direction or scatter [1 p. 5, ll. 145–160], nor in time to take off [1 p. 6, ll. 164–166]. A third group kept in darkness for 1.5–6.5 hours had the same mean heading (235°, 25 bats) but was not significantly clustered (p = 0.23) [1 p. 5, ll. 149–151], in a test with only 31% power [1 Fig. S1]. One experiment, one autumn, not yet peer reviewed. See section 2.

**PARTLY TRUE**

*"Here though they found the mammals do not use the same light activated magnetic compass birds do."*

The episode, at 00:01:55 [2 00:01:55]

The authors call their result "inconsistent with a compass requiring photon input at transduction", the light-driven mechanism characterised in birds [1 p. 8, ll. 227–229]. But they do not say what compass the bats use: three mechanisms "remain consistent with our result" [1 p. 9, ll. 258–259], light-started signals that persist are constrained "rather than exclude[d]" [1 p. 8, ll. 255–257], no mammalian magnetoreceptor has been found [1 p. 9, ll. 275–276], and the magnetic nature of the heading is an assumption carried over from earlier work [1 p. 4, ll. 118–120]. One bat species, one preprint. See section 3.

**MISREAD**

*"But more importantly this is confirmation of the widespread across up and down the animal kingdom navigational failures forecast during this magnetic pole shift."*

The episode, at 00:02:02 [2 00:02:02]

The experiment changed the light, not the magnetic field, and the preprint never mentions pole shifts, excursions, reversals or a weakening field [1 Fig. 2]. It cannot confirm a forecast it does not address. The peer-reviewed record points the other way: robins orient in a 4 μT field, under a tenth of their local field, after 17 hours of exposure [12], and bats orient at 10 μT and follow a reversed polarity [14]. We found no peer-reviewed forecast of widespread navigational failure. See section 4 and section 5.

**TRUE**

*"Mammals, which are the focus here, are among insects, marine creatures, and reptiles that use the field for life necessary reasons"*

The episode, at 00:01:45 [2 00:01:45]

Bats, mole-rats, ants and bees, sea turtles, salmon, lobsters and newts all orient by the field in experiments, and a 2026 review calls the sense "widespread across the animal kingdom" [17][16][36][33][32][35][37][27]. The preprint itself notes the limit on the mammal side: "a handful of species", with the receptor found in none of them [1 p. 9, ll. 282–283]. See section 6.

**UNVERIFIED**

*"not to mention about eight different things in the plant life cycle"*

The episode, at 00:01:51 [2 00:01:51]

The episode gives no source and we found none. Reviews of plant magnetoreception describe effects of altered fields on germination, roots and shoots, gravitropism, redox status, photosynthesis, lipids, development and flowering, mostly in fields far stronger than Earth's and with mixed results; one calls the geomagnetic field's impact on plants "not well-understood" [43][44]. A near-null field does delay flowering in Arabidopsis [45][46]. See section 6.

1 · THE EXPERIMENT

## Eighty-one wild bats, 72 headings, three light conditions, one unchanged magnetic field

Nathusius' pipistrelles caught on autumn migration at Pape Ornithological Station on the Latvian coast, between August 21 and September 1, 2025, were released one at a time in a circular arena inside a yurt, under starlight-level light or verified total darkness, and the direction each took off in was read from its tracks on a chalked floor [1 pp. 9–12, ll. 288–354].

### The bats

Wild adults, 81 of them, caught in a large funnel trap [1 p. 9, ll. 288–289]. The species migrates more than 2,000 km between the Baltic and south-western Europe, and its autumn departure from Pape is south-west by radio-tracking, by releases after translocation and by ring recoveries [1 p. 4, ll. 111–115].

### Three light conditions

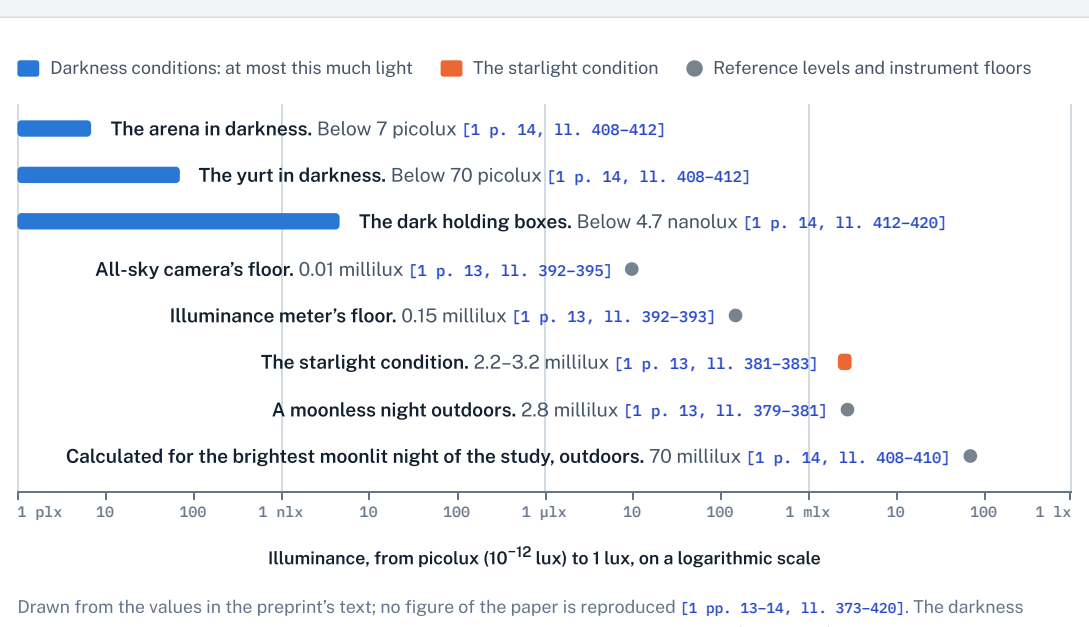
Starlight before and during the test (the controls); starlight before, total darkness during; and total darkness before and during [1 p. 4, ll. 121–124]. The "starlight" was two LEDs behind two layers of milky acrylic, set to about 2.2 millilux at the centre of the arena and 3.2 in the holding boxes, matching a moonless night measured outdoors, about 2.8 millilux [1 p. 13, ll. 373–383].

Every bat had the same transfer: 3 minutes in darkness, 2 minutes under an opaque box in the arena, then up to 3 minutes to take off [1 p. 10, ll. 309–315]. Acclimation lasted 1.5–6.5 hours, because the bats were tested one after another [1 p. 10, ll. 304–307].

### What was not changed

The magnetic field. Every bat was released in the local geomagnetic field; no coil system is described, and the paper gives no field values [1 Fig. 2]. The authors treat the heading as the output of a magnetic compass on the strength of earlier work at the same site, "an assumption we examine explicitly in the Discussion" [1 p. 4, ll. 116–120].

### How dark is "total darkness"?



Drawn from the values in the preprint's text; no figure of the paper is reproduced [1 pp. 13–14, ll. 373–420]. The darkness values are upper limits; the value calculated for the brightest moonlit night of the study (70 millilux) times the yurt's measured attenuation of $10^{-9}$, the arena's $10^{-10}$ and the boxes' $6.67 \times 10^{-8}$. For scale, daylight is about 100,000 lux, the value the authors measured outside the yurt [1 p. 14, ll. 405–406].

### How the darkness was verified

Five observers who had dark-adapted for 45 minutes saw nothing inside the yurt. At night, a NIST-traceable illuminance meter (floor 0.15 millilux) and an all-sky camera (floor 0.01 millilux) detected no light inside it. By day, measurements outside and inside gave the attenuation factors above [1 pp. 13–14, ll. 384–412].

The bats were handled under night-vision goggles whose infrared illuminator emits at 940 nm, beyond the long-wavelength limit of bat vision (about 680 nm) and outside the absorption bands of the flavin that a cryptochrome compass would need [1 p. 11, ll. 330–338].

### Controls against other cues

The yurt's interior is rotationally symmetric, so echolocation offers no landmark. The side from which each bat entered was chosen at random; the arena was rotated to a random orientation and its chalk renewed between trials; the bat was released remotely by a pulley, and take-off was detected by an ultrasound detector from outside [1 pp. 11–12, ll. 322–354].

Roles were split: one person chose the condition at random and ran the trial; another read the heading, blind to the condition [1 p. 12, ll. 355–357]. Take-off latency was recorded in every trial as a check on the bats' behavioural state [1 p. 4, ll. 134–136].

BATS

**81 → 72**

Caught, then analysed for orientation: 26, 24 and 31 went into the three conditions, and 3, 0 and 3 did not take off within 3 minutes [1 p. 6, ll. 166–169]; two tracks could not be read [1 p. 12, ll. 351–352].

ACCLIMATION

**1.5–6.5 h**

In starlight or in a light-tight box, before a 3-minute transfer in darkness and 2 minutes of settling under an opaque box [1 p. 10, ll. 304–315].

THE BOOKKEEPING

OUR ANALYSIS

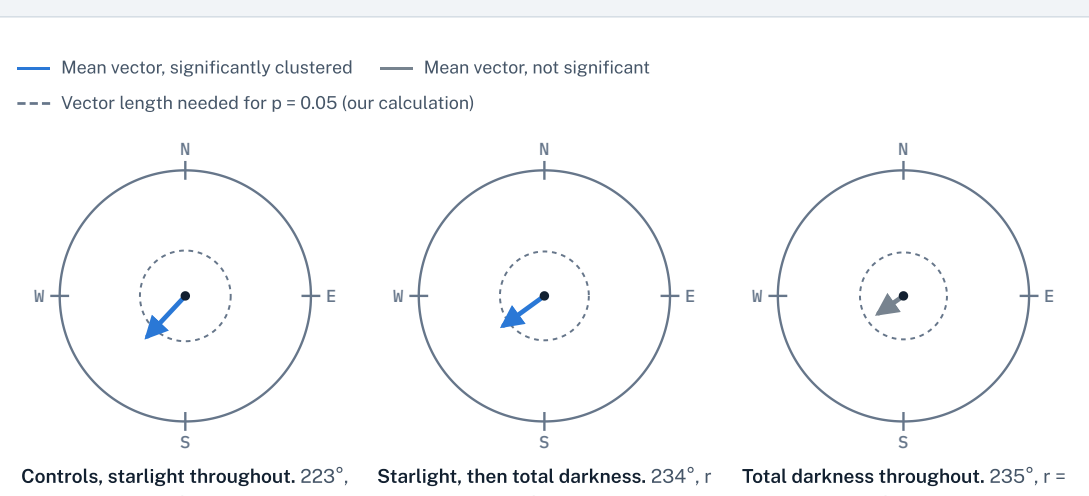
**1 bat**

unaccounted for: 81 bats less the 6 that stayed put leaves 75 departures, and 2 unreadable tracks leave 73, but the three groups analysed add up to 72 (23 + 24 + 25). A slip in the preprint's counts, all in the dark-acclimated group (28 departures, 25 analysed, two unreadable tracks); it changes no result.

2 · WHAT THEY FOUND

## Both groups that saw starlight before the test headed south-west, with or without light at take-off

The group held in darkness for hours had the same mean heading but did not pass the significance test [1 p. 5, ll. 145–151], and the authors do not treat it as evidence of a light requirement [1 p. 7, ll. 202–205].


Mean vector, significantly clustered
Mean vector, not significant
Vector length needed for p = 0.05 (our calculation)
N
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S
W

**Controls, starlight throughout.** 223°, r = 0.44, 23 bats, p = 0.01

**Starlight, then total darkness.** 234°, r = 0.40, 24 bats, p = 0.02

**Total darkness throughout.** 235°, r = 0.24, 25 bats, p = 0.23

Drawn from the mean directions, mean vector lengths (r, from 0 for headings spread evenly round the circle to 1 for all alike) and sample sizes reported in the text [1 p. 5, ll. 145–151]; the preprint's Figure 2 is not reproduced (CC BY-NC 4.0), and the individual headings are not public, so no points are shown. The arrow's length is r times the radius. The dashed circle is our calculation of the vector length a Rayleigh test needs for p = 0.05 with that sample size, about √(3.0 ÷ N); the arrow clears it in the first two groups and falls short in the third.

### The numbers behind the diagrams

| CONDITION | BATS | MEAN HEADING | R | RAYLEIGH P | TIME TAKE |
|---|---|---|---|---|---|
| Starlight throughout | 23 | 223° | 0.44 | 0.01 | 104 : |
| Starlight, then darkness | 24 | 234° | 0.40 | 0.02 | 90 ± |
| Darkness throughout | 25 | 235° | 0.24 | 0.23 | 85 ± |

From the results text [1 pp. 5–6, ll. 145–166]. No pair of groups differed in mean direction (Mardia–Watson–Wheeler tests, p = 0.99, 0.70 and 0.76) or in scatter (p = 0.81, 0.30 and 0.42); time to take off did not differ (Kruskal–Wallis p = 0.39), nor did the share of bats that stayed put (3 of 26, 0 of 24 and 3 of 31; p = 0.31) [1 pp. 5–6, ll. 156–169]. The paper does not say what the ± values are.

### The third group

For the bats kept in darkness throughout, a model comparison gives the uniform distribution the best score and the oriented ones scores within two units of it, so the paper reports that "both uniform and unimodal" models are supported [1 Table S1][1 p. 5, ll. 151–153]. A simulation puts the Rayleigh test's power at 0.31 for a sample this scattered, a 69% chance of missing real orientation [1 Fig. S1][1 p. 5, ll. 153–155].

A second simulation runs the other way: had this group been uniformly spread, the chance of pairwise tests as non-significant as those observed would have been 0.02 against the controls and 0.01 against the other darkness group [1 pp. 5–6, ll. 160–164]. The authors conclude that "a complete loss of direction appears unlikely" and that they "do not treat that group as evidence of a light requirement" [1 p. 7, ll. 204–205].

OUR ANALYSIS

The Rayleigh p-values reproduce from the sample sizes and vector lengths (Z = N $r^2$: 4.45, 3.84 and 1.44, giving p of about 0.012, 0.021 and 0.24; the small-sample form that circular-statistics packages use gives 0.010, 0.020 and 0.24, matching the paper). The 5–8 minutes between the last photon and take-off are the 3-minute transfer, the 2-minute settling period and up to 3 minutes before take-off [1 p. 10, ll. 309–315]; for the group held in darkness, the interval was its 1.5–6.5 hours of acclimation plus the same 5–8 minutes. The three mean headings lie within 12° of one another, close to the south-westerly departures recorded in free-flying bats at this site [1 p. 8, ll. 235–238].

What the numbers do not show is three oriented groups: the third is a non-result, as the paper says. And a mean heading within 11° of the controls, for bats whose only difference was the absence of light at take-off, is the finding that carries the paper.

3 · WHAT DARKNESS CAN DECIDE

## The test rules out a compass that must be lit at the moment it is read, not any mechanism in particular

Three mechanisms are on the table for how animals sense the field, and only one of them needs light. A darkness experiment can show whether the magnetically sensitive molecule has to be made by light as the field is read; on its own it cannot say which mechanism is at work [1 pp. 2–3, ll. 45–59, 82–84][24][27].

NEEDS LIGHT

### Radical pairs

A photon absorbed by a cryptochrome protein creates a pair of radicals whose chemistry depends on the direction of the field [24]. This is the mechanism best characterised in birds, whose cryptochrome 4 is magnetically sensitive in the test tube [1 p. 2, ll. 47–50]. Mammals have only the type II cryptochromes, which lack that light-driven function, so whether a light-dependent compass exists in mammals at all is an open question [26][1 p. 3, ll. 87–89].

NO LIGHT NEEDED

### Magnetite

Crystals of magnetic iron oxide that move with the field, as they do in magnetotactic bacteria [1 p. 2, ll. 50–53]. In big brown bats, a brief magnetic pulse of the kind that re-magnetises such crystals altered homing, which is the main behavioural evidence for magnetite in a mammal [18].

NO LIGHT NEEDED

### Induction

Head movements through the field drive tiny currents in the fluid-filled canals of the inner ear, read by cells like those of electric-sensing fish, a mechanism proposed for pigeons [1 p. 2, ll. 53–57]. A 2026 whole-brain screen found a pigeon circuit activated by magnetic stimuli in light and darkness alike; a physics analysis questions whether canals the size of a bird's, let alone a bat's, carry enough signal [1 p. 9, ll. 264–275].

### In the authors' words

"RP1" is the canonical light-driven radical pair; "persistence-based variants" are versions of the hypothesis in which a signal started by light outlasts the light.

> *"The magnetically sensitive species must therefore be generated in darkness. The present results are therefore inconsistent with a compass requiring photon input at transduction (the canonical RP1 pathway) in P. nathusii"*
>
> Cellarius et al. (2026) [1 p. 8, ll. 227–229]

> *"We therefore constrain rather than exclude these persistence-based variants: mechanisms requiring signal half-lives on the order of minutes are difficult to reconcile with any of our groups, whereas mechanisms with half-lives well beyond 6.5 h remain formally possible."*
>
> Cellarius et al. (2026) [1 p. 8, ll. 255–257]

> *"Three candidate mechanisms remain consistent with our result: a radical-pair mechanism, a magnetic-particle mechanism, and electromagnetic induction. Our behavioural data do not rank them"*
>
> Cellarius et al. (2026) [1 p. 9, ll. 258–259]

### The timing argument

The only cryptochrome radical pair shown to exist and to respond to a magnetic field is made by light and lives for one to five microseconds. The bats released in darkness took off five to eight minutes after their last photon, seven to eight orders of magnitude later [1 p. 7, ll. 217–221]. A reading taken earlier would not help: a compass encodes the field's direction relative to the head at that moment, and a bat carried for three minutes in a bag and two under a box no longer holds that heading [1 pp. 7–8, ll. 221–227].

A second radical pair can form without light while the protein's flavin is re-oxidised, over minutes; the authors note it has not been shown to exist even in the test tube, that superoxide-containing pairs are doubted on physical grounds, and that the dark-held bats took off 1.5–6.5 hours after their last light [1 p. 8, ll. 240–251]. One insect result keeps the door open: in a firebug, a cryptochrome-dependent magnetic response set up under light lasted at least 24 hours in darkness [48][1 p. 8, ll. 251–254]. A hybrid sensor in which a magnetite particle amplifies the field for a nearby radical pair would still need light, the authors note, because the radical pair must still be generated photochemically [25][1 p. 8, ll. 246–249].

### Birds in the dark behave differently

European robins tested in total darkness head west in spring and in autumn alike, a "fixed direction" response that does not involve their light-dependent compass and that disappears when the upper beak is anaesthetised, pointing to a second, iron-based receptor [23]. The bats' heading in darkness was instead their seasonal migration direction, which the authors read as the same compass being read out with and without light [1 p. 7, ll. 193–201].

The paper describes the mammalian magnetic sense as established but unexplained: big brown bats' homing is deflected by a shifted field [17], migratory bats resolve the field's inclination [19], and yet "Magnetic orientation in mammals has so far been examined in a handful of species and traced to a receptor in none of them" [1 p. 9, ll. 282–283].

OUR ANALYSIS

### The assumption behind the word "compass"

Nothing in this experiment manipulated the magnetic field, so the magnetic basis of the heading rests on earlier work at the same site: soprano pipistrelles released from the same arena shifted their take-off after a field rotated by 120° at sunset, and lost all orientation when the field's inclination was reversed as well [19]; brief radiofrequency noise, a treatment that disrupts radical-pair compasses in birds, left them randomly oriented [20]. Nathusius' pipistrelles calibrate their compass on the sun's position at dusk [49], not by polarised skylight [21], and need an intact cornea to orient in free flight [22]. The authors' own list of cue controls, rotational symmetry, random entry and a rotated arena, rules out a fixed cue inside the apparatus [1 p. 8, ll. 238–239]; cues reaching the yurt from outside, at a station on the Baltic shore, are not discussed.

A fair reading: these bats kept their migratory heading without light, and the case that the cue is magnetic is strong but inherited. The result argues against a compass that must be lit as it is read; it identifies no mechanism, and a light-started signal with a long enough life is constrained, not excluded. The authors say as much.

4 · WHAT THE EPISODE SAID

## A fair gist of the compass finding, then a conclusion the paper nowhere supports

The episode introduced the preprint at 00:01:31 and drew two conclusions from it [2 00:01:31]. We quote the automatically generated transcript as it stands, with its punctuation.

### In the episode's words

The presenter, introducing the preprint.

> *"Now, if you don't watch this show regularly, you may still think it's just birds that use Earth's magnetic field for seasonal migration, but it's daily activities, too. foraging, finding reproductive zones."*
>
> S0 News, 00:01:31 [2 00:01:31]

> *"And it's not just the birds. Mammals, which are the focus here, are among insects, marine creatures, and reptiles that use the field for life necessary reasons, not to mention about eight different things in the plant life cycle."*
>
> S0 News, 00:01:42 [2 00:01:42]

> *"Here though they found the mammals do not use the same light activated magnetic compass birds do. But more importantly this is confirmation of the widespread across up and down the animal kingdom navigational failures forecast during this magnetic pole shift."*
>
> S0 News, 00:01:55 [2 00:01:55]

| THE EPISODE SAYS | WHAT THE PREPRINT, OR THE LITERATURE, SHOWS | OUR VERDICT |
|---|---|---|
| **They found the mammals do not use the same light-activated compass birds do** [2 00:01:55]. | One species. The authors' wording is that the result is "inconsistent with a compass requiring photon input at transduction" and that they "constrain rather than exclude" light-started signals that persist [1 p. 8, ll. 227–229, 255–257]. Three mechanisms remain, unranked, and no mammalian receptor is known [1 p. 9, ll. 258–259, 275–276]; the field was not manipulated [1 Fig. 2]. Mammals lacking the bird compass molecule is background, not a finding of this paper [26]. | **PARTLY TRUE**<br>The gist of the authors' reading; "found" and "the mammals" turn a hedged inference from one bat species into a settled fact. |
| **This is confirmation of the widespread navigational failures forecast during this magnetic pole shift** [2 00:02:02]. | The preprint contains no mention of pole shifts, excursions, reversals, a weakening field or navigation failing, and it changed light, not the field [1 Fig. 2]. Published experiments show compasses adapting to fields far weaker than today's [12][14]; today's dipole is about 9% below its 1840 strength and "probably not reversing" [5][10]. See section 5. | **MISREAD**<br>The paper cannot confirm a forecast it does not address. |
| **It's not just birds: mammals, insects, marine creatures and reptiles use the field, and not only for migration** [2 00:01:31][2 00:01:42]. | Supported by decades of experiments across those groups and by reviews that call the sense widespread [27][28][29][30]. Some of the "daily activities" evidence in mammals is contested [38][39][40]. See section 6. | **TRUE**<br>In broad terms. |
| **About eight different things in the plant life cycle** [2 00:01:42]. | No source is given and we found none. Reviews list plant responses to altered fields, mostly fields far stronger than Earth's, with mixed results [43][44]; a near-null field delays flowering in Arabidopsis [45][46]. The preprint says nothing about plants. | **UNVERIFIED**<br>We could not find what the eight are. |

OUR ANALYSIS

### The gap between the paper and the episode

The preprint asks a sensory question: does the bats' compass need a photon at the moment the field is read? The episode answers a different one: will animals lose their way as the field changes? The two meet nowhere in the text. A bat that keeps its heading with the lights off says nothing about what a bat does when the field weakens or its poles move, because that was never tested here, and the paper does not claim it was.

### How we rated

Each statement is rated against the preprint and, where the preprint is silent, against the peer-reviewed literature, on our standard scale.

| | |
|---|---|
| **TRUE** | The evidence supports the claim. |
| **PARTLY TRUE** | Part of the claim holds up and part doesn't. |
| **MISREAD** | Cites a real source but gets wrong what it says. |
| **UNVERIFIED** | We couldn't find the source or record it depends on. |

5 · THE FIELD TODAY AND IN AN EXCURSION

## A compass reads direction, dip and polarity; an excursion changes all three, but the field never vanishes

Magnetic compasses read the field's direction, its dip below the horizontal (the inclination) and, in some animals, its polarity, within a window of field strengths that can be re-tuned [13][15][16][12]. The experiment used the local field, unchanged [1 Fig. 2]. Here is what that field is, how far it has fallen, and how far it fell in the last big excursion.

AT EARTH'S SURFACE

**23–67 μT**

the field's range around the globe in the World Magnetic Model [3 Table 1]

AT PAPE, AUGUST 2025

OUR ANALYSIS

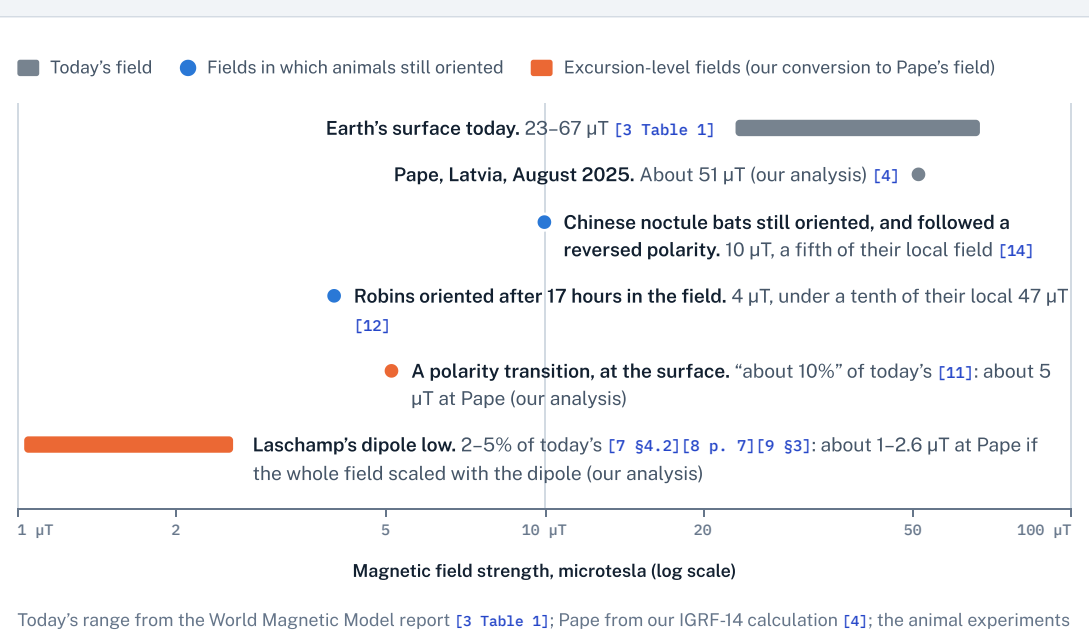
**≈51 μT**

dipping 71° below the horizontal and pointing 7.8° east of true north, from the IGRF-14 field model at 56.15°N, 21.02°E [4]. The preprint gives no field value.

LASCHAMP'S LOW, ABOUT 41,000 YEARS AGO

**2–5%**

of today's dipole strength, in global field models of the last big excursion [7 §4.2][8 p. 7][9 §3]



Today's range from the World Magnetic Model report [3 Table 1]; Pape from our IGRF-14 calculation [4]; the animal experiments from their abstracts [12][14]. The excursion rows are our conversions: a transition takes the surface field "to about 10% of its current value" [11], and Laschamp's dipole fell to about 2–5% of today's in global models [7 §4.2][8 p. 7][9 §3], though the non-dipole part of the field remains and the surface field in an excursion varies from place to place. No experiment we found tested a compass at 1–3 μT.

### What a compass reads

European robins' compass takes its north from the axis of the field lines and their dip, not from polarity: the birds take as north the end of the axis that dips downward [13]. Mole-rats use the opposite, a polarity compass [16], and so, by their roosting positions, do Chinese noctule bats [15]; migratory soprano pipistrelles also respond to a reversed inclination [19]. The avian compass "works in a fairly narrow functional window around the intensity of the local geomagnetic field, but adjusts to intensities outside this range when birds experience these new intensities for a certain time" [12].

### What an excursion changes

During the Laschamp excursion the dipole fell to a few percent of today's [7 §4.2][8 p. 7][9 §3]; a polarity transition brings the surface field "to about 10% of its current value" [11]. Directions swing too: at Laschamp, fully reversed directions lasted a few centuries in sediment records, and the dip changed with them, as our review of excursions sets out with its sources. A compass animal in such a field would read a different direction, a different dip and, for a few centuries, a reversed polarity, in a field a tenth or less of today's. What it would not read is nothing.

### Animals already live with a drifting field

Migratory bats calibrate their compass on the sun's position at sunset [49][19], and the preprint's own assay was validated through that calibration window [1 p. 4, ll. 116–118]; a field drifting over centuries is re-referenced season by season. The magnetic "map" that salmon and sea turtles use to find their natal areas already tracks the field's secular drift: the route Fraser River sockeye take round Vancouver Island follows it [32], and loggerhead nesting at North America's largest rookery shifts along the coast as magnetic signatures converge or diverge [33]. The authors of the imprinting hypothesis note one implication: "unusually rapid changes in the Earth's field, as occasionally occur during geomagnetic polarity reversals, may affect ecological processes by disrupting natal homing" [31].

### Today's field, and the forecasts

Earth's axial dipole is about 9% weaker than in 1840, a loss of about 5% per century on average [5][6], and a study of past field states concludes it is "probably not reversing" [10]; our check of the countdown puts even a halving of the dipole centuries away. A review of polarity transitions and life finds "no clear picture of a geomagnetic link" [11], and a 2023 perspective argues that reversals had evolutionary effects on life, without presenting data on navigation [47]. We found no peer-reviewed forecast of widespread navigational failures.

OUR ANALYSIS

The conversions are simple: 10% of Pape's 51 μT is about 5 μT, and 2–5% is about 1–2.6 μT. The strongest published tests of weak-field orientation reach 4 μT in robins, after 17 hours of exposure [12], and 10 μT in bats, which also followed a reversed polarity at that strength [14]. That covers a transition's "about 10%" and comes within a factor of two of the upper end of Laschamp's range, and a factor of four of its lower end; nothing we found tested a compass at 1–3 μT, and no study tested a migrating animal through a direction swing lasting centuries. The IGRF-14 calculation uses our own script, kept with the verification notes; its 2025 dipole coefficient matches the value on our next-excursion page, and its values at Pape and at three test points agree with the British Geological Survey's online IGRF-14 calculator to within a nanotesla [50].

6 · NOT JUST BIRDS, AND THE PLANTS

## Magnetic sensing is widespread; the "eight things" in plants have no source we could find

Two of the episode's side claims are about the breadth of magnetic sensing. The first is right in broad terms; the second has no identifiable source [27][43].

### Who uses the field

**Mammals.** Big brown bats' homing is altered by an artificially shifted field [17] and altered by a magnetic pulse [18]; Chinese noctules respond to polarity [15]; mole-rats find their way underground by a polarity compass [16]. A 2005 review already saw "a possibly magnetite-based mechanism in mammals" [29].

**Insects.** Ants and bees "use the geomagnetic field to orient and navigate in areas around their nests and along migratory paths" [36].

**Marine animals and reptiles.** Sea turtles and salmon imprint on the magnetic signature of their natal areas [31][32][33]; loggerhead turtles learn the magnetic signatures of feeding areas [34]; spiny lobsters navigate by a magnetic map [35]; magnetic positional information is documented in turtles, lobsters, newts and birds [30], and newts use a magnetic map to home to breeding ponds [37].

A 2026 review: the sense "is now recognized as widespread across the animal kingdom" [27]; a 2018 review of long-distance navigation treats magnetoreception as one cue among several [28].

### Daily activities

Red foxes hunting under snow or tall grass direct their jumps roughly north-east, and the northward attacks succeed far more often, which the authors propose is magnetic alignment aiding the hunt [41]. Dogs, in 7,475 observations, aligned north–south when excreting under a calm field and stopped when the field's declination was changing fast [42]. Cattle and deer were reported to graze and rest aligned north–south in satellite images and field counts [38]; a second team found no such alignment [39], and the first replied with further support [40]. "Finding reproductive zones" is best documented in salmon, sea turtles and newts, through magnetic maps, rather than in mammals [31][32][33][37].

### The plants

Plants respond to magnetic fields in "a multitude of ways", a 2005 review found, while noting that the work was "pursued in a somewhat unsystematic manner and no biological advantage of any magnetoresponse is immediately obvious" [44]. A 2014 review groups the reported effects of fields stronger than Earth's under germination, cryptochrome, roots and shoots, gravitropism, redox status, photosynthesis and lipid composition, and of weaker fields under development and the transition to flowering, and calls the geomagnetic field's impact on plants "not well-understood" [43]. In Arabidopsis, a near-null field delays flowering and alters hypocotyl growth [45], with flowering genes down-regulated [46]. Whether those are the "eight different things" the episode means, we cannot tell: it names none, and the preprint says nothing about plants.

7 · LIMITS AND CONCLUSIONS

## A well-controlled behavioural test with one untested assumption, and a result still awaiting review

Our assessment of the study's design, of what the preprint can and cannot support, and of our own check.

OUR ANALYSIS

### Strengths

- ⊕ **Darkness that was measured, not assumed.** Human observers, a traceable illuminance meter, an all-sky camera and daytime attenuation measurements, with upper limits stated [1 pp. 13–14, ll. 384–420].
- ⊕ **Blinded scoring and randomised cues.** The heading was read by someone who did not know the condition; the entry side and the arena's orientation were random [1 pp. 11–12, ll. 340–357].
- ⊕ **A behavioural-state control.** Take-off latency and the share of bats that stayed put were recorded and did not differ [1 p. 6, ll. 164–169].
- ⊕ **Wild migrants doing the task.** Bats were tested on the nights of their migration, and the headings match free-flying departures from the site [1 pp. 8–9, ll. 235–238, 282–284].
- ⊕ **Honesty about the third group,** with a power analysis and a model comparison in the supplement [1 Table S1][1 Fig. S1], and its circular-statistics functions in a public repository [1 p. 14, ll. 424–425].

### Limitations

- ⊖ **The field was not manipulated.** That the heading is a magnetic compass reading is inherited from earlier work, mostly in a sister species [1 p. 4, ll. 116–120][19][20].
- ⊖ **One species, one site, one autumn, 72 headings.** The third group's test had 31% power [1 Fig. S1].
- ⊖ **Mechanism not identified.** Three remain; light-started signals with long lives are constrained, not excluded [1 pp. 8–9, ll. 255–259].
- ⊖ **Raw data on request only** [1 p. 15, l. 459], and one bat unaccounted for in the group counts (section 1).
- ⊖ **Cues from outside the yurt** are not discussed, at a station on the coast [1 p. 8, ll. 238–239].
- ⊖ **Not peer reviewed.** A first version, posted October 11, 2026; no journal version existed when we checked [1].

## Limits of this check

### Abstracts for most cited papers

We read the preprint and its supplements in full and the IGRF-14 file; for the other papers we read abstracts and publisher records, and for six older papers whose pages sat behind cookie walls, abstracts through Europe PMC.

### The supplementary figures

We read their captions and Table S1, not the images, and the raw headings are not public, so the compass diagrams show reported means, not data.

### Our field values are modelled

The field at Pape comes from the IGRF-14 model at coordinates we assigned (56.15°N, 21.02°E), not from a measurement at the site; the preprint gives none. The excursion conversions scale the whole field with the dipole, which is a simplification.

## What would change this verdict

**01**

The same darkness test with the magnetic field rotated or its inclination reversed: a heading that follows the field in the dark would settle the "compass" question that this experiment assumes.

**02**

A larger group acclimated in darkness, or a magnetic-pulse or radiofrequency test in darkness, in this species; the authors note that pulse re-magnetisation is a diagnostic that could be applied to this species [1 p. 9, ll. 262–264].

**03**

For the episode's claim, any peer-reviewed study showing a migrating animal losing its way in an excursion-level field, or a published forecast of such failures; we found neither.

Peer review and a replication in a second season would firm up the first verdict; they would not touch the third, which rests on what the paper is about.

### The authors conclude

That a migratory mammal expresses its seasonal heading without concurrent light, in a lineage that lacks the photoreceptor the avian compass relies on, so the magnetically sensitive species must form without photons [1 p. 2, ll. 35–39]; and that the receptor, still unidentified in any mammal, must yield a bearing in the dark [1 p. 9, ll. 275–278].

OUR ANALYSIS

### Our conclusion

A clean, well-measured experiment whose central result, the same heading with and without light at take-off, holds up on its own numbers, and whose authors claim no more than it shows. It says nothing about pole shifts, field decline or navigation failing, because it tested none of those things, and the peer-reviewed record on weak-field orientation runs against the episode's reading rather than for it.

Prepared by Fact-Checked Science from the text and supplementary files of Cellarius et al. (2026), bioRxiv 2026.10.07.757263, CC BY-NC 4.0 [1]. No figure of the preprint is reproduced; the compass diagrams and the two scales are drawn from numbers given in the text and the cited sources. The assessment is our own and has not been reviewed by the authors.

## Sources

Bracketed numbers refer to this list. For the preprint [1], p. and pp. are pages of its PDF (1–21), ll. the line numbers printed in its margin, Fig. a figure and Table S1 the table in its first supplementary file. For the episode [2], the time is the position in the video. Table 1 is in [3]; § marks a section of a source. Links checked October 21, 2026.

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2 SpaceWeatherNews (S0) (October 20, 2026). Magnetic Pole Shift Brain Impact, Volcano Warning | S0 News Oct.20.2026. YouTube video. Quoted from the automatically generated transcript; times are positions in the video.

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METHOD

## How this was checked

On October 21, 2026, we checked every statement, number, quotation and citation on this page against its source: the preprint's full text, read in its PDF and web versions, its two supplementary files, the episode's automatically generated transcript, the IGRF-14 coefficient file, the British Geological Survey's IGRF-14 calculator, and the 46 other sources listed here, read as abstracts and publisher records, about 95 items in all. Every number taken from the preprint reproduced: the sample sizes, mean headings, mean vector lengths and p-values, the take-off latencies, the light levels and the darkness arithmetic. The check found one bookkeeping slip in the preprint, which the page notes, and confirmed that its text contains no mention of pole shifts, excursions, reversals or a weakening field. A fresh reviewer then read the built page against the sources, re-ran our calculations and resolved every DOI. That check corrected a garbled word in one transcript quotation, the count of bats (81 tested, 72 headings analysed), the browser title's "navigate", the citation for sunset calibration, the wording of two bat studies' results, the availability of the preprint's code and how close the weak-field experiments come to Laschamp's low, and tightened a dozen smaller statements; the change log lists them.

The verdicts and the items tagged "Our analysis" are our own assessment, built on the cited sources. They cover the Rayleigh p-values recomputed from the sample sizes and vector lengths, the significance circles on the compass diagrams, the count of bats, the magnetic field at the study site computed from IGRF-14, the excursion-level field strengths derived from it, and our reading of how far the preprint's result supports what its authors, and the episode, say about the bats' compass.

The individual headings are not public (the authors offer their data on request), so we re-ran only what the text allows: the Rayleigh tests from the sample sizes and vector lengths, the minutes between the last photon and take-off, the darkness attenuation arithmetic, and the field at the study site from the IGRF-14 coefficients, with a script kept in our verification notes and checked against the British Geological Survey's online IGRF-14 calculator, which gives the same values to within a nanotesla. The supplementary figures were read through their captions and table, not their images. The publisher pages of six of the older papers sat behind cookie walls, so their abstracts were read through Europe PMC.

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

| | |
|---|---|
| **MISREAD** | Cites a real source but gets wrong what it says. |
| **UNVERIFIED** | We couldn't find the source or record it depends on. |
| **PARTLY TRUE** | Part of the claim holds up and part doesn't. |
| **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 21, 2026 | Published on factchecked.science after a full check against the sources. Built from our verification report on the preprint (its full text and both supplementary files), the episode's transcript, the peer-reviewed literature on magnetic compasses, geomagnetic excursions and the breadth of magnetic sensing, and our own IGRF-14 calculation of the field at the study site. Changes after the fresh review: the second transcript quotation in section 4 had lost two letters ("And i' not just the birds") and is now verbatim; the dek and the heading of section 1 say 81 bats were tested and 72 headings analysed, and the limitations say "72 headings"; the browser title says "keep their heading" rather than "navigate", since the preprint tests compass orientation, not navigation; sunset calibration is cited to Lindecke et al. 2019, which demonstrated it, with the 2015 polarised-light study kept for what it shows, and the assay is described as validated through the calibration window; big brown bats' homing is "deflected by a shifted field" and "altered by a magnetic pulse", as the sources say, rather than "disoriented" and "scrambled"; the preprint's analysis code is on request, with only its circular-statistics functions public; the weak-field experiments come within a factor of two of the upper end of Laschamp's range and a factor of four of its lower end, not "within a factor of two of the low"; the IGRF-14 values are compared with the British Geological Survey's calculator rather than unnamed test points; the presenter is "introducing the preprint", since no one here watched what was on screen; the third group is one the authors "do not treat as evidence of a light requirement"; the bookkeeping slip is placed in the dark-acclimated group; the Rayleigh note adds the small-sample p-values; the hybrid-sensor sentence cites the lines where the authors say the radical pair must still be made photochemically; the 70-millilux night is a calculated value; "no coil system is described" replaces "there were no coils"; pulse re-magnetisation is "a diagnostic that could be applied"; the robin field is "under a tenth of their local field"; and the dek names the authors' other institutions. |

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Last updated Oct 21, 2026